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Lesions of the anterior cruciate ligament of the knee and the ICIDH system

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The presentation is intended to call attention to an international registration system that is highly useful in orthopedics as well, in this instance to make a survey of the consequences of lesions of the anterior cruciate ligament of the knee. The patient's requirements or wishes on the one hand, and the residual capacity on the other determine the management with a view to limiting or preventing further damage to the knee joint. Treatment may be either conservative or surgical.

The ICIDH system has been in use since 1986 in the Zwolle registration project. The ICIDH (International Classification of Impairments, Disabilities and Handicaps), composed by the WHO in 1989, describes the consequences of a pathological condition, in this case a lesion of the anterior cruciate ligament. Three levels are to be distinguished; firstly there are impairments: consequences for the organ, the knee joint. These lead at the second level to disabilities, consequences for the person, his body, which at the third level result in a handicap in his social functioning.

Apart from the impairments such as pain, swelling and reduced mobility, disabilities are scored regarding walking on a flat or uneven surface, stairclimbing etc., with manifestations in activities of daily life, housework, occupation and sports. The previously accepted Lysholm disability score was incorporated and plotted against the intensity of activity in the Tegner score. The handicap score indicates the difference between the desired activity score and the score achieved. A patient's handicap score decreases if a treatment succeeds, but also if he resigns himself to a reduced activities level.

The variations of scores on all three levels over the period 1986–1989 are shown. The system not only allows comparison of groups, acute-chronic, partial-total lesion or surgical-conservative treatment, but particularly also discloses the individual result.

Partial lesions appear to have slightly lesser residual consequences than total lesions.

If in the individual case a conservative treatment has the effect that the disability does not become a handicap, that treatment has been successful. It remains part of the orthopedist's task to assess if the damage, although not repaired, is sufficiently limited and if future damage is adequately prevented.

The three levels of the ICIDH are also suitable to describe the process of the evolution of the consequences of a lesion to the locomotor system.

Study of the relationships between 'quality of life' and the waiting for a total hip prosthesis

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Definition of the problem: What is the difference between the 'quality of life' (QofL) before and after a total hip prosthesis (THP) and to what extent is the QofL influenced by the duration of the waiting period?

Method: The QofL was studied with the aid of 4 structured questionnaires and of functional examination in terms of the Harris Hip Score (HHS). The questionnaires were sent out twice, at an interval of 6 months to all females between the ages of 65 and 75 who 1) were on the waiting list and 2) had undergone an operation during the year before. The questionnaires included a request to visit the hospital for function testing.

Results: A total of 295 questionnaires were sent out; the response rate was 80%. The HHS was established in 35% of the patients. All methods indicated that THP leads to a gain in QofL. Statistical analyses revealed no significant relationships between 1) duration of waiting and the QofL after THP and 2) duration of waiting and QofL on the waiting list.

Discussion: Since the QofL is better after the operation, shortening of the waiting list results in a gain of QofL. The possibility of operating the 'worst' patients first excludes

testing of the null hypothesis that the difference increases as the waiting period grows longer. The appropriate method of investigating this is longitudinal study.

The SHP prosthesis, principles of design

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Total hip surgery is success surgery. The main problem that negatively affects the long-term results is mechanical loosening. The Dutch Ortech Group has researched the evolution of loosening and factors influencing it, and on this basis developed a cemented hip prosthesis (the Scientific Hip Prosthesis).

The following design principles were observed:

1. *The isostress principle:* The aim was to design the shape of the prosthesis in such a way that the stresses at the cement-bone interface are distributed as evenly as possible.
2. *The isostrength principle:* All links in the prosthesis-cement-bone system have to be as strong as possible. This principle leads to a number of choices regarding cementing technique, thickness of cement layer, etc.
3. *The reproducibility principle:* Anatomical variations or imperfections of the implantation procedure may cause technical errors. The probability of optimal implantation is increased by a specially developed set of instruments and operation procedure.
4. *The anatomical make-to-measure principle:* The basic measurements of the proximal femur were formulated by means of CT examination, and a realistic prosthesis design was developed on this basis.
5. *The optimal mobility principle:* Wear and tear of components with impingement of parts of the prosthesis may promote loosening.

The present design aims at optimal mobility without impingement, combined with a minimal degree of dislocation.

The first results of implantation of the SHP hip prosthesis

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The Ortech Group (Dr P Jaspers, Dr J Ypma and P Spierings, B Sc) and the Biomechanics Laboratory of the University of Nijmegen (Prof Dr R Huiskes) between 1986 and 1991 developed a new cemented hip prosthesis on the basis of 4 principles: isostrength, isostress, patient-tailored and reproducible implantation.

In a clinical trial, after authorization by the Medical Ethics Committee and patient information, some one hundred hips were implanted between November 1991 and the present.

Cementing was done with lavage, vacuum mixing and pressurizing.

The results of the first 51 hips are presented, with follow-up between 3 and 15 months. There were 49 patients, 34 women and 15 men, with a mean age of 68 years. There were 26 left-sided and 25 right-sided operations, with bilateral operations in 2 women.

The H H score was 43 before operation and 84 after operation.

A difference in leg length of 1 cm occurred in one case. Function was ample. Dislocation, not related to the design of the prosthesis, occurred twice. These dislocations occurred in the first group of implanted hips. They were treated conservatively, without subsequent redislocation.

Among the last 80 hips no further dislocations were seen. In one case, a superficial wound defect healed after intravenous antibiotic treatment.

The radiographs showed that implantation of the prosthesis was adequately predictable, in the AP as well as in the axial projections. The cement encircles the prosthesis beautifully and the cement-bone fusion looks optimal.

Conclusion: Prothesis and surgical technique so far are meeting requirements. Both clinical results and predictability of the implantation are good. Time will have to show whether the biomechanical concept of isostress and isostrength will lead to more protracted fixation compared with conventional prostheses.

The frozen shoulder—conservative management?

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Frozen shoulder (capsulitis) is a clinical syndrome characterized by pain and some limitation of passive and active movement in the glenohumeral articulation. Frozen shoulder occurs mostly in age group 40–70 years, slightly more often in women than in men. Prevalence in this age group is estimated at 12%. The disorder as a rule runs a self-limiting course, but its duration varies from a few months to several years. The literature contains a range of conservative treatments (NSAIDs, exercise therapy, manipulations, physiotechnical applications, local injections of corticosteroids, distention) and surgical therapies (mobilization under anesthesia, arthroscopic distention and open release) which allegedly are efficacious in the treatment of frozen shoulder. The efficacy of both physiotherapy and injections has been insufficiently researched, however. While a fair number of non-randomized studies have been described, there are only

few reports of clinical trials with methodological adequate randomization. Currently, the literature contains no data on the cost effectivity of interventions in frozen shoulder. So far, little or nothing is known about the effect of the various methods of treatment of frozen shoulder on the duration of absenteeism.

The helical CT scan in orthopedics

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In helical CT scanning the scanner makes a continuous rotating movement while the patient is being slid through the tunnel, which results in a helical movement. For serial scanning, single-slice images are made during the patient's horizontal movement.

The helical CT scan in the past 9 months was used in our hospital in 250 orthopedic patients. The three-dimensional images were used in injury cases, often with use of the possibility to rotate the bone or to filter out certain parts to improve insight. Imaging congenital anomalies and performing functional studies were also well possible. The two-dimensional images of the helical CT scan were mostly used in CT arthrography, with air as the contrast medium. In addition, tumors and metastases were traced and CT-guided biopsies performed. Furthermore, these images were used to determine the dimensions of special prostheses. Finally, the images indicated the size of inflammations better than the conventional technique.

In conclusion it may be stated that the helical CT scan provides a good image quickly and with low radiation exposure, but that the resolution and softtissue contrast are less good than with the single-slice technique. As a result of helical CT scanning the treatment schedule was altered in a number of cases. As a rule, the helical CT scanning was requested to replace a conventional technique in view of the lesser exposure of the patient, or to obtain a better insight into the pathology. The helical technique rendered use of the single-slice technique superfluous.

Malignant bone tumors of the pelvis

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A total of 46 patients with malignant bone tumors of the pelvis were seen in Leiden University Hospital in the period 1978 through 1991. There were 27 cases of chondrosarcome, 9 of Ewing sarcome, 6 of osteosarcoma and four of MFH (malignant fibrous histiocytoma). The patients were staged according to the Musculo Skeletal Tumor Society (MSTS) schedule: IA (4), IB (19), IIA (2), IIB (16), III (5).

3 of these 46 patients were not treated: two because they refused treatment for age reasons and one because of extensive metastases. Eleven patients received only radiotherapy and/or chemotherapy.

In the remaining 32 patients tumor resections were carried out 25 times. Most operations involved ample resection interrupting the continuity of the pelvic ring. Some form of reconstruction was performed in 15 patients: arthrodesis (2), saddle prosthesis (4), bone autograft reconstruction (2), allograft reconstruction (7). Hemipelvectomy was carried out in 7 patients. Local recurrences during the follow-up were seen in 8 cases. The strong correlation between local recurrence and the surgical margin is obvious: 3/24 recurrences after ample resection, 4/6 recurrences after marginal resection, 1/2 recurrence after intralesional resection.

At follow-up after an average of 42 months, 20 patients were alive and tumor-free. Of the remaining 26 patients, 14 displayed metastasization of the process (chondrosarcoma 2/27, Ewing sarcome 6/9, osteosarcome 4/6, MFH 2/4); 5 of the 26 patients were still alive with a recurrence and/or metastases, 21 had died of the disease. Of the patients treated surgically, only 8 developed complications (5 after hemipelvectomy and 3 after resection): 4 cases of impaired wound healing, 3 infections and 1 dislocation of the saddle prosthesis. With the exception of the dislocated saddle prosthesis, all these complications could be treated adequately.

The postoperative results were assessed according to the MSTS schedule: the functional results in the group of 25 resection patients: excellent (9), good (8), fair (2), poor (1), not applicable (5); stability of the pelvic ring after resection: excellent (13), good (4), fair (3), poor (0), not applicable (5). Emotional acceptance after resection: excellent (9), good (6), fair (5), poor (0), not applicable (5). This was better than the acceptance after hemipelvectomy: excellent (1), good (2), fair (1), poor (1), not applicable (2). The disease-free survival in our series was: chondrosarcoma 56%, Ewing sarcoma 33%, osteosarcoma 17% (mean free interval 49 [1–230] months). Although the prognosis relates to the type and grading of the tumor, the surgical margin and the tumor localization are the principal parameters of the probability of developing a recurrence. In 5 of the 8 patients with a recurrence, contamination of the wound area had occurred during the operation. Patients cope better emotionally with resection in the pelvis than with hemipelvectomy.

In this series, performance of a resection with reconstruction during one session resulted in a smaller number of complications in spite of the longer duration of the operation.

Posterior glenoid osteotomy for treatment of habitual posterior subluxation of the shoulder

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This retrospective study is concerned with 13 shoulders in 9 patients subjected to posterior glenoid osteotomy with crest bone grafting because of habitual posterior subluxation of the shoulder. Patients with multidirectional instability or voluntary subluxations that could be related to a personality or psychiatric disorder were not operated. Follow-up ranged from 2 to 151 months. The results were assessed on the basis of subjective and objective scores and radiographic examination. The results were classified as good, fair or poor. There were no poor results. One woman with generalized articular laxity, subjected to bilateral operation, developed a recurrence in her right shoulder 5 months postoperatively. After intensive physical therapy no further dislocation occurred; there was a tendency to subluxation which, however, she could control completely. This result was classified as fair. None of the other patients had pain or showed signs of osteoarthrosis. All had normal mobility and could do their jobs without impairment. They were classified as good. In our opinion, posterior glenoid osteotomy with implantation of a crest bone graft, without additional capsular reef or infraspinatus plasty, given careful performance, constitutes a good method of surgical treatment of habitual posterior subluxation of the shoulder.

The Mecron screw cup in total hip arthroplasties—results after 3–7 years

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In the period 1984–1989 we performed 411 total hip arthroplasties using the uncoated Titanium Mecron cup (Mecring) in combination with a cemented Stanmore femoral component. The indications for implantation of the Mecring were patients up to age 70, acetabular protrusion and revision arthroplasty. Contraindications were poor bone quality and an incomplete acetabular ring. 331 patients (378 hips) were available for clinical and radiographic follow-up after a mean duration of 4.5 (3–7) years. Mean age was 63 (26–91) years. The preoperative diagnoses were coxarthrosis in 85%, avascular bone necrosis in 3%, revision arthroplasty in 4% and 'other' in 8% of the cases. The mean Harris Hip score was 91; good to excellent clinical results were seen in 82% of the total group. Contrary to these favorable findings we observed a disappointingly large proportion of radiological detachments. 31% of the 7-year follow-up group showed migration, although without major clinical symptoms in the majority of the cases. At conclusion of the study 21 hips (6%) had been revised. Migration was seen more frequently in females, in patients younger than 50 years, after revision arthroplasty and in case of incomplete containment of the cup.

Conclusion: The disappointingly large proportion of radiological detachments forced us to discontinue use of the Mecring in this form.

Total knee prosthesis—should the patella be replaced?

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Formulation of the question: Are the clinical results, frequency of complications and/or number of reinterventions because of patellofemoral problems affected by whether or not the Miller Galante knee arthroplasty includes insertion of a patellar prosthesis, and does the type of patella play a part?

A retrospective multicenter trial involved follow-up in 3 comparable groups (a total of 219 Miller Galante I-knee prostheses) after 2 to 6 years. There were 68 knees with a metal backed patellar component, 83 with a full polyethylene patella and 68 knees in which no patellar prosthesis was implanted. The population consisted of 182 female and 37 male knees with the following indications for operation: primary osteoarthrosis 175 times, rheumatoid arthritis 32 times and other indications 12 times. Mean age was 69 years.

The groups were found not to differ with regard to pain score, range of movement, mobility, limitation of extension, extension deficit, walking distance and/or stair-climbing (determined according to the new Insall Knee Score). Patellofemoral complications such as patellar fractures, patellar dislocation and patellar lateralization were also distributed proportionally and independent of the pre- or postoperative axial position. The frequency of reintervention for patellofemoral problems was the same in the groups with and without a patellar prosthesis, with the metal-backed patella scoring better in spite of longer follow-up. Lateral release (95 times) was accompanied by a larger number of complications.

Clinical results of perichondrial grafting in cartilaginous lesions in the knee

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Introduction: In Maastricht University Hospital 88 patients with a cartilaginous defect in the knee were treated with perichondrial grafting from September 1968 to December 1992 inclusive. No exclusion criteria were applied. Even patients with osteoarthrosis, instability, earlier cleansing interventions or meniscectomies were operated. 70 patients presented an isolated defect. In 18 patients, two defects in the same knee were grafted. In 13 patients, the perichondrial grafting was combined with a supplementary intervention, such as plastic repair of the anterior cruciate ligament or a meniscectomy. The results were evaluated by means of HSS knee scores, radiographic examination, arthroscopy and patients' subjective assessments. Several biopsy samples were collected for histological examination.

Results: Mean duration of follow-up was 52 (14–80) months. Mean age of the patients at the time of the operation was 31 (15–54) years. Location of the grafts: patella in 37, medial femoral condyle 28, lateral femoral condyle 2, trochlea 3, double grafts at different locations 18. Overall results for the (heterogeneous) group as a whole (N 88): good results in 33, fair results in 7, poor results in 48. The isolated patellar grafts failed in 23 out of 37. Of the isolated medial femoral condyle grafts, 10 out of 28 failed. 14 out of 18 of the double grafts failed. The main cause of failure was found to be loosening of the graft: in the group as a whole 24 out of 88 of the grafts loosened in the course of time, patellar grafts markedly more frequently than the MFC grafts (32% and 21%, respectively). In 10 out of 88 failure was due to the graft expanding to form a a hard embossment. Radiographically, it was found that Indocid medication, 25 mg 3 dd for 2 weeks, distinctly counteracted calcification of the graft. Instability of the knee, earlier meniscectomy, combination of the perichondrial grafting with other forms of knee surgery, synovitis and size of the graft proved not to affect the clinical results in our series. On the other hand, adverse effects were observed of earlier drilling or shaving of the defect, longer preoperative duration of symptoms and age over 40 years. Osteochondritis dissecans and traumatic cartilaginous injuries proved to be a good indication for perichondrial grafting. Two grafts in one knee as a rule led to poor results. Osteoarthrosis of more than IInd degree (slightly fibrillated) in other parts of the knee was found to constitute an absolute contraindication to perform perichondrial grafting. In none of the cases of this nature was a good result achieved.

Conclusions: We achieved the best results in our series in the isolated cartilaginous lesions of the medial femoral condyle without further evident osteoarthrosis in the knee. Results were good in 54% of the cases, fair in 11% and poor in 35%. The present improved surgical technique is expected to lead to even better results. The graft should be thin, with perforations to prevent its being forced loose by a hematoma beneath the graft. Low-calcium fibrin glue should be used. No hinged cast. Indocid medication if possible. Currently, animal studies are being evaluated regarding the effect of a layer of biological material between the subchondral bone and the graft in preventing calcification of the perichondrial graft which sometimes proceeds from the subchondral bone.

A new technique for fixation of the supracondylar varus-inducing femoral osteotomy

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Lateral compartment arthrosis of the knee with a valgus position occurs less frequently in non-rheumatic patients than medial gonarthrosis with a varus position. There is consensus in the literature that in such cases supracondylar varus-inducing osteotomies give better results than tibial osteotomies. The fixation of supracondylar osteotomies is difficult, however. This is probably the reason why this osteotomy has never gained much popularity. We have developed a simple fixation technique for this osteotomy: a vitallium plate is anchored in the condylar block and fixed with screws. We have used this technique in 10 patients since 1981. Consolidation without deterioration of position was achieved within 3 months in 9 of these patients. In 8 of these, the duration of follow-up was sufficient for assessment of the effect of this operation. Implantation of a total-knee prosthesis was necessary in 1 patient 1 year after the operation. In the other 7, this operation gave good results.

We recommend this operation for young patients with lateral gonarthrosis and a valgus deviation of the knee.

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BASIC SCIENCE

Studies on endothelial function in isolated bone arteries

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Introduction: Vascular endothelium can release both vasoconstrictory and vasodilatatory substances and thereby modulate vascular tone. We have established a method for investigation of vascular reactivity in bone tissue by direct observation of isolated bone arteries (1). The purpose of this study was to investigate endothelial function in isolated bone arteries.

Materials and methods: The distal femur was removed from anesthetized pigs (65–85 kg) immediately post mortem and the condyles were sliced sagittally. Arteries (diameter ca 250 µm) were dissected from the epiphyseal cancellous bone and mounted as ring preparations on a small vessel myograph for investigation of isometric force development (2). The test chamber contained oxygenated physiological saline at 37 °C. The arteries were passively stretched to a degree, that allowed optimal active force development (1). Submaximal contraction was induced with noradrenaline before cumulative addition of acetylcholine (Ach, 10^{-8}–10^{-4} M), bradykinin (BK, 10^{-11}–10^{-6} M) and calcitonin gene-related peptide (CGRP, 10^{-9}–10^{-7} M). The vasorelaxing effects were investigated with repeated stimulation and after mechanical removal of the endothelium.

Results: Ach. Only 2 of 14 vessels relaxed to Ach, i e to 68% and 75% of the precontraction level, respectively. *BK* induced a concentration dependent, fully reproducible, vasorelaxation in all vessels. Maximal concentration induced relaxation to 35% of precontractions (mean of 22 vessels). No relaxation was found after endothelial removal (9 vessels). *CGRP* induced vasorelaxation, which was still pronounced after endothelial removal (9 vessels). This indicates that CGRP has a direct effect on the smooth muscle cells.

Conclusions: We have demonstrated preserved endothelial function in isolated bone arteries. The vasorelaxing effect of BK, but not CGRP, was dependent on endothelial function. The inconstant effect of Ach was not due to endothelial damage since all vessels relaxed to BK prior to endothelial removal. BK is ideal for assessment of endothelial function in bone arteries because the induced relaxation is reproducible and mediated through the endothelium.

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Axial versus peripheral skeletal blood flow

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Aim: To compare the distribution of blood flow between the axial and the peripheral skeleton and to determine whether this distribution shifts during physical exercise.

Material and methods: 6 Göttingen miniature pigs, 18 months, 38–42 kg, were catheterized chronically in the left cardiac ventricle and the descending aorta. Blood flow was measured with radioactively labelled microspheres at rest, after 15 min exercise at 3 km/h, and at rest again 30 min after exercise. All vertebral bodies were removed and separated into end plates, cancellous bone, and the cortical shell. Scapula, pelvis, humerus, femur, and tibia were dissected into a number of well defined cancellous and cortical zones. In addition, the femoral and tibial diaphyseal cortex was separated into endosteal and periosteal shells. Regional blood flow was calculated and analyzed by ANOVA and Students *t*-test.

Results: There was a slight blood flow gradient along the vertebral column. Blood flow was significantly and substantially greater in the axial skeleton in cortical as well as cancellous bone. No significant redistribution of skeletal blood flow was observed during exercise. Hyperemia prevailed post exercise in vertebral spongiosa and cortex, but not in vertebral end plates. The same was true in pelvic spongiosa

and in tibial cortex, particularly in the innermost endosteal shell.

Blood flow in mL/min/100g, mean SEM

	Cortex		Spongiosa		Total	
Vertebrae	22.9	2.0	30.9	3.4	21.6	1.8
Scapula	6.7	1.3	28.1	4.7	8.6	1.8
Pelvis	7.3	0.9	19.6	2.8	10.8	1.4
Humerus	3.6	0.5	18.5	2.1	9.3	1.1
Femur	4.8	0.4	13.6	2.2	6.6	1.3
Tibia	1.4	0.3	4.9	1.0	3.3	0.6

Discussion: Bone blood flow is substantially greater in the axial skeleton than in long bones of the extremities, presumably due to a faster turnover of axial bone, consistent with the preferential involvement of the axial skeleton in osteoporosis. Moderate exercise does not appear to induce major shifts in skeletal blood flow.

Hemodynamic domain of the nutrient artery in the artificially perfused porcine tibia

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Introduction: An artificially perfused tibia has been used in vivo or in vitro for investigation of the pharmacology of the bone circulation (1,2,3). We investigated the following questions concerning the bone blood supply of an in situ artificially perfused porcine tibia (4):

1. Is the total blood flow and the regional blood flow distribution of the prepared tibia comparable with that of the normal tibia?

2. What is the vascular domain of the nutrient artery (TNA), i e what fraction of total tibial blood flow is delivered through the TNA, and how is that fraction distributed among regions within tibia?

3. Can alternative supply routes compensate for the loss of TNA?

Material and methods: 8 landrace pigs of both sexes, 50–55 kg, were used. TNA of one tibia was exposed, catheterized, and supplied with blood from the left carotid artery through a constant volume pulsatile infusion pump. Bone blood flow estimates were made using the radiolabelled microsphere technique serially (5). The first microsphere injection was performed 30 minutes after steady state of the perfused tibia during perfusion of the tibia with blood from the extracorporal circuit. During the second microsphere injection the perfusion pump was fed with freshly drawn arterial blood kept in an external blood reservoir without microspheres. The third microsphere injection followed 30 min after shut down of the TNA supply. Both tibiae were isolated and divided into 23 well defined anatomical regions.

Results: The total flow in the artificially perfused tibia was lower than that of the control tibia by 28 ± 4% ($p < 0.001$). Overall TNA delivered 17 ± 3% of the tibial blood supply. In the tibial shaft (diaphysis + metaphyses) the percentage of blood deriving from the TNA was 30 ± 5% in the cortical bone and 42 ± 9% in the central shaft (marrow and spongiosa). TNA favoured diaphyseal over metaphyseal cortex and endosteal over periosteal cortex, while the distribution of the TNA blood supply to central shafts favoured central diaphyseal marrow over proximal and distal metaphyseal spongiosa. The blood flow to tibia was normalized 30 min after closure of TNA.

Conclusion: The artificially perfused tibia had an altered flow distribution suggestive of vasoconstriction in the TNA domain. However, no parts of the bone were ischemic. TNA supplies one fifth of the tibia with preference for the diaphysis and marrow and spongiosa. Alternative supply routes readily take over when the TNA perfusion is lost.

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Serological markers of type I and III collagen turnover following tibial fractures

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Introduction: Types I and III collagen are key elements in fracture repair. The serumconcentration of the carboxy-terminal propeptide of type I procollagen (PICP) reflects type I collagen synthesis, and the serumconcentration of the carboxy-terminal telopeptide of type I collagen (ICTP) reflects type I collagen degradation. The serumconcentration of the aminoterminale propeptide of type III procollagen (PIIINP) reflects type III collagen turnover.

The aim of the study was to describe the sequential appearence of serum-PICP, -ICTP and -PIIINP following tibial fractures.

Material and methods: 8 patients with fracture in the tibial condyles and 16 patients with fracture in corpus tibiae were included. Blood samples were collected at admittance and during fracture healing and analysied for PICP, ICTP and PIIINP with RIA-technique.

Results: Condyle fractures: PIIINP increased after 4 days

with maximum after 2 weeks. PICP increased after 1 week with maximum after 6 weeks. Corpus fractures: PIIINP increased after 1 week with maximum after 2 weeks. PICP increased after 1 week with maximum after 2 weeks. In both groups ICTP increased after 4 days with maximum after 2 weeks. No parameters were significantly elevated after 26 weeks.

Conclusion: Similar sequential changes of serum-PICP, -PIIINP and -ICTP were found in the 2 groups. We conclude that changes of serum-PICP, -PIIINP and -ICTP may reflect fracture healing in humans.

Induction of c-fos by growth factors in human osteoblast-like cultures A comparison of osteoarthritis, rheumatoid arthritis and normal cells

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Introduction: Old patients and patients with rheumatoid arthritis (ra) on steroid therapy have a low bone turnover. Current knowledge suggests that proto-oncogenes, among these c-fos may be responsible for the control of normal cell proliferation. We have studied the induction pattern of c-fos by serum growth factors in osteoblast-like (hOB) cultures derived from patients with osteoarthritis (oa) or ra. These cultures were compared with controls.

Materials and methods: Cultures were obtained from 6 patients aged 54–83 years with o a, 5 patients aged 24–66 years with r a and 4 normal patients aged 23–69 years. The culture medium used is minimal essential medium containing 10% fetal calf serum (FCS). On day 3 the medium was replaced with serum free medium. After 24 h, cells were stimulated for different time periods by adding medium supplemented with 10% FCS. The cells were then harvested at intervals of 15 min for isolation of RNA (Chomczynsky and Sacchi, 1987). At each time point l0 µg of RNA were electrophoresed and transferred to nylon filters. The filters were hybridized with c-fos DNA. The relative amounts of the mRNAs were determined against GAPDH expression by densitometric analysis of the autoradiographs developed from the Northern blots.

Results: The serum stimulatioń of quiescent normal hOB resulted in c-fos expression after 15 min with an increase to a maximum at 30 min. The level of c-fos mRNA decrease to almost undetectable levels by 75 min poststimulation. The above described pattern showed to be the same for both oa and ra hOB. If we considered the age of the donors the pattern of c-fos mRNA expression was the same.

Discussion: The present data indicate that the c-fos gene induction by serum growth factors is not affected by aging. The data also indicate that hOB cultures derived from oa or ra do not differ from normal hOB cultures regarding c-fos gene expression. The low bone turnover in older people and in ra patients under steroid therapy may be found in the genes controlling the maturation of osteoblast and the mineralization process of bone matrix i e alkaline phosphatase and osteocalcin. But it is also warranted to investigate the expression of the other proto-oncogenes in bone i e c-jun and c-src.

The effect of flow on thrombus formation at an arterial repair site

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Introduction: Failure following replant or free flap surgery is often due to thrombotic occlusion at the site of microvascular repair. Following arterial anastomoses reconstructive surgeons prefer to reperfuse the reconnected artery with maximal flow velocity. This technique is based on the assumption that more flow minimizes the threat of thrombus formation, however controlled studies have not been done to substantiate this.

Methods: At the iliac artery (1–1.2 mm) in 20 male Sprague Dawley rats (275–300 g) an incisional arteriotomy was made through 1/3 of its circumference. To create a reproducible thrombogenic injury which would provide large but not occlusive thrombi a technique was used which surgically invert a full thickness lip of the arterial wall into the lumen. To vary flow velocity aaoss the thrombogenic injury an adjustable clamp was placed on the abdominal aorta upstream (n 10) and applied until the pressure was reduced to half its original value. The flow was measured using an ultrasound flowmeter (Transonic). To continuously visualize and measure thrombus formation in the iliac artery a specially designed fiberoptic transilluminating device was placed under the artery directly beneath the site of arterial injury. The transilluminated image was viewed by a stereo microscope (x30), recorded on a video tape for 60 minutes and subsequently analyzed using a computer-assisted grey level analysis system designed for this purpose.

Results: In the low flow group the mean thrombus size was 0.28 ± 0.08 mm^2. This is not significantly different from 0.15 ± 0.04 mm^2 in the normal flow group. The thrombus reaches its maximum size after 7 ± 3 minutes in the normal flow group which is significantly ($p < 0.05$) faster than 25 ± 8 minutes in the low flow group.

Conclusion: In our model reduction in blood flow across a thrombogenic arterial injury does not affect thrombus sizes, however, it does decrease thrombus growth rate. The model is a valuable tool for quantitatively analyzing the effect of potential treatment modalities for preventing thrombosis following microsurgical arterial repair.

SPINE

Thoraco-lumbo-sacral spondylodesis (Cotrel-Dubousset technique) in children with neuromuscular scoliosis

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Spondylodesis is performed to correct pathological spinal angling in both planes, improve posture and avoid the need for a brace. 18 patients aged 12–20 underwent surgery. The diagnoses were myelomeningocele (1), Duchennes muscular dystrophy (7), other types of muscular dystrophy or spinal atrophy (4), cerebral palsy (4), and traumatic plegia (2). The curves were measured according to Cobb from 33 to 134 degrees. The spondylodesis was performed through a posterior middle line incision with resection of facet joints. The Cotrel-Debousset (CD)-instrumentation was distally fixated to sacral blocks with screws to the promontory and lateral mass. In the lumbar spine pedicular screws at 2 levels with transverse plates were inserted. In the thoracic spine the rods were fixated to pedicular and laminar hooks. In cases without very rigid curves the correction was performed as derotation, re-establishing the sagittal balance. The proximal and distal constructions were connected establishing the frontal balance. Postoperatively, curves measured from 10 to 82 degrees. The patients were followed for 3–24 months. Radiologically sacral screw retraction could be demonstrated in 8 patients. 3 were reoperated due to definite loosening of a sacral block. After changing the procedure to insertion of iliac screws and 6 months of postoperative bracing there have been no problems with the instrumentation. All patients and their relatives were satisfied with the outcome of treatment.

Back complaints in conscripts A 10-year follow-up

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Purpose: To investigate the significance of back complaints in conscripts after session.

Material and methods: 92 former conscripts returned a questionnaire, identical with one already answered 10 years before. The conscripts consisted of 3 groups in 1979: Group A: 28 back-rejects (BR) (19 Scheuermann's Disease (SD), 6 Scoliosis columnae lumbalis and 3 discdegeneration. Group B: 28 non-back-rejects (nBR), but with back complaints. Group C: 36 conscripts who never have had back complaints (control group). Group B and C fulfilled their national service.

Results: After national service or rejection, all in group A had back-pain compared to 6 (21%) in group B and 3 (8%) in group C. In 1989 23 (82%; 17 SD) in group A had back-pain within the last year compared to 15 (54%) in group B and 10 (28%) in group C. The difference between group A and C and between A and B were significant ($p < 0.05$). 8 (5 SD) in group A had radiation of pain to the lower extremities in 1989 compared to 4 (2 SD) in 1979. There were none with radiating pain in group B and C. 14 (9 SD) had been reported sick compared to 6 in group B and 4 in group C; correspondingly in 1979: 9 (5 SD) in group A, 15 in group B and 0 in group C. The difference between group A and C and between A and B were significant ($p < 0.05$) in 1989. There were no significant increment within the groups from 1979–1989.

Conclusion: Our study shows no significant changes in the back-symptoms 10 years after back-rejection.

TRAUMA

Intramedullary nailing of tibial fractures

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Material: 41 patients were treated with 45 reamed intramedullary intralocked Grosse-Kempf nails for tibial fractures. All patients were reviewed (follow-up 32 months).

Results: In 31 cases, intramedullary nailing was the primary treatment. Patients were mobilized/weight-bearing at 4/9 days. Healing was obtained in 27 fractures after 6.4 months (312). Alignment and length was retained, and patients received a good functional result. Complications: 2 fracture dislocations, 2 broken nails, one with non-union, 1 deep infection and 1 peroneus pareses. In 14 cases of secondary treatment, healing was obtained in 11 fractures after 7.3 (4–15) months with a good functional result. Complications: 1 refracture, 4 deep infections and one non-union. 3 out of 4 deep infections occurred in patients who had pin-site infection after external fixation.

Conclusions: Pin-site infection seems to be a contraindication to the subsequent use of intramedullary nailing. A principal problem was anterior knee pain in two thirds of the cases. To avoid this, it seems important to bury the nail in the tibial cortex and to avoid splitting the patella tendon. Generally patients were satisfied with the treatment, and we found it to be a good method for treating fresh fractures, non-unions and delayed unions of the tibia.

Infections in traumatic wounds treated with primary closure by suture repair in the accident department

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The aim of this study was to determine the rate of infection in traumatic wounds treated in the accident department with suture repair, and to try to relate infections to the age of the patient, the body locale and the length, type and age of the wound.

Materials and methods: Included were all patients with suture-demanding wounds, who agreed to participate. Excluded were inebriated patients, senile patients, and patients who did not live in Denmark. Bite wounds were excluded. The wounds were all cleaned by scrubbing with soap and water followed by saline irrigation. Nylon suture was used for skin closure. The patients were sent to their private physician for suture removal and wound valuation. A brought questionnaire concerning signs of infections was filled in by the physician and returned to the accident department. If the questionnaire was not returned a second one was sent out to the patient. Wounds were considered infected if they showed pus.

Results: 2059 patients with 2094 wounds were included. Median age 29 (1–92) years. Length of wounds 2 (1–16) cm. Mean time from wounding to repair 1 (1–24) hours. 81.5% of the questionnaires were returned. 192 wounds were infected (11.4% of the patients). Head wounds were significantly less infected than wounds in other body locales ($p < 0.01$). Infection was significantly higher in age group 21–60 compared to age 1–20 and age 61–92 ($p < 0.01$). There was no difference between age group 1–20 and age group 61–92. Blunt injuries were significantly more infected than sharp ($p < 0.01$). We found a significant correlation between length of wound and infection (Spearman test: $p = 0.011$).

Wound healing time is not directly proportional to wound size

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Introduction: The relationship between wound size and healing rate is important for understanding the mechanisms in the healing process. The purpose of this study is:

1) to measure the rate of epithelialization and neovascularization in 2 differently sized concentric full thickness wounds at the ear of the hairless mouse, and
2) to determine the degree of wound contraction in this model.

Methods: Bilateral concentric full thickness wounds (diameter 2.25 mm and 4.00 mm) were created on the dorsum of the ears of 11 adult male hairless mice (8–12 weeks, 20–30 gr). Epidermal and subcutaneous tissue were removed, down to the cartilage. Epithelialization and neovascularization were measured every third day using intravital video microscopy and computer assisted planimetry. The degree of wound contraction was measured by means of tatoomarks the following 9 days.

Results: 2.25 mm and 4.00 mm diameter wounds epithelialized in 10.2 ± 0.4 and 12.4 ± 0.5 days, and neovascularized in 20.8 ± 0.4 and 24.0 ± 0.7 days, respectively (values given as mean ± SEM, $p < 0.05$). The average rate of epithelialization was 0.47 mm^2/day in small wounds. In large wounds the average rate of epithelialization was 1.00 mm^2/day until the wounds were reduced to the initial size of small wounds. The rate of epithelialization in the large wounds was from this point reduced to 0.50 mm^2/day. The average rate of neovascularization was 0.23 mm^2/day in small wounds, whereas it was 0.48 mm^2/day in large wounds. We found no sign of contraction.

Conclusion: Wound healing time in non-contracting full thickness wounds in the hairless mouse ear wound model is relatively faster in large wounds than in smaller wounds. This applies to both epithelialization and neovascularization.

Prophylactic antibiotics in Danish orthopedics

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Introduction: A department selects the prophylactic antibiotics to use in the department by itself or in cooperation with the local microbiological department. The aim of this study was to investigate the choice of prophylactic antibiotics in ortopedic at Danish hospitals and to illuminate eventual dissimilarities between the departments as a potentially causal relation for postoperative wound infections.

Materials and methods: From January to April 1993 questionnaires were sent out and collected from all Danish departments with orthopedic function. The departments was asked about their recommended routine of prophylactic antibiotics to various major orthopedic operations. Futhermore, the departments were asked about their use of gentamicin-impregnated bone cement (GBC) for arthroplasty and indications for this use.

Results: 56 departments (93.3%) returned the questionnaire. In primary total hip arthroplasty the choice of prophylactic antibiotics is penicillinase-resistant penicillins (PRP) in 28 departments, second generation cephalosporins (2.CF) in 11 departments and other antibiotics in 3 departments. The antibiotic prophylaxis is added GBC in 3.3 and 0

departments, respectively. Same pattern is seen in primary total knee arthroplasty. In revision arthroplasty or arthroplasty, after failure of a osteosynthesis, the departments combine with GBC in 89% and 61% respectively. In osteosynthesis of hip fractures 20 departments use PRP, 11 use 2.CF and 1 uses penicillin G. 23 departments do not use antibiotic prophylaxis in this type of osteosynthesis. In amputations 7 departments do not use antibiotic prophylaxis, 15 use PRP, 15 use 2.CF, 17 use penicillin G and 5 departments use other antibiotics. The figures conceal a few antibiotics in combination.

Conclusion: In relation to the recommended use of prophylactic antibiotics in the literature, Danish departments use the recommended in arthroplastic surgery. In osteosynthesis of hip fractures recommended is used, though this is due to some controversy in the litterature. In amputations some departments do not use the recommended.

The role of serum alkaline phosphatase in diagnosing infections related to orthopedic surgery

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Introduction: Alkaline Phosphatase (AP) can react as an "acute phase reactant", and raised values of AP are frequently associated with acute extrahepatic infection[1]. In order to determine the value of AP in diagnosing infections related to orthopedic surgery we wanted to establish the course of AP together with other parameters indicating infection in relation to a major orthopedic operation.

Materials and methods: 6 patients with implantation of total hip arthroplasty, 5 patients with implantation of total knee arthroplasty and 5 patients operated for lumbar disc herniation were included. Blood-samples for analysis of AP, sedimentation rate and white cell count were taken the day before operation, and at every second day afterwards, until the patients were discharged. The methods of anestesia and clinical signs of infection were registered.

Results: None of the patients showed major clinical signs of infection. Mean values of AP declined 25% on the first postoperative day, but were normalized after approximately 2 weeks. However, in 4 patients with slight seeping from drains and/or elevated sedimentary reaction AP was still raised 2 weeks postoperatively. The method of anestesia did not seem to affect the above mentioned course of AP.

The role of arthroplasty-cementation, duration of operation, bone destruction, infectious ethiology and Low-Molecular-Weight Heparins on the course of AP are due to be analyzed in a contemplated study.

Reference: 1. Parker S G. Postgrad Med J 1991; 67: 638–642.

25% Cod Liver Oil ointment accelerates wound heling

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Introduction: Cod Liver ointment consists of Vitamin A, Vitamin D and polyunsaturated fatty acids and Vaseline. It is used clinically although the effect has never been proven. The aim of this study was to evaluate and quantitate the effect of 25% Cod Liver ointment to accelerate reepithelialization and angiogenesis in healing wounds.

Methods: In order to measure angiogenesis and reepithelialization we used the Hairless mouse ear wound model which permits direct visualization and repeated measurements of these processes throughout the healing process. Under anesthesia bilateral standardized full thickness dermal wounds (2.25 mm diameter; 0.125 mm depth) were created, with a circular punch-type knife, on the dorsal anterior part of the mouse ear. After creating bilateral standardized wounds the mice were divided into 3 experimental groups. Group 1: 25% Cod Liver Oil ointment (n 8) was applied on one ear and Vaseline (n 8) was applied on the contralateral control ear. Group 2: 25% Cod Liver Oil ointment (n 10) on one ear and saline (n 9) on the contralateral ear and finally Group 3 recieved saline (n 7) versus Vaseline (n 4). The wound sizes were recorded the day of wounding and hereafter every third day until epithelialization and angiogenesis were completed using an in-vivo microscope. The wound images were digitalized using a frame grabber. The wound areas were hereafter calculated using an image software package (Optimas 4.0).

Results: Wounds receiving 25% Cod Liver ointment on one ear epithelialized significantly faster (Mean ± SEM), (8.9 ± 0.72 days) than the control ears receiving Vaseline (13.9 ± 1.86 days) ($p < 0.05$; Students t-test). Angiogenesis was significantly faster on the Cod Liver ointment treated ears (22.5 ± 1.32 days) compaired with Vaseline (29.1 ± 0.55 days); $p < 0.001$), we also found sigificant difference between Cod Liver Oil ointment (23.1 ± 1.72 days) compaired with Saline (26.9 ± 1.40 days) ($p < 0.05$).

Conclusion: In full thickness wounds topical therapy with 25% Cod Liver oil ointment significantly accelerates the epithelial component compaired with Vaseline. The vascular component of healing is faster compared with both saline and Vaselin treatment. We found no difference between Vaseline and saline treatment.

Changed pattern of injuries in a casualty department after new principles for the practitioner (GP)-on-call system

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Introduction: At the 1st of January 1992 new principles for the GP-on-call system was established all over Denmark. The new principles implied a change from several GP's-on-call spread all over the country to few units of GP's typically located in the county hospitals. There has been contradictory informations about changes in the number of patients consulting the casualty department after the introduction of this new GP-system.

Materials: We present an analysis of the patient-data in the casualty department before and after January 1992 and make comparisons with the changes in the number of services rendered by the practitioner on call.

Results: The total number of patients consulting the GP-on-call decreased markedly with 39% in 1992 and 21% in 1993 after establishing the new system. On the other hand, the total number of services rendered by the casualty department was unchanged since 1991, but the part of injuries older than 24 hours increased significantly outside working hours. In general we observed a decline in the number of fractures and distorsions/ruptures, which perhaps could contribute to a similar decline in the number of acute admission to the hospital, which we also observed. The share of wounds increased in 1992 and 1993, probably due to the fact that the GP-on-call now is located just beside the casualty department, where the facilities for treatment of wounds are more accessible.

Results of open treatment of unstable fractures of the pelvic ring and acetabular fractures using the Mears sacroiliac plate and Letournel plating

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Introduction: 37 patients (median age 26 years) with unstable fractures of the pelvic ring and/or acetabular fractures were treated operatively.

Material: 25 patients with pelvic ring disruptions or pelvic ring disruption combined with an acetabular fracture. 12 patients had solely acetabular fractures. The strategy of treatment included restoration of the pelvic ring by open reduction and anterior and/or posterior plating. 70% had other lesions needing surgical intervention.

Results: Median follow-up: 20 (12–36) months. All fractures healed primarely and there were none with secondary dislocation or failure of the implants. No one developed DVT or deep infection. 4 had developed athrosis of the hip and 6 had pain requiring medication. Only 2 patients had severe neurological deficits. 8 patients had reduced movements in the hip and 9 patients had a median difference in leg-length of 1 cm. 81% were able to work after median 34 weeks and 1/3 did some kind of sport at follow-up. Visual analogue scale were applied to evaluate the pain in the pelvis, the legs and the back.

Conclusion: It is concluded that the outcome of early rigid stabilization of unstable pelvic ring fractures and acetabular fractures is good.

KNEE

Arthroscopy in Denmark 1992 A national inquiry

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Arthroscopy of especially the knee joint in diagnostics and treatment gradually has become routine in the orthopedic departments all over Denmark.

With the purpose of creating a survey of the arthroscopic activity in Denmark in 1992, a questionnaire was sent to 32 orthopedic departments and 26 departments of generel surgery.

52 departments out of the 58 invited answered the questionnaire, 28 of these were orthopedic units (overall reply rate 90%). 7 of the departments of general surgery answered that they did not perform arthroscopic surgery. Private arthroscopists were not included in the primary study.

The departments had great difficulties in finding the figures, since only 9 of the units were using protocols to register their activity. The total number of arthroscopies in 1992 was 15,304 (knee 14,360, shoulder 498, elbow 194, wrist 10, hip 9, ankle 235). The incidences of knee arthroscopy in the 16 Danish counties varied from 89–450 per 100,000 inhabitants. Great variations in pre- per-, and postoperative procedures in connection to knee arthroscopy were found. 49% of the departments were doing a preoperative radiograph of the knee as a routine, 56% of the units offered their patients a postoperative examination in the out-patient clinic. In 69% of the 45 departments, the patients were offered instruction by a physiotherapist as a routine. 56% of the departments performed arthroscopy in less than a week posttraumatically in case of hemarthrosis of the knee. 29 of the hospitals performed ACL reconstruction, 12 of these departments did the operation arthroscopically. Usually a bonetendon-bone graft was used. 23 (51%) of the departments did all their meniscus resections arthroscopically. The incidence of arthrotomy in meniscal tears for the remaining

22 departments varied from 1–100%. 33 departments performed suture of suitable meniscal tears arthroscopically. The 498 shoulder arthroscopies were performed in 24 departments who did from 2–100 shoulders per year. 12 of these units did arthroscopic operation in case of recurrent shoulder dislocation, 14 departments performed subacromial decompression arthroscopically.

The most surprising finding in our inquiry was the incidence of arthrotomy in meniscal tears as mentioned above, since no meniscal tears should require arthrotomy for resection.

As a consequence of these findings and the great variations in procedures, we propose a Danish Arthroscopy Group under the Danish Orthopedic Society with the specific purpose of supervising the Danish arthroscopists and making educational arrangements.

The effect of inforatio on pain in the arthrotic knee

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Introduction: Severe rest pain characteristic of advanced arthrosis of knee joint is postulated or documented to be due to the abnormally high intraosseous pressure (1). In order to reduce intraosseous pressure a Rush-pin predrill is advanced through the cortex to subchondral bone. The purpose of the study was to evaluate the long time effect of pain reduction in knees with arthrosis by a minor surgical procedure, inforatio, performed in conjunction with arthroscopy.

Material and methods: 77 cases of mild to moderate arthrosis of the knee diagnosed by arthroscopy were evaluated at median 4 (2–7) years. Using the Visual Analog Scale (VAS) the patients were asked for their subjective feeling of rest pain and/or activity pain a) before the operation, b) pain-score at best after inforatio, c) duration of effect in months and d) pain-score at follow-up. 16 patients with mild to moderate arthrosis of the knee diagnosed by arthroscopy, who did not undergo inforatio or any other concomitant surgical treatment, were selected as controls and evaluated through a similar questionnaire.

Results: Pain by VAS-score was reduced after inforatio in more than two thirds of the cases for median 24 (1–76) months. Patients with evenly distributed arthrosis were more prone to benefit from inforatio than those with unicompartmental arthrosis. The effect was seen in both patients where rest pain predominated (n 39), and in patients with activity pain (n 14). Complications were rare (n 1; hemarthrosis). Reduction in pain by VAS-score was seen in a significant greater proportion of patients ($p = 0.006$), undergoing inforatio than compared to the control group.

Conclusion: Inforatio is a simple surgical procedure, which when performed in conjunction with arthroscopy has a beneficial effect on knee pain in the majority of patients with mild to moderate arthrosis of the knee. The effect, which can last for years, was seen in both patients with rest pain and in patients with activity pain only. The procedure is associated with a minimal risk of complications.

Reference: 1. Arnoldi C C, Lemperg R K, Linderholm H. Intraosseous hypertension and pain in the knee. J Bone Joint Surg (Br) 1975; 57(3): 360–63.

Presentation of an in-vitro knee analysis system, based on the Genucom

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Aim: To create an experimental system for 3-dimensional examination of movements and related forces in the knee together with specific measurements of internal structures of the knee.

Material and methods: Based on the Genucom Analysis System (FARO) for in-vivo examinations we developed new software and collected data from a goniometer arm and a force plate, through a 16 channel AD converter. Additionally the experimental design made room for up to four internal sensors in the cadaver knee. Knee phantoms were developed to estimate the systems variability.

Results: A known distance of 10 mm was measured with a mean between 9.94 and 10.19 mm and with a standard deviation (SD) between 0.21 and 0.34 mm. A phantom knee joint was constructed in order to evaluate the complete digitizing and testing procedure of the goniometer arm. An 11 mm a/p translation of the phantom was measured to mean 11.17 with a 0.34 mm SD. A rotation of 24° was measured with a SD of 0.22 mm. The forces measured both by the Genucom force plate and the piezoelectric Kistler cell attached to a reconstruction of the ACL, was done with a SD of 0.5 N within a range of 0 and 140 N. The drift in the measurements done hy the Kistler cell was initially 6% within a range of 25–140 N. This temperature dependent drift disappeared after 1 hour.

Conclusion: The knee analysis system is capable of measuring force and translations with an acceptable inaccuracy. It is possible to describe change in knee kinematics associated with ACL reconstructions.

Analgesic effects of aspirin combined with codeine in the relief of postarthroscopy pain

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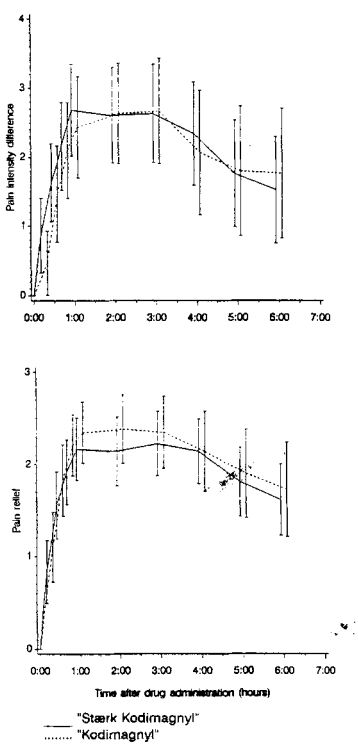
Introduction: The aim of the study was to compare the pain relief and side effects of "Stærk Kodimagnyl" (500 mg aspirin combined with 30 mg codeine) with ordinary "Kodimagnyl" (500 mg aspirin combined with 10 mg codeine) following out-patient knee joint arthroscopy.

Materials and methods: The study was performed as a prospective, randomized double-blind study and consisted of a single dose study, where the patients took 2 tablets of the medication, followed by a multiple dose study, where the patients took the medication according to requirement for 1 to 4 days. A total of 215 patients entered the study (132 males). Median age: 34 years (variation: Q1–Q3: 25–43 years). Diagnostic arthroscopies were performed in 48% of the cases. Local analgesia was used in 73% of the arthroscopies and the rest were performed in general anesthesia. Tourniquet was used in 20% of the patients. The check analysis showed that the demographic data were evenly distributed between the two patient categories. A total of 57 patients did not use the analgesics offered.



Results: This study showed no significant pain intensity and pain relief difference between the two patient categories, neither in the single dose study as shown below, nor in the multiple dose study.

The frequency of side effects reported was significantly greater for the group of patients who were given "Staerk Kodimagnyl" than for the rest; especially more patients with drowsiness, nausea and diffuse gastrointestinal complaints.

Conclusion: In this study we found no significant difference in the pain relief of "Stærk Kodimagnyl" compared with "Kodimagnyl", and at the same time we found significantly more side effects in the group of patients who were given "Stærk Kodimagnyl". Finally, we concluded that outpatient arthroscopy is only followed by moderate pains, and 57 patients (27%) did not take any analgesics.

Serological bonemarkers after cementless total knee arthroplasty

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Introduction: Fracture healing and bone growth around joint prostheses are today monitored on the basis of clinical examination and radiographs only. There are however available methods for measuring the serological levels of peptides and propeptides, reflecting bone activity and wound healing. The carboxyterminal pro-peptide of type I procollagen (PICP) is liberated during the synthesis of type I collagen, reflecting bone formation. The carboxyterminal telopeptide part of type I collagen (ICTP) is liberated during the degradation of type I collagen, reflecting bone resorption. The level of the aminoterminal propeptide of type III procollagen (PIIINP) reflects fibroproliferative activity such as seen during wound healing. The aim of the study was to describe sequential changes in the serological markers mentioned following a major standardized bone trauma (the cementless TKA).

Materials and methods: 17 patients with primary gonarthrosis had cementless TKA (AGC 2000). Blood samples were drawn as follows: Preoperativelv and postoperative days 1, 7, 14 and 30.

Results:

µg/L	Pre-op	Day 1	Day 7	Day 14	Day 30	
PICP	119	62.9	114	163	202.5	a,c
ICTP	4.4	5.5	7.95	8.9	8.75	b
PIIINP	3.7	3.1	5.15	8.0	8.9	a

Page test:
[a]Increasing tendency Day 1 to 30, $p < 0.001$.
[b]Increasing tendency pre-op to Day 30, $p < 0.001$.
[c]Wilcoxon: Fall from pre-op to Day 1, $p < 0.001$.

Conclusion: Increasing PICP and ICTP levels in the first postoperative month may reflect initial bone remodelling around the prosthesis. ICTP seems to reach a maximum around day 14, perhaps a sign of decreasing bone resorption. Serological bone markers may become useful in the monitoring of bone activity following arthroplasty.

Complement activation in shed blood autotransfused after cementless TKA

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Introduction: Autotransfusion (AT) of unwashed, postoperatively collected shed blood is reported to have caused severe systemic complications. To elucidate the safety of the procedure, shed blood and venous blood following AT was analysed for various complement factors (C3d, C4, Factor B).

Materials and methods: 14 patients with primary gonarthrosis had cementless TKA (AGC 2000) and were postoperatively connected to the CONSTAVACTM autotransfusion system Shed blood was collected over the first 6 hours postoperatively, analysed and autotransfused without complications, median 630 (200–900) mL. Venous blood was drawn before AT and 2, 4 and 18 hours after AT.

Results:

	Venous before	Shed blood	Venous		
			2 h	4 h	18 h
C3darb units (4–7.6)	4.45	20.5	4.7	4.4	4.35
C4arb units (40–135)	86.0	69.5	88.5	88.0	80.0
Factor-Barb units (47–100)	69.5	63.0	79.0	77.0	83.0

Conclusion: In the CONSTAVACTM-system complement activation happens via both the classic (C4) and alternative (Factor B) pathway. This leads to a rise in C3d in the shed blood ($p < 0.005$), indicating formation of anaphylatoxine C3a. Following AT there is only a modest rise in C3d levels of venous blood ($0.05 < p < 0.1$), possibly caused by transfused C3d and not because of complement activation in the patient, as there is no simultaneous drop in C4 and Factor B levels. AT of unwashed shed blood does not seem to induce complement activation in the recipient.

Reference: Woda R, et al. Upper airway oedema following autologous blood transfusion from a wound drainage system. Can J Anaesth. 1992; 39: 290–2.

Survival of reinfused shed erythrocytes following knee arthroplasty

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Introduction: Evaluation of the clinical effect of autologous transfusions (AT) is often based only on the need for supplementary homologous transfusions (HT). The need, if any, for (HT) is however multifactorial dependant and gives no information about the quality of the autotransfused red blood cells (RBCs). To assess whether the life span of RBCs, collected from surgical drains following surgery of the knee, was affected by the procedure of AT, we determined the long-term survival of 51-chromium(^{51}Cr)-labeled autologous RBCs.

Patients and methods: 10 patients with primary arthrosis of the knee had unilateral, non-cemented, total knee arthroplasty and were postoperatively connected to the Constavac™-autotransfusion unit, which is a closed, autologous blood recovery system, that allows postoperative collection, fltering and reinfusion of unwashed shed blood. Shed blood was collected for 6 hours postoperatively and reinfused within the following 2 hours. Immediately before reinfusion, 18 ml of the shed blood were aspirated from the system and radiolabeled with ^{51}Cr. AT of the shed blood was performed and the ^{51}Cr-labeled RBCs were reinfused towards the end of the autotransfusion. Subsequent venous blood samples were drawn after 20 minutes (baseline) and repeated 3 times weekly until 50% activity of ^{51}Cr was reached, followed by samples drawn weekly until less than 33% activity remained in the blood (minimum 40 days postoperatively). The time until 50% activity of ^{51}Cr in blood (corrected for physical decay, but not for elution) was determined by monoexponential ftting.

Results: The time from 100% activity to 50% activity (T_{50}Cr) was 22 days.

Conclusions: T_{50}Cr for autotransfused erythrocytes from unwashed shed blood is equal to T_{50}Cr for banked autologous blood (1), suggesting equal long-term survival, but both are slightly shorter than the normal values of 25–33 days reported for autologous RBCs (2).

References:

1. Högman CF, et al. Red cell suspensions in SAGM medium. Further
experience of in vivo survival of red cells, clinical usefulness and plasma-saving effects. Vox-Sang. 1983.
2. Peters AM, Lewis SM. Haematology (chapter 15). In: Clinical Nuclear Medicine. Chapman & Hall Medical, second edition 1991.

Osteochondral lesions in the knee—one year follow-up after treatment with Meda carbon-rods

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Aim: To evaluate the effect of treating osteaochondral lesions in the knee with Meda carbon-rods.

Material: 19 patients with verified osteochondral lesion in the knee and pain at activity were operated from with Meda carbon rods in the period 25 September 1991–4 March 1993. Age ranged from 22 to 41 years, median was 29 years. There were 14 men and 5 women. 9 lesions were caused by trauma and 10 were non-traumatic. 6 were priorily operated for osteochondral lesion.

Method: All lesions were examined arthroscopically before operation. Operation vas carried out via arthrotomia. Degenerated cartilage was remowed through arthrotomia and after predrilling 1 carbon-rod was inserted per square centimeter. Postoperatively patients were placed in a continuously-passive-motion machine (0°–90°). Patients were allowed weight bearing on straight leg after 6 weeks and allowed squatting after 9 months. At follow-up pain, movement and crepitation was registered. At second-look arthroscopia 1 year after operation healing, regularity and visual rods were registered.

Results: In patients having sedentary pain preoperatively, 75% were sedentary painless after 1 year. 53% of patients with activity-pain were painfree at activity after 1 year. From patients with traumatic lesions, 60% of patients with traumatic lesions were painfree at activity. There were no relation betwen size of lesion and postoperatively pain. 33% of patients priorily operated got better.

Conclusion: Traumatic osteochondral lesions with cronic pain can get better by insertion of Meda carbon-rods.

Arthroscopic reconstruction of the anterior cruciate ligament using patella tendon

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Aim: Quality control of arthroscopic reconstruction of the anterior cruciate ligament using BTB technique. To evaluate a modified IKDC-table.

Material: 94 patients were from 1 january 1991–30 June 1993 arthroscopic operated for insufficiency of the anterior cruciate ligament using BTB-technique. There were 31 women and 63 men. 32 were soccer-injuries, 26 handball, 4 badminton. The mechanism were in 71 cases contact, 29 noncontact and 17 were traffic. Mean observation time from injury to contact with hospital were 704 days, mean observation time from injury to operation were 932 days, and from hospital-contact to operation were 239 days.

Method: Patients were evaluated with a modified IKDC-table preoperatively and after 6 and 12 months. All patients were operated using arthroscopic technique. The reconstruction was carried out using the mid third of ligamentum patellae inferior as a free transplant. Drillholes were placed isoanatomically with Protac-guide and intensive magnifier. Boneblocks were fixated with interference-screws.

Results: 6 months postoperatively mean Lysholm-kneescore had risen from 55 to 90. Lachmann measured with Stryker Laxity Tester at 25 degrees 30 Ibs compared to contralateral side was reduced from mean 6.2 mm to 1.4 mm. There was no difference betwen acute (< 2 months) and chronic patients. 6 months postoperatively mean extention defect was 2.4 degrees.

Conclusion: At 6 months follow-up after arthroscopic reconstruction of the anterior cruciate ligament we find that: Lysholm-score has increased from 55 to 90 points. Lachmann laxity reduced from 6.25 to 1.35 mm. Overall IKDC-score (rating from 1–4 with 4 as best score) has risen from 1.66 to 2.48 points. Modified IKDC-table seems suitable for registration of the course of anterior cruciate ligament reconstruction.

BONE MINERALISATION

Dual-energy radiograph absorptiometry measurement of bone mineral density (BMD) around proximal porous-coated Taperloc® femoral implants

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Purpose: 1) Estimation of BMD changes around cementless Taperloc® femur stems 4.5–6 years after implantation. 2) Comparison of radius and lumbar spine BMD with periprosthetic bone mineral changes. 3) Precision study of the used Hologic QDR-2000 bone densitometer.

Materials: DXA measurements of lumbar spine, nondominant radius and both hips were performed on 25 patients, unilaterally operated with a cementless Taperloc® femur stem. Estimation of BMD changes around the hip implant, were obtained by comparing BMD of seven Gruen zones in the operated with the non-operated hip. 13 patients were scanned twice on the prothesis side.

Results: Average BMD in the 7 hip zones were lover on the operated side. The greatest decrease in BMD (22.3%) occurred in the calcar area. There were relatively large vari-

ations of the BMD changes between the patients. No association between skeleton BMD and the size of hip mineral differences were found. The average precision was 2.2–4.9% for the 13 patients.

Conclusion: DXA is a reliable method for measuring BMD around hip joint implants. There was a severe loss of bone mineral around the implants. BMD of the lumbar and radius could not predict the BMD differences between the 2 femoral bones.

Resorption of hydroxyapatite coating during continuous implant loading

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The purpose of the present study was to quantitate the resorption of plasma-sprayed HA on porous coated titanium (Ti) alloy implants and to correlated the resorption of HA to the duration of the micromotion period.

Materials and methods: An implant device allowing controlled micromovements of 150 µm during each gait cycle was inserted unilaterally into the medial femoral condyles of 14 mature labrador dogs. The thickness of the HA coating was intended to be 50 µm. 4 weeks after surgery, 7 of the dogs had the implant immobilised, group A; the other 7 dogs had a sham operation, i e the implants were still subjected to micromotion, group B. 16 weeks after the first operation the dogs were terminated. Histological cross sections were studied in the scanning electron microscope using backscattered electron image. The surface area covered with HA, the volume of HA, the mean thickness of HA, and the bone apposition were calculated using stereological methods.

Results: 73% of the surface area of a non-inserted control implant was covered with HA. This was significantly reduced to 26 and 16% in group A and B, respectively. The difference between group A and B was not significant (NS). The volume of HA was significantly reduced to 0.23 and 0.14 mm3 per mm implant in group A and B, respectively. The difference between group A and B was NS. The mean thickness of HA on the control implant was 24 µm. On the test implants the thickness was reduced to 18 and 12 µm in group A and B, respectively (NS). Bone apposition defined as bone in direct contact with the implant surface or HA was 46% for group A, and 36% for group B (NS).

Conclusion: The HA as volume and surface area at the implants were reduced, significantly. Moreover we found a tendency towards greater resorption, when the implant had been subjected to continuous micromotion compared to immobilisation after 4 weeks.

Bone mineral density measurements around the femoral component—precision and the significance of rotation

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Introduction: Several cross-sectional studies about the Bone Mineral Density (BMD) around the femoral component in THA has been published. However, individual differences in BMD (age/sex) and immobilization induced loss in BMD, emphasize the need of longitudinal studies. The precision of BMD measurements and the significance of the rotation of the femur are examined in an experimental study.

Material: A cadaver femur with an implanted uncemented prosthesis. Norland XR26 Mark II scanner.

Methods: BMD measurements by Dual Energy X-ray Absorptiometry (DEXA). The femur was rotated along the longitudinal axis with increments of 5° from 0°–45° and repeated 3 times at 10°, 20° and 30°. The BMD was measured in the 7 zones according to Gruen and in the major- and lesser trochanter.

Results: The mean coefficient of variance (CV) was 6.7% (range: 0.6% (zone 4) – 14.1% (zone 2)). Repeated measurements at the same degree of rotation yielded a CV lesser than 2% in all zones.

Conclusion: It is mandatory to ensure equal rotation of the prosthesis/bone-component in THA, when measuring BMD around the femoral component. This is applied to both cross-sectional- and longitudinal studies.

BMC in the proximal tibia in various orthopedic conditions

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Bone mineral content (BMC) in the proximal tibia was measured by dual photon absorptiometry in patients suffering from various orthopedic diseases. BMC was measured in the following patients: 1) 10 women with recent Colles' fractures. 2) 11 women with primary coxarthrosis (measured in both legs). 3) 23 women with primary gonarthrosis. 4) 12 women with ankle fractures (measured postopeatively and 6 months later). 5) 13 women with earlier ACL-lesions (measured in both legs). The data were adjusted in a z-plot for age and compared with normative data based on 102 healthy women aged 20–86 years.

BMC in the proximal tibia in women with Colles' fractures was significantly lower compared with controls ($z = -1.32$, $p = 0.0003$) and in patients with gonarthrosis BMC was significantly higher ($z = 0.95$, $p = 0.0002$). Patients

with ankle fractures had BMC within normal range at the time of the fracture, but after 6 months BMC was 18.3% lower ($p = 0.003$) compared with initial value and BMC was now significantly lower ($z = -0.95$, $p = 0.01$) compared with normative data. In women with coxarthrosis BMC was decreased by 19.3% compared with the healthy contralateral legs ($p = 0.004$) and was significantly lower compared with BMC in healthy women ($z = -0.79$, $p = 0.02$); BMC in the healthy leg was within normal range. In women with ACL-lesions BMC in the injured legs was not different from normative data, but it was decreased by 8.6% ($p = 0.002$) compared with healthy contralateral legs.

Bone Mineral Density of calcaneus in normal males and females, measured by Dual Photon Absorptiometry

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A highly selected material of os calsis measured by Dual Photon Absorptiometry (DPA) technique is presented. 167 healthy persons, without known osteoporosis, were measured, 88 women age 21–88 and 79 men age 21–89. The persons were divided into 7 decades for each sex, with at least 10 in each decade. Bone Mineral Density (BMD) g/cm^2, and Bone Mineral Content (BMC) g/cm were measured in the posterior part of the collum area of the calcaneus. This area has the greatest homogenity and reproducibility. 50 persons were measured on both sides. The BMD values were corrigated to the depth of scanning and the static stress of the os calcis.

The scanning was performed with a Gammatec GT-50 (DPA) scanner using a gadolinium 153 source.

The precision measured on a known standard was 0.3% CV. Precision on the standard mounting was 1.9% CV measured on cadaverbones. Mispositioning of the analysed field within 2 mm in all directions gave a mean CV of 3%. The size of analyze field, 1x1 or 1.4x1.4 cm was with minor influence. Tilting of the os calcis ± 10° and 20° away from the standard mounting gave an error up to 20%, mean 4.6% CV. The day-to-day variation was 2.2% CV. The interobserver variation was 1.5%.

The decrease in calcaneus-BMD on females was 7% per decade, an increasing loss was seen postmenopousal. The peak bone mass was seen in the third decade. The ekvivalent loss in males was 4% per decade, peak bone mass was at the fourth decade, and was 25% higher than in females. There was no significant side difference on the calcaneus measurements, paired t-test ($p < 0.05$).

Correction for the depth of the scanning and the static load to the calcaneus, decreased the scattering for the females 1.6% on the BMD measurings, but an incresing error was introduced on the measuring.

The os calcis can be measured with DPA technique with high precision if accuracy with the positioning is kept in mind. Correction of BMD measurements need a higher precision on width measuring of the calcaneus to be useful in a longitudinal study. Calcaneus DPA measurements could be useful as a screening method in early diagnostic of osteoporosis.

A comparative study of Broadband Ultrasound Attenuation (BUA), Ultrasound Speed (SOS) and Dual Photon Absorptiometry (DPA) expressed as Bone Mineral Density (BMD) on the human os calcis in vivo

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Introduction: Previous investigations have shown significant correlation between BUA- and SOS-measurements on the os calcis and Dual X-ray Absorbtiometry (DXA) on the axial skeleton. No materials have yet been published about the correlation between ultrasonic measurements and DPA on the human os calcis in vivo. Since SOS is related to the elasticity (E) and bone density (@) as follows:

SOS= Square root of E/@

a significant correlation between BMD and SOS is expected. BUA, however, is a more complex parameter of cancellous bone reflecting some qualities such as: the porosity of cancellous bone, the density and viscosity of the marrow, density of mineral bone, and the permeability of the trabecular framework. Thus the correlation between BUA and BMD is expected to be more complex than between SOS and BMD.

Materials and methods: We examined 254 women and 65 men aged 20 to 86, all healthy. BUA and SOS were measured by a LUNAR Achilles ultrasound scanner. BMD was measured by a Gammatec 50 dual photon scanner.

Results: Significant correlation was demonstrated between both BUA and BMD ($r = 0.80$), and between SOS and BMD ($r = 0.80$). All 3 values decreased almost equally with age. Adipous individuals, however, had relatively lower SOS values than expected from BMD measurements. This might be due to a soft tissue error.

Conclusion: Ultrasound measurements on the human os calcis could become an important screening method for detection of osteoporosis, but it seems important to improve soft tissue correction.

UPPER EXTREMITY

Variation of the a-p-translation in patients with normal, hypermobile and traumatic anterior unstable shoulders

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Purpose: To evaluate the a-p-translation in patients with normal shoulders, hypermobile shoulders and traumatic anterior unstable shoulders. Using a new shoulder laxity tester.

Method and material: The Donjoy KLT (Knee Laxity Tester) was placed on the shoulder girdle and fixed in a standardized test position. A force of 20 lbs was applied and the a-p-translation measured in millimeters. Test-retest was performed on 14 shoulders (on/off 6 times each). Test of the ability to measure a difference between shoulders was performed in 10 persons with healthy shoulders, 10 patients with known traumatic anterior instability and in 10 patients with general joint laxity.

Results: The reproducibility of the test was 95%. A significant difference in the a-p-translation was found between shoulders.

Persons with general joint laxity had a mean a-p-translation of 17 mm, traumatic anterior unstable shoulders 5 mm and normal shoulders 3 mm. The side difference in normal and hypermobile shoulders was 1 mm, whereas traumatic anterior unstable shoulders had 3 mm side difference.

Conclusion: The Donjoy KLT is usable as shoulder laxity tester. It has a high reproducibility and differences in a-p-translation can be measured objectively on a numerical scale.

Artroscopic versus upen reinsertion of the Bankart lesion

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Purpose: To compare artroscopic (Morgan) with open (Mitec®) reinsertion of the Bankart lesion in patients with chronic anterior instability in the shoulder joint.

Method and material: 41 patients were included in the investigation, 21 with artoscopic and 20 with open reinsertion (Mitec®). The patients was followed prospectively and evaluated by a blinded observer at a 2 year follow-up.

Results: 1 patient had a reluxation with a relevant trauma 5 months after artroscopic surgery. No patients in the open group had a reluxation ($p > 0.05$). Rowe score (95 in both groups). Statistical significant differences were a decrease in the abduction external rotation in the open group (from 0°–15° loss of motion) compared to normal motion in the artroscopic group. Cosmetic complaints in 50% in the open group versus 10% in the artroscopic. A-P stability in the shoulder joint measured by Don-Joy KLT showed identical stability (plus 1 mm on the affected side). There were no major complications and no differences in minor complications.

Conclusion: Both methods results in a good shoulder stability in this material with patients at different levels of activity. The open procedure results in a minor loss of motion, more cosmetic problems and a longer hospital stay.

MRI versus arthroscopy in the diagnosis of labral tears

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Purpose: The evaluation of labral tears with magnetic resonance imaging.

Material and method: Between May 1991 and September 1993 61 patients were examined with MRI and arthroscopy. 35 patients suffered from posttraumatic chronic shoulder pain after a non-dislocating trauma whereas 26 had experienced traumatic dislocation. Average age was 29 (16–55) years. There were 54 men and 7 females. Magnetic resonance imaging was performed with a 1.5-T MR Imager using spin-echo technic obtaining protondensity and T2-weighted coronal 5 mm sections with a 0.5 mm intersection gap. This sequence was followed by a gradient-echo sequence with a thin-slice (1.0–1.5) mm contiguous 3-D imaging of the shoulder. TR = 60 ms, TE = 18 ms and the flip angle was 25°. The evaluation was performed before the arthroscopic examination and the images were described by 3 experienced radiologists.

Results: Correlation between MRI and arthroscopy is shown in Table 1. MRI diagnosed 44 tears.

Table 1.

		MRI			
Arthroscopy		True +	True –	False +	False –
Labral tear	44	39	16	1	5

Sensitivity was 0.89, specificity 0.94 and accuracy 0.90.

Conclusion: Conventional MRI is a reliable method in order to perform a non-differentiated evaluation of labral tears.

Low power laser versus placebo in tennis elbow

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Introduction: Although widely used among therapists for alleviation of musculoskeletal pain including lateral humeral epicondylitis, the effect of Low Power Laser is not documented. The aim of this study was to investigate the effect of Low Power Laser versus placebo in tennis elbow.

Materials and methods: 36 patients with lateral epicondylitis of the elbow (19 women, 17 men, median age 48 years) were treated either with active laser (18 patients) or sham laser (placebo) (18 patients). The active laser was a GA-AL-AS 30 mW/830 nm low power laser (LPL), the sham laser was optically reduced 100%. The study design was double blind and randomized. A follow up was performed by telephone recording the first 10 weeks after the last treatment.

Results: No difference between laser and placebo was found on lateral elbow pain following last treatment or after 10 weeks. We found a non-significant trend toward pain reduction in both groups during the treatment period and after 10 weeks (Mann Whitney test, 95% confidence limit).

Conclusion: We conclude that low power lasers have no effect on musculoskeletal pain such as lateral epicondylitis, and that non-controlled studies showing an effect of LPL reflect the spontaneous course of the elbow pain syndrome, rather than a specific laser-effect.

Injuries to the hand and wrist A study of 50,272 injuries

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Patients and methods: The study reports the causes, characteristics and treatment of injuries to the hand and wrist presented to 5 accident and emergency departments in a 2-year survey of 13% of the Danish population.

Results: The rate of injury to the hand or wrist was 28.6% of all injuries, or 3.7 per 100,000 inhabitants per year. 34% of the accidents were domestic, 35% were leisure accidents, 26% were occupational and 5% were traffic accidents. Sports injuries were primarily registered as recreational accidents and constituted 7,370 injuries (15% of all accidents). Injury by cut or bite, punching and falling comprised 96% of all the injuries. The most frequent lesions at the fingers and metacarpal region were wounds followed by contusions and fractures At the wrist, fractures were most frequent, comprising 55% of all wrist lesions, followed by sprains and contusions. Only 2% of the patients were admitted to hospital for further treatment or observation and 13% were referred to a hospital as outpatients. The most frequent causes for admission were fractures (42%), tendon lesions (29%) and wounds (12%). Based on the figures presented, the requirement of hospital beds and outpatient capacities for acute hand and wrist injuries can be estimated as 243 bed-days and 500 first out-patient attendances per 100,000 inhabitants per year. If wrist fractures are excluded from the material, the requirement are reduced to 175 bed-days and 310 first out-patient attendances per 100,000 inhabitants per year.

HIP

Total hip arthroplasty revision with Exeter X-change

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Introduction: We want to report our experience and evaluate short-term results after the use of the Exeter X-change transplantation technique in revision of THA with pronounced bone resorption.

Material and method: 13 patients (8 men, 5 women) of median age 73 (60–82) years, all with aseptic loosening with marked bone resorption in the proximal femur (2 grade 2, 11 grade 3 according to the Endo-Klinik classification) have been revised with the Exeter X-change system. There were 10 first, 2 second and 1 third time revision. Median preoperative Harris hip score (HHS) was 36 (15–55).

Results: 5 patients have been followed 12–14 months, 4 patients 6–12 months, 2 patients 3–6 months, 1 patient is dead. At the last visit 10 of 12 patients were complete pain-free. The remaining 2 patients had occasional light, non-activity limiting pain. Patients followed >6 months had at the last visit a median HHS of 83 (72–95). Median subsidence after 3 months were 2 (0–7) mm, after 12 months 3 (0–10) mm. There were no radiolucent lines between prosthesis/cement or cement/allograft. It is possible in 2 of 5 patients followed more than 1 year to see cortical bone regeneration, and in 3 patients trabecular graft incorporation. The only major complication has been an early deep infection, which was succesfully treated with debridement and antibiotics. 2 stems have been inserted in 4 and 8 degree varus malposition, besides that there have been no major

technical problems with the use of the Exeter X-change system.

Conclusion: The Exeter X-change technique, with massive bone transplantation in revisions with massive femoral bone resorption, seems to be a promising method, which in short term shows good results. Long time follow-up is demanded, but our results are comparable with the only published report about the method(1).

Reference: 1. Gie GA et al. Impacted cancellous allografts and cement for revision total hip arthroplasty JBJS 1993; 75-B: 14–21

Follow-up of EXETER Total Hip Replacement 1985–1987

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Introduction: EXETER total hip replacement has been known and used since 1970. Since 1985 the EXETER-prosthesis has been usen at the department in a number of approximately 600. The purpose of this follow-up was to evaluate the observed survival, rate of dislocation and the clinical results; especially pain, walking distance and leg length discrepancy.

Materials: Patients operated with EXETER-prosthesis in 1985–1987 was included; 22, 46 and 61; totally 129. 5 patients failed to attend rewiev.

Methods: Case records was evaluated concerning: preoperatively status, postoperatively complications, prosthesis failures and radiograph pictures concerning placing of the prosthesis components. The patients were rewieved clinically and radiologically.

Results: The observed survivel of the prosthesis for 1987 was approximately 96% after 6 years; for the period 1985–1987 approximately 78% after 7.5 years. 8% had dislocation. At the review 73% was painfree, 22% had moderate pain and 5% marked pain. More than 90% had a walking distance of at least 500 m. 12% had a leg length discrepancy exceeding 1 cm.

Conclusion: The observed survival of the prosthesis for 1987 is acceptable, but the observed survival for 1985–87 is low and unsatisfactory. This might be due to a learning phase, and this has recently been confirmed by a observed survival at 96% after 5 years for 1988. The clinical results regarding pain, walking distance and leg length discrepancy are satisfactorily.

10-year follow-up of cemented total hip arthroplasty with Richards' series 2 hip prosthesis

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Purpose: To follow-up the department's first 131 consecutive cemented total hip arthroplasties (THA) (11–13 year follow-up).

Materials and metods: In the time from 1 January 1981 to 31 December 1982 131 THAs were performed on a total of 116 patients. There were 53 menhips and 78 womenhips operated. The average age at the time of operation was 67 (49–87) years. All operations were performed with Richards' Series 2. Posterior approach, plug, lavage, cementation with cement pistol, antibiotics and low-dose Heparin.

At the time of follow-up 44 patients were dead (= 49 THA), 3 patients (3 THA) omitted because of lacking data recording and 13 patients (14 THA) were not able to participate, but answered the questionnaire. 56 patients representing 65 THA (50%) were available for the follow-up, on avarage 12 (11–13) years after the operation. The patients' hip/hips were examined as regards a) pain b) walking ability and c) hipmobility (M d'Aubigné)(HFI). A frontal radiograph of the pelvis and hip/hips was taken. The examining surgeon evaluated the hip/hips based on a clinical examination and the radiograph as 1) stable, 2) perhaps loose, 3) most likely loose and 4) definitely loose, both with regard to the acetabular and femoral component.

Results: Preoperatively 78% of the patients had an ideopatic coxarthrosis, 6% rheumatoid arthritis, 7% sequela after femoral neck fracture, 2% sequela after dysplasia and 7% other diagnosis. 8 patients (6.2%) had considerable postoperative complications (Table 1). 10 patients (7.8 %) were reoperated during the examination period. 2 due to loosening of the total prosthesis, 1 loosening of the cup, 3 loosenings of the femoral component, 2 because of recurring luxations, 1 late (deep) infection and 1 fracture of the femur near the prosthesis. Preoperatively the patients' HFI was at 8.6, at follow-up 15.8.

Table 1. Postoperative complications

	n	(%)
AMI, pulmonal embolus[a]	1	0.80
Deep vein thrombosis	0	0
Pneumonia	4	3.1
DIC	1	0.80
Abscessus subcutaneous	2	1.6
Luxations	0	0
SUM	8	6.2

[a]died 43 days postoperatively

The clinical and the radiographic examination showed that 86% of the acetabular cups and 63% of the femur components were fixed solidly. Definite signs of a loosened

femur prosthesis were found in 5% and on the acetabular cup-side in 3% of the follow-up patients. This was in good correlation to the HFI and the questionnaire survey.

The Kaplan-Meier survival analysis had a prosthesis survival of 93% after 10 years (95% confidence limits 87–100%).

Conclusion: The study has shown satisfying results as regards complications and prosthesis survival and is in good accordance with other long-term surveys of cemented THA of conventional design.

Cementspacer for infections involving the hip joint

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Introduction: We want to describe a peroperatively made cementspacer for use in case of infection in the hip joint, where insertion of a THA in a 2-stage operation are planned. We also want to report our early results with the method.

Method and material: The spacer is made of 2–3 portions of bonecement with gentamycin (Palacos®), which peroperatively, over a core of 2 Rush pins, are modelled into the shape of a hemialloplastic. The spacer has been used in 9 patients (5 men, 4 women), aged 52–77 years. The indication was infection after: THA (4 patients), osteosynthesis of medial collum fracture (3 patients), osteosynthesis of acetabulum fracture (1 patient), bacterial arthritis (1 patient).

Results: All patients have been mobilised with minimal weight-bearing 2–3 days postoperatively. All have been reoperated after 23–60 days with insertion of a THA. They are followed up to 6 months without signs of reinfection. 3 patients have been discharged in 8–21 days. No fractures of the spacer have occurred. The only spacerrelated complication has been 1 case with luxation of the spacer, probably because of deficient rim posteriorly in the acetabulum. The spacer was removed.

Conclusion: The use of a cementspacer in the interval in a 2 stage operation because of infection in the hip joint, seems to be a usable method, which have the following advantages: 1) mobilization immediately postoperative is possible, 2) later insertion of prosthesis is made considerably more easy, and 3) patients which are able to manage at home with minimal weight-bearing can be discharged in the period before insertion of the prosthesis.

Observer variation in the radiographic classification of femoral neck fractures

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The inter- and intra-observer variation in the classification of femoral neck fractures according to Garden's system were assessed.

Material and method: Radiographs of 96 patients were classified independently by 6 observers. The observers were: 1 consultant radiologist and 1 senior radiologist, 2 senior orthopedic surgeons and 2 orthopedic trainees. 3 months' later the radiographs were reviewed by the same observers. The observer variationwas analyzed by kappa statistics. We defined kappa values < 0.50 as poor and values > 0.75 as excellent agreement.

Results: The overall interobserver variation was large with kappa values from 0.39–0.40. When reducing Garden's system to non-displaced (stage 1+2) and displaced (stage 3+4) fractures we found good agreement (kappa: 0.67–0.68). The intraobserver variation varied between 0.54–0.78 and for the reduced system between 0.64–0.87. Regarding the single stages 1–4, we found poor to moderate agreement (kappa: 0.51, 0.39, 0.22, 0.55). For the reduced system the agreement was nearly excellent; stage 1+2 (kappa: 0.71) and stage 3+4 (kappa: 0.69).

Conclusion: We found poor-moderate reliability in the classification of femoral neck fractures into Garden's system. The problem seems to be the delimitation of stage 2 and 3 fractures. Good reliability is reached using the reduced systems.

Ectopic ossifications after hip arthroplasty compared to skeleton Bone Mineral Density (BMD) measured by Dual Energy X-ray Absorptiometry (DXA)

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Background: Sex (male), age (>60 years) and former development of heterotopic ossifications are risk factors for development of heterotopic ossifications after Total Hip Arthroplasty (THA). A hereditary disposition has been suggested too. A simple method is needed to identify patients at risk.

Aim: Comparison of BMD in the peripheral and axial skeleton in patients with and without heterotopic ossifications after THA.

Materials: BMD in 8 men with heterotopic ossifications Brooker Class III and IV (age 48 [41–61] years, 4 with cemented and 4 with non-cemented THA) and in 8 men without radiological signs of heterotopic ossifications (age 48 [43–59] years, all with noncemented THA) was measured by DXA, HOLOGIC QDR-2000 bilaterally in the hip region, lumbar spine (L2–L4) and non-dominant distal radius.

Results: There was no significant association between BMD in the spine, radius and periarticular area ($p > 0.05$). Sex- and age-adjusted normal values were used. Furthermore, no significant differences in BMD in patients with heterotopic ossifications and without ossitications were found.

Conclusion: No significant association between peripheral- and axial-BMD and heterotopic ossifications after THA were found. DXA-measurements cannot be used to identify persons with increased risk of heterotopic ossifications.

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Bone-Tendon-Bone (BTB) patellar ligament reconstruction in anterior cruciate ligament deficiency—open and arthroscopy assisted methods compared

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Of 54 patients with chronic (n 49) or acute (n 5) anterior cruciate ligament instability, 52 were evaluated after a mean of 16 months' follow-up after open (n 18) or arthroscopy assisted (n 36) bone-tendon-bone patellar ligament reconstruction. Preoperative Knee Signature System side-to-side difference at 200 N load in anterior displacement decreased from 7.9 mm to 3.5 mm at follow-up ($p < 0.0001$). An objectively satisfactory limit of 5 mm in side-to-side difference was achieved in 73 percent. At follow-up there was a positive pivot shift sign in 8 knees (1 definite and 7 trace). Lysholm knee scores improved from 69 to 83. The only significant difference between the arthroscopy assisted and open groups was a smaller side-to-side anterior displacement in the arthroscopic group (2.2 mm vs. 4.8 mm, $p = 0.002$). Results suggest that more accurate and isometrically correct placement of the graft is possible with the arthroscopy assisted technique.

Spinal growth and progression of idiopathic scoliosis

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Spinal growth and progression of scoliotic curves were measured from two successive radiographs taken of 110 untreated idiopathic scoliotic girls. At the first visit the mean age was 14 (11–16) years, the mean magnitude of major curves 24 (9–38) degrees, and that of minor curves 14 (2–38) degrees, The spine in measured segments (Th4–L4) grew most rapidly at the age of 11–12 years. The progression of curves (major plus minor) correlated with the spinal growth (r = 0.384). The greater the initial curves were, the stronger was the correlation (0.046–0.639).

Anthropometric measurements and the incidence of low-back pain in a cohort of pubertal children

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A number of anthropometric measurements were studied for their prediction of low-back-pain (LBP) in children who had not had such pain at entry (408 girls and 451 boys). The children were examined annually from the average age of 11.8 to 13.8 years to follow their trunk asymmetry, posture and growth. The one-year (from 12.8 to 13.8 years) incidence of LBP was 18.4% in girls and 16.9% in boys. Trunk asymmetry measured by the forward bending test and sitting height were found to be significant determinants of the incidence of LBP. In the whole cohort the odds ratio (OR) of trunk asymmetry adjusted for all the other risk determinants was 1.19 and its confidence interval (CI) was 1.00–1.39 per one standard deviation increase of the trunk hump. In the multivariate analysis comprising both sexes, OR per one standard deviation increase of sitting height was 1.24 (95% CI 1.03–1.46). In boys standing height (OR 1.40, 95% CI 1.13–1.65, per one standard deviation) and sitting height (OR 1.35, 95% CI 1.09–1.63, per one standard deviation) were positively associated with the risk of LBP. These associations were not significant in girls. We conclude that sitting height and trunk asymmetry may contribute to LBP in pubertal children. In general, however, the role of anthropometric characteristics seems only modest.

Spondylodesis augmented by transpedicular fixation in the treatment of olisthetic and degenerative conditions of the lumbar spine

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51 patients who were treated with lumbar or lumbosacral posterolateral fusion with pedicle screw internal fixation were reviewed retrospectively two years after the fusion by an independent observer. In 44 patients the underlying condition was lytic or degenerative spondylolisthesis. The fusion rate was 94%. The mean Oswestry score was 38% preoperatively and 24% two years after the fusion. Preoperatively only every fifth patient was able to work; two years postoperatively almost 60% were at work. Complications due to internal fixation were recorded in 57% of the cases. Most of these, such as screw breakage and screw loosening in the sacrum, were not of clinical importance. The use of internal fixation seems to enhance the fusion rate but is associated with more complications than posterolateral fusion without implants.

Lumbar disk space height after external fixation and anterior interbody fusion

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42 consecutive patients with severe spine problems were tested by temporary external fixation of the lower lumbar spine. 27 experienced marked relief of pain, and were subjected to anterior interbody fusion. The disc height was measured on radiographs taken before the external fixation, during the test with disc space distraction, after the anterior fusion, and one and two years postoperatively. The Oswestry disability score and the visual analogue scale (VAS) for back and leg pain were also registered at the same intervals of time. The two-year clinical results were assessed as excellent in 9, good in 10, fair in 3 and poor in 5 cases. 10 patients had a non-union. The mean disc height increased with external fixation and anterior interbody fusion, but returned to preoperative levels during the follow-up. The changes in disc space height did not correlate statistically with the clinical results or with the occurrence of non-union. A significantly better clinical outcome, however, was found in patients with solid fusion, compared with patients with non-union.

Treatment strategy for tibial fractures stabilized under external fixation

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In previous laboratory studies, we characterized the union mechanisms of long-bone fractures stabilized under external fixation. Since 1990, we have applied acquired basic biologic and biomechanical knowledge to modify our treatment strategy for externally stabilized tibial fractures. The treatment is individualized according to the fracture type and the severity of soft-tissue injury. There are two main alternatives in the selection of the fracture union mechanism: 1) primary osteonal bone union (stable fracture patterns stabilized under constant compression) and 2) secondary osteonal and non-osteonal bone union (unstable fractures and fractures with bone defects stabilized under neutralization mode) augmented by early cancellous bone grafts. The fixation is maintained until fracture union. By using this treatment strategy in 19 patients, fracture union has been constantly achieved without the need for secondary intramedullary fixation or plating procedures. Time to union (median) has been 20–22 weeks in both primary and secondary bone union mechanisms.

Distribution and treatment of physeal fractures in Kuopio University Hospital

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290 children, aged 0–15 years, were treated for physeal fracture at Kuopio University Hospital in 1984 and 1988. Growth plate fractures accounted for 24% of the cases (n 71). Fractures involving distal radius (20%), proximal growth plates of fingers (15%), distal tibia (15%) and lateral humeral condyle (10%) were most common. Salter-Harris type II fractures accounted for over 56% of the cases. 21% of the physeal fractures required operative treatment. Kirschner pin fixation was used in 53% of the cases. Our results concerning distribution and treatment of physeal fractures are in agreement with most previous reports.

The occurrence of lumbar spondylolisthesis in relatives of patients with symptomatic spondylolisthesis

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Radiographs of the lumbar spine in 130 close relatives of 45 patients with lumbar spondylolisthesis were examined. In 37 of them (28.5%) spondylolysis or olisthesis was found. The occurrence is more than four times higher than the incidence (6%) in the Finnish population in general. This result emphasizes the role of genetic factors in the etiology of spondylolisthesis.

MRI or arthroscopy?

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Magnetic resonance imaging (MRI) has been observed to be useful in knee disorders. To examine the accuracy of MRI in knee disorders, we assessed 25 patients with both MRI and arthroscopy.

Results: Arthrosis of the knee was observed in 3 patients by means of MRI, but in only one through arthroscopy. Degenerative lesion of the medial meniscus was found in 9 patients, and of the lateral meniscus in 5 patients with MRI. However, only 3 medial and 2 lateral meniscus ruptures were found during arthroscopy. Rupture of the anterior cruciate ligament and a medial synovial plica were observed in 3 patients with MRI, but in only 2 patients during arthroscopy.

Discussion: Degenerative lesions of the meniscus and the anterior cruciate ligament can be reasonably difficult to determine by magnetic resonance imaging, as can synovial plica. One chondromalacia patellae and two plicae were found by arthroscopy in knees that were judged to be normal by MRI. The accuracy of magnetic resonance imaging in this study was good, although the method was started only one year earlier.

Ilizarov's technique in treating rigid ankle and foot deformities in diastrophic dysplasia

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Diastrophic dysplasia (DD) is an autosomal recessive type of skeletal dysplasia producing a short-limb dwarfism and progressive joint contractures. DD is more common in Finland than in other countries. Especially hip and ankle joints of these patients are often markedly contracted. Great variations exist in the foot deformities and there is a tendency for the deformity to recur even after several operations.

Patients and methods: A total of 5 patients (7 feet) were operated on because of a rigid equinus-, equinus-adductus or equinovarus-adductus deformity. The patients (3 girls and 2 boys) were 3.5–17 years of age at the time of operation. Ilizarov's circular frame was applied, 1–2 rings to the tibia and a frame to the foot. The calcaneus and metatarsals were fixed with two pairs of olive pins. Either a constrained or a non-constrained fixation technique was used. At the time of operation achilles tenotomy, soft tissue release and decancellation of tarsal bones were performed. The deformity was then corrected by gradual distraction for 2–4 weeks, whereafter the fixation was continued for up to 3 months. After removal of the frame, an orthosis was used for 1–2 months.

Results and conclusions: The deformities could be primarily corrected by distraction in all except one patient, in whom a slight bilateral equinus remained. Two patients still wear the fixator. The follow-up time for 3 patients (5 feet) was 6–12 months after removal of the frame. The result in 4 of these feet was good. In one patient a tarsal valgus and recurrent equinus deformity developed even after a repeat distraction and fixation period. Complications included pin tract infections in all patients and one transient plantar nerve paresthesia. Although the technique is demanding and subject to complications, it may be the only solution in treating rigid foot deformities in DD.

Shear strength of distal rabbit femur during consolidation of an osteotomy fixed with an absorbable polyactide expansion plug

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More knowledge is required about the biomechanical behaviour of absorbable implants for fixation of fractures and osteotomies. The aim of this experimental study on rabbits was to assess the consolidation and strength of a transcondylar osteotomy of the distal femur fixed with a self-reinforced poly-L-lactide expansion plug.

Material and methods: The poly-L-lactide expansion plug, measuring 4.5 mm i diameter and 30 mm in length, has deployable distal fins to secure the grip of the device. A transverse transcondylar osteotomy of the distal rabbit femur was fixed with the expansion plug. The consolidation of the osteotomy was studied radiographically and mechanically. The peak shear force was assessed by stressing the

osteotomy site to failure. The intact contralateral femur of the rabbit served as a control. Fifteen rabbits were tested in groups of 5 animals with follow-up times of 6, 12 or 24 weeks after fixation of the osteotomy.

Results: 13 osteotomies showed a radiographically solid bony union. The mean shear strength ofthe specimens was 3.5 MPa at 6 weeks, 3.5 MPa at 12 weeks and 4.3 MPa at 24 weeks. The mean shear strength ofthe control distal femora was 3.6 MPa. The final consolidation ofthe plug-fixed osteotomy took place between 112 and 24 weeks.

Discussion: The fixation properties of the newly developed absorbable expansion plug was deemed satisfactory in this experimental fracture model.

The effect of a self-reinforced polyglycolide (SR-PGA) membrane on the cortical bone An experimental study on rats.

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Material and methods: 93 Wistar rats were used as experimental animals. In 64 rats a self-reinforced polyglycolide (SR-PGA) membrane was fixed around the right femoral shaft. In 32 of these animals the absorbable membrane was placed around the femoral shaft subperiosteally and in another 32 rats of the periosteum. In another 29 rats periosteal stripping of the right mid-femoral shaft was made to serve as a control group. After a follow-up time of 1, 3, 6, 12, 24 and 30 weeks both femora were analyzed using radiographic, histological, histomorphometric, oxytetracycline-fluorescence and microradiographic techniques.

Results: No infections or other complications were encountered. The SR-PGA membrane was found to be surrounded by a fibrous tissue capsule that extended into the implant and finally replaced it. The absorbable membrane had virtually disappeared by 30 weeks. The fibers of the absorbable material showed a tendency to decrease in diameter during the follow-up time, indicating a degradation of the fibers. SR-PGA membranes had the effect of increasing the new bone formation in rats.

Discussion: SR-PGA membrane was well tolerated by cortical bone and evidently had a positive effect on new bone formation. This can be due to the surface charge or geometry of the implant material. The present study indicates that SR-PGA membranes may have some applications in augmentation of cortical bone.

Long-term results of primary scalenotomy in the treatment of thoracic outlet syndrome

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107 patients with TOS were surveyed in average 4 (2–11) years after primary scalenotomy. The sample included 86 women and 21 men, mean age at surgery was 42 (16–59) years. The three most disturbing preoperative symptoms were pain at rest (87%), numbness (66%) and lack of strength (55%). The postoperative success rate diminished from 71% (one month after operation) to 63% at follow-up. Early retirement varied from 6% up to 33% during the follow-up time. It was highest, 60%, among factory workers. Of the patients older than 45 years at surgery, 68% were retired at the time of follow-up. We emphasize the importance of careful selection of the patients to be operated on, and also the need to consider vocational rehabilitation before resorting to surgical treatment of TOS, However, TOS can be a very disabling disorder. We recommend surgical treatment especially for younger persons with evident TOS, who are engaged in occupations demanding little overhead work. It is among them that we found the best results.

Suprascapular nerve entrapment

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54 patients with suprascapular nerve entrapment were evaluated on an average of 5.6 (2–9) years after surgical release. There were 32 men and 22 women. The supposed etiological factor was exertion at work or during vacation in 36 cases. 16 patients had atrophy of the supraspinatus and 26 of the infraspinatus muscle. Conduction time to the supraspinatus muscle was 4.5 (2.2–14.4) ms and to the infraspinatus 8.6 (2.5–43.6) ms. The mean time from the onset of the symptoms to surgery was 2.8 years (3 months–14 years). The mean age at operation was 38 (10–61) years. 2 patients were operated on bilaterally within 2 and 4 years. All but 2 patients were operated on at the suprascapular notch. A new cranial approach is advocated.

The most dramatic effect of the operation was prompt disappearance of the pain in 24 cases and marked diminishing in 15 cases (72%). At the follow-up, a moderate atrophy of the supraspinatus muscle was found in only 1 patient but of the infraspinatus in 11 patients. There were 10 poor long-term results, some of them presumably operated on under the wrong diagnosis and some in the wrong region.

Suprascapular nerve entrapment is a more common cause of shoulder pain than is usually recognized and should be kept in mind when diagnosing painful shoulders.

Massive rotator cuff tear

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Massive rupture of the rotator cuff was repaired in 92 patients during a 14-year period from 1977 to 1990. The follow-up was done after an average of 6 years. The purpose of this study was to evaluate the long-term results of 4 different operative methods. All operative techniques included subacromial decompression. The operative method was side-to-side suture and reattachment to the bone in 43 patients; repair with tendon graft in 26 patients; resection of the greater tuberosity and transfer of the tendinous cuffin 14 patients; acromionplasty alone in 9 patients. Relief of pain was obtained in 80 patients. A good primary result 6 months after the operation remained good at follow-up. Side-to-side suture and reattachment of bone, and resection of the greater tuberosity with transfer of the tendinous cuff, rendered better results in relief of pain and range of motions than either repair with tendon graft or acromionplasty alone. Suture and attachment to bone restored muscle strength more reliably than the other methods. Acromionplasty alone gave poor relief of symptoms. These results suggest that a good primary result endures and that the defect of the rotator cuff should always be repaired.

Proximal osteotomy for hallux valgus—long-term results. A retrospective study

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Hallux valgus in 125 patients (167 feet) was treated by proximal osteotomy of the first metatarsal. In addition, a resection of the base of the proximal phalanx was made in 115 feet and the head of some lesser metatarsal bone was resected in 25 feet. The average preoperative metatarsophalangeal angle was 38°; this was reduced by 22° postoperatively. The average preoperative first intermetatarsal angle was 15°, reduced by 5° after the operation. 8 (5–10) years postoperatively, the patients were sent a questionnaire regarding the present state of their feet. 105 patients (142 feet) replied, stating no pain in their feet at all in 63% of the cases. 86% of the patients stated that, all in all, the operation was worthwhile. The most common complaint was difficulty of finding shoes that fit; 22.5% of the patients stated that they had a hard time finding well-fitting shoes.

In statistical analysis, no correlation between the preoperative body mass index, the hallux angle, the first intermetatarsal angle, the reduction of the above mentioned angles achieved by the operation and patient satisfaction was found.

Wound infections associated with absorbable implants

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Patients and methods: A total of 2114 operations were performed using devices of self-reinforced (matrix and fibres of the same polymers), totally absorbable alpha-hydroxy polyesters. Chemically, the devices were polyglycolide in 63% of the cases, poly-L-lactide in 20%, and PGA+PLLA in 17%. Cylindrical rods or pins, screws, tacks, expansion plugs and wires were used.

Results: The infection rate was 3.5%. When only polyglycolide (PGA) devices were used, the infection rate was 4.0% and for only poly-L-lactide devices 0.7%. When displaced ankle fractures were fixed with either metallic or absorbable devices, the infection rate was 4.1% and 2.2%, respectively.

Discussion: When poly-L-lactide devices were used in fixation of fractures, arthrodeses and osteotomies, the infection rate was lower than when polyglycolide devices were used. When absorbable implants were compared with metallic ones, the infection rate was lower for absorbable implants, but the fractures fixed were more severe in the metallic group.

Surgical treatment of lumbar spinal stenosis—the results in single-operation and multiple-operation patients

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Introduction: Persistent or recurrent leg pain after lumbar surgery is an increasing diagnostic and management problem for the surgeon. The key to successful treatment is accurate diagnosis.

Patients and methods: We evaluated 251 (110 women, 141 men) single-operation (SO) and 66 (13 women, 53 men) multiple-operation (MO) patients treated for lumbar spinal stenosis. Only patients with an AP-diameter equal to or less than 12 mm on myelography were included in this study. The mean age was 55 years in the SO group and 51 years in the MO group ($p < 0.0004$). The mean follow-up time was 4.2 years in both groups. The MO patients had undergone an average of 1.23 prior surgical procedures. Laminectomy was performed on an average of 0.26 levels during previous surgery in the MO group; in the latest operation laminectomy was performed on an average of 1.75 levels and 1.52

levels in the SO and MO groups, respectively. Assessment of outcome was based on the Oswestry questionnaire and graded as excellent-to-good or poor-to-very poor.

Results: An excellent-to-good outcome was achieved in 67% of the SO group and in 46% in the MO group ($p < 0.0017$). Women fared worse in both groups. Myelography findings correlated significantly with outcome in the SO group but not in the MO group. The number of prior surgery procedures did not influence the outcome. The optimum time for achieving successful results from subsequent surgery began 18 months after prior surgery.

Discussion: The outcome of patients reoperated on for spinal stenosis was significantly poorer than for primary surgery. In considering a reoperation for lumbar stenosis, we have not one but many factors to weigh in the decision-making process.

Lumbar spinal stenosis: analysis of factors correlated with the postoperative working capacity of surgically treated patients

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Introduction: There are few reports in the literature concerning the postoperative working capacity of patients treated surgically for lumbar spinal stenosis (LSS).

Patients and methods: We re-examined 400 patients (167 women, 233 men) operated on for LSS during the period 1974-1987. The mean age was 53 years (women 55 and men 52; $p < 0.004$). The mean follow-up time was 4.3 years. The mean number of laminectomies was 1.6 levels (women 1.5, men 1.6). Myelography was performed on all 400 patients. Assessment of disability was based on the Oswestry low-back pain questionnaire and graded as excellent-to-good or poor-to-very poor.

Results: Before surgery 76 patients were able to work, 201 were on sick leave and 123 were retired. No retired patient returned to work after operation. Of the 76 patients able to work, 45 patients were able to work and 31 were retired after surgery; of the 201 patients on sick leave, 65 patients were able to return to work and 136 patients were retired after surgery ($p < 0.00005$). Both sexes had similar results. Prior back surgery had a negative effect on working capacity, but the result was statistically significant only in men. Excellent-to-good outcome was found in 62% of the patients (women 58%, men 66%) The outcome was excellent-to-good in 46% of patients with prior surgery and in 67 of patients without prior surgery ($p < 0.0003$).

Discussion: Surgery was a poor weapon for returning patients to work, especially patients who were on sick leave preoperatively or who had had prior surgery.

Longevity of an uncoated polyethylene acetabular cup

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Materials and methods: 90 arthroplasties on 78 patients, 55 women, 23 men, mean age of 64 (47–79) years with a mean follow-up of 8.2 (7.0–9.0) years, were reviewed. The acetabular socket was the original hemispheric RM cup manufactured from ultra-high molecular weight polyethylene (Rob Mathys Co, Bettlach, Switzerland) with circular grooves and two 8 mm thick and 15 mm pegs outside with an inner diameter of 32 mm. The survey was based on standard anterior-posterior radiographs. Migration of the socket in a medial and superior direction in relation to tear drop was measured in terms of the change in the location of the centre point of rotation i millimeters, as presented in the clinical and radiographic standard terminology CART.

Results: A dislocation of the femoral head had occurred in 10 hips. There were 5 failures defined as revisions performed because of a loose acetabular component, 4 hips had been revised because of a loose stem and 3 because of dislocations. These revised cases were excluded, leaving 78 hips in 66 patients for the analysis, which revealed a migration of 5 mm or more in a superior direction in 14%, broken fixation screws in 9 cases and bent screws in 9 cases. An osteolytic area around the upper lateral part of the femoral stem occurred in 38 cases (49%) and calcar resorption in 25 (32%). In cases with a migrating socket a broad radiolucent line was observed in 75% and calcar resorption in 50%, respectively.

Discussion: Wilson-MacDonald and Morscher reviewed in 1990 their 5 to 10-year results and found 7% socket loosenings after 7 years and 17% and 28% after 8 and 9 years, respectively. The results of the present series are in line with this report. The revision rate for loosening is still only 6% , but alterations in the bone-component interface are clearly threatening. If we apply the same criteria as Wilson-MacDonald, our failure rate is now 21%. Osteolytic foci, which existed in 19% of the cases, are obviously accelerated by wear debris remaining between the acetabular bone and the uncoated polyethylene. The group of patients who had loose sockets demonstrated calcar resorption and a radiolucent area laterally in the region of the greater trochanter more frequently than those with a fixed socket ($p < 0.05$).

Discussion: The practice of fixing a polyethylene socket directly to the bone is not optimal because of the high rate of loosenings and osteolytic changes in the adjacent bone, and should be abandoned.

An absorbable expansion plug for the fixation of the coracoid bone block in Bristow-Latarjet procedures

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Introduction: The Bristow-Latarjet procedure is one of the established methods for treatment of recurrent anterior dislocation of the glenohumeral joint. However, numerous complications that have necessitated the removal of the metallic device used to fix the transferred coracoid bone block to the glenoid rim have been reported. The purpose of this prospective clinical study was to examine the ability of an absorbable expansion plug to fix the transferred coracoid bone block to the glenoid rim in a modified Bristow-Latarjet procedure and simultaneously to assess the biocompatibility of these implants.

Patients and methods: 36 patients with recurrent anterior dislocation of the shoulder were treated using biodegradable poly-L-lactide expansion plugs in the fixation of the transferred coracoid bone block. 33 patients could be followed-up regularly for at least 6 months, with the mean follow-up time being 12 (maximally 28) months. In 5 patients radiographs revealed loosening of the coracoid bone block. No redislocations occurred. To assess the incorporation of the bone block, serial computed tomographic (CT) scans were obtained in 18 randomly selected patients.

Results: 15 out of the 18 showed solid bony fusion of the transferred coracoid bone block to the neck of the scapula in CT scans. The geometry of the implant was unaffected by degradation during the first 18 months. The average ultimate loss of the external rotation range was 8 degrees. There were no signs of inflammatory foreign-body reaction.

Discussion: To avoid the complications that sometimes have necessitated removal of the metallic implants used in Bristow-Latarjet procedure, the biodegradable expansion plug can be regarded as a promising new method to fix the transferred coracoid bone block.

Symptomatic lumbar spondylolisthesis—neuroimmunohistochemical studies

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Spondylolysis (a defect in the pars interarticularis of the vertebral arch)/spondylolisthesis is a common condition, thought to be caused by a congenital weakness and mechanical stress causing a fracture associated, for an unknown reason, with defective healing. Tissue from the spondylolysis defect was collected from seven patients undergoing posterolateral fusion operations. Histological examination disclosed delayed union/pseudoarthrosis-like changes with fibroblast- and macrophage-like cells in a two-cell-layer thick pseudosynovial lining membrane, and occasional perivascular infiltrates containing mainly CD2-positive T lymphocytes and CD1 lb-positive monocytes/macrophages. In a well-vascularized connective tissue stroma PGP 9.5, synaptophysin and neurofilament staining disclosed perivascular nerves, which, however, did not extend to the synovial lining layer and which mainly represented postganglionic sympathetic nerve fibres, but also calcitonin gene-related peptide and substance P-containing sensory fibers. These findings suggest that pain in spondylolysis/spondylolisthesis in part derives from the spondylolytic defect itself, probably from stretching of the local neural elements, rather than from their sensitization/stimulation by locally produced inflammatory mediators. Due to the resemblance of the neuroimmunohistochemical changes to those reported in the non-union of the long bones, and to sparsity of stromal innervation, it seems likely that the characteristic defective healing is in part due to lack of neurogenic influences normally regulating bone growth and remodelling.

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The first Scandinavian Orthopedic Research Society (SORS) meeting was arranged in Stockholm in 1988. Thereafter meetings have been held together with the biannual Congresses of the Scandinavian Orthopedic Association, and as separate meetings every other year.

The seventh meeting of the SORS was arranged in Oslo, November 1993. Researchers not only from the Scandinavian countries, but also from Japan and England had submitted abstracts. A broad field was covered from molecular biology to reconstruction of the anterior cruciate ligament, and young researchers had the opportunity to familiarize him/herself with many parts of orthopedic research during the two days.

LIGAMENTS & MISCELLANEOUS

Peroperative anterior cruciate ligament tension—how much? A pilot cadaver study

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Postoperative complications to anterior cruciate ligament (ACL) reconstruction has called for optimizing of the operative technic. Often is the ligament tension introduced as "a good firm pull" by the assistant before a distal fixation of the ligament to the tibia. This study is dealing with the tension requirements for the anterior cruciate ligament implants and introducing an experimental set-up for in vitro knee analysis based on the Genucom Knee Analysis System (FARO).

Methods: The Genucom kinematic linkage and force plate was used with a re designed software to measure the 3-D forces, moments and movements introduced to the cadaver knees. Locations on the cadaver knee was digitized with a pointer handle to create a moving coordinate system for calculations. The cadaver specimens were pre-tensioned by performing cyclic loading of approximately 150 N at 10° increments of knee flexion. The cadaver knees were subjected to anterior/posterior (a/p) forces of 140 N and internal/external (i/e) rotations with a 6 Nm moment, at 10°, 30°, 50°, 70° and 90° of knee flexion. The test procedure was done with intact ACL ligament, with the ligament excised and after reconstruction with the use of 5, 33, 66, 99 and 132 N tensioning at 30° of knee flexion. The ABC (Surgicraft) ligament used for ACL reconstruction was attached to a Kistler load cell. The ABC ligament was preconditioned with a force of 250 N to settle the structure before reconstruction.

Results: The variability of the test-rig was analyzed. A known distance of 10 mm was measured with a mean between 9.94 and 10.19 mm and with a standard deviation (SD) between 0.21 and 0.34 mm. A phantom knee joint was constructed in order to evaluate the complete digitizing and testing procedure of the goniometerarm. An 11 mm a/p translation of the phantom was measured to mean 11.17 with a 0.34 mm SD. A rotation of 24° was measured with a SD of 0.22 mm. The forces measured both by the Genucom force plate and the pizoelectric Kistler cell was done with a SD of 0.5 Newton.

The a/p laxity increased after ACL excision, mainly at 30° and 10° of knee flexion and the previous a/p laxity profile was reestablished after reconstruction with only 5 N tensioning. The knees were gradually constrained with increased tensioning. The i/e rotation was unaffected by ACL excision and reconstruction with 5 N tensioning force, but increasing tensioning produced serious restrictions in rotation at 10° of knee flexion.

Discussion: Preliminary experiments indicate that even minor tensioning forces introduced at ACL reconstruction's produced restricted knee motion especially at 10°–30° of knee flexion. An over constraint knee is likely to cause pain or wear out the reconstructed ACL ligament.

Quadriceps contraction protects the anterior cruciate ligament during tensile loading

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Introduction: The anterior cruciate ligament (ACL) may be subjected to tensile loading by femurotibial distraction through hyperextension or valgus force[1]. The main force component of the patellar tendon is perpendicular to the tibial plateau resisting femurotibial distraction. At the terminal degrees of knee extension an anterior tibial shear force component loads the ACL[2]. The aim of this study was to examine the contribution of quadriceps contraction to the separation force during tensile loading of the ACL in an in vivo anesthetized rat model.

Methods: 10 Wistar rats of median 425g (400–436) b.w. were used. In both knees the joint capsule and ligaments except the ACL were devided and the menisci resected using a stereomicroscope. The ACL of the right knee was loaded in tension to failure by femurotibial distraction at a loading rate of 2.5 mm/sec. during quadriceps contraction induced by electrical stimulation of the femoral nerve. The ACL of the left knee was loaded with unstimulated muscles as control. The knee flexion angle during testing was 60°. Maximum contraction sustained during the entire loading of the ACL to failure.

Results: All the ACLs failed in the ligament substance. The ultimate tensile load during muscle contraction was 140% more than tested with relaxed muscles ($p < 0.0001$). 300 % more energy was absorbed until failure of the ACL during muscle contraction ($p < 0.0001$). Linear stiffness increased by 55 % ($p < 0.0004$). The deformation remained unchanged.

Discussion: In trauma situations when the quadriceps is contracted sufficiently at the instant of injury, failure may be avoided during external loading that exeeds the rupture limit of the ACL alone.

Conclusion: Quadriceps contraction protected the anterior cruciate ligament during tensile loading by femurotibial distraction.

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Incomplete recovery of muscle function following midshaft femoral shortening osteotomies—a prospective study with 2 years follow-up

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A femoral shortening osteotomy may be indicated both in patients with leg length discrepancy [1] and in persons with unaccepted tallness [2]. The purpose of this study was to evaluate the long-term effect of mid-diaphyseal shortening osteotomies on thigh muscle function

Material and methods: Isokinetic tests of muscle force at angular velocities of 60°/sec. and 180°/sec. were performed in 10 patients who had undergone transverse mid-diaphyseal femoral shortening osteotomies (12 femurs; 2 bilateral and 8 unilateral). The osteotomies were fixed with an interlocking intramedullary nail. Testing was conducted preoperatively, and 3, 6, 12, and 24 months postoperatively.

Results: The average femoral shortening was 46 (27–70) mm, and the mean relative shortening (length reduction/original length x 100) was 9.3% (range 5.4–13.4). At 2 years post-shortening there was a significant reduction of peak torque (PT) at 60°/sec. and total work (TW) at 180°/sec. For the hamstrings muscles the average decrease in PT was 12% ($p < 0.05$) and in TW 20% ($p < 0.05$) For the quadriceps the corresponding decreases were 26% ($p < 0.001$) and 21% ($p < 0.01$) for PT and TW, respectively. Linear regression revealed a strong relationship between muscle force deficits and degree of femoral shortening ($r^2 = 0.86$ for hamstrings TW and $r^2 = 0.71$ for quadriceps TW). Muscle force in relative shortenings of more than 10% (n 5) resulted in a significant loss of muscle force for all parameters tested.

Discussion: Shortenings of more than 10% of the femoral length resulted in permanent loss of muscle function. In a previous study we have shown that subtrochanteric shortenings may retain the muscle function better than mid-shaft shortenings [2], and it is possible that shortenings exceeding 10% should be done subtrochanterically.

Conclusion: A long-term loss in muscle force should be expected after a femoral midshaft shortening osteotomy of more than 10%.

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Congenital spinal deformities in mice induced by carbon-monoxide hypoxia

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The etiology of congential spinal deformities (CSD) is unknown, but hypoxia is known to be associated with CSD. Apart from high altitude, tissue hypoxia (low pO_2) can be produced by CO exposure (1). The purpose of this study was two-fold: 1) Create an animal model of spinal growth and development 2) Assess the induction and development of CSD from CO exposure.

Materials and methods: Pregnant female mice (DBA/1J strain) were used (2). 11 females were exposed to CO (1000 ppm) for 7 hours at day 9.5 of gestation in 1m3 chambers with an air flow of 14 m^3/hour; 11 were exposed to clean air. The pregnant mice were sacrificed at day 19 of gestation and the fetuses removed. All specimens were analyzed by use of High Resolution Radiography (Mammography), 3-dimensional Micro Computer Tomography (μCT), KOH soft tissue reduction (Dawson/Spalteholtz tecnique), and histology (H&E, Gomori's Trichrome). The two-tailed Fischer's exact test was used to compare the proportion of CSD in the exposed and non-exposed groups; a $p < 0.05$ was considered significant.

Results: Spinal anatomy could be assessed with certainty in 62 fetuses: 46 controls and 16 experimentals (Table 1). 14 (87.5%) of the exposed fetuses had CSD in the thoraco-lumbar region, while only 2 (4.3%) of the controls had CSD ($p < 0.001$).

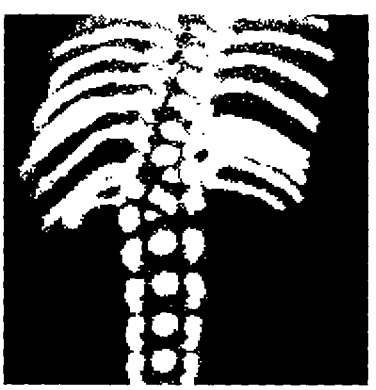

Figure 1. Micro-CT (30 μm voxels) image of a prepared mouse fetus showing vertebral body anomalies in the thoracolumbar spine with rib fusions. The specimen was exposed to CO at day 9.5 of gestation.

Table 1. Distribution of control and experimental fetuses regarding normal and abnormal vertebral columns

	Normal	Abnormal	Total
Control	44	2	46
CO exposed	2	14	16

$p < 0.001$ (Fischer exact test; two-tail).

Conclusion: Our results indicate that we have developed a successful animal model of congenital vertebral anomalies induced by carbon monoxide hypoxia. The model needs further investigation regarding time/dose relationships. Older and more mature animals should be used to study the anatomical and histological pathology in more detail.

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Basic fibroblast growth factor enhances the ingrowth of new bone into bone allografts

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The stimulative effects of bFGF on osteogenesis in vivo have recently been reported (1). bFGF also increases cartilage formation during both fracture healing and induced demineralized bone formation (2). We investigated whether bFGF can enhance the incorporation of bone grafts.

Material and methods: We inserted bone grafts into "the Bone Conduction Chamber" (BCC). This is a cylindrical titanium chamber which is inserted in the proximal tibia of rats. That end of the cylindrical chamber which is implanted in bone has two openings for bone ingrowth. The rest of the chamber is closed. Cancellous bone plugs were prepared from both proximal tibiae of 109 donor rats (200 g), using a cylindrical plug cutter. These plugs were kept in pairs, one pair from each donor. They were frozen and defatted in chloroform methanol. *Study A:* The recipients were 12 male, SD rats (350 g). Before implantation, one bone plug in each pair was deposited for 16 hours in a hyaluronate gel, containing 2.5 μg/mL of bFGF. The other plug (control) was deposited in a similar gel without bFGF. The two grafts were then fitted into the BCCs which were implanted bilaterally in the proximal tibiae of the rat. *Study B:* Allografts with 5 concentrations (0.02, 0.5, 2.5, 12.5 and 62.5 μg/mL) of bFGF in the gel were studied in unilateral tibiae of 114 rats. *Study C:* Allografts contaning 2.5 μg/mL bFGF and controls were inserted bilaterally in 40 rats. The rats in study A and B were killed at 6 weeks, and in study C at 1, 2, 4 and 10 weeks, respectively. Bone formation was evaluated by histomorphometic measurements of how far the new bone that had reached into the grafts and by Tc-MDP activity. Statistics was done by Anova.

Result: Study A: The bone had penetrated 51% deeper into the bFGF treated grafts ($p < 0.002$). *Study B:* In the dose response study, the medium doses gave a similar increase, whereas the highest and lowest dose had no effect at 6 weeks. *Study C:* The bone formation was increased at 2, 4 and especially 10 weeks using both histomophometic and Tc-MDP parameters (10 weeks: $p < 0.05$).

Discussion: The results indicate that local bFGF application can enhance new bone penetration into bone allograft in rats. BFGF is present in osteoblasts and in the bone matrix and affects both cell proliferation and the synthesis of various matrix components (1). A direct stimulatory effect on the early proliferat ive stages during bone ingrowth in this model is possible. Also, a stimulatory effect on capillary formation is probably involved, as has been shown in another bone graft model (3).

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Defatted allograft bone implants in the iliac crest evaluated by CT, MRI and biopsy

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Bank bone was used to refill the iliac crests after bone graft harvest in 4 patients with severe rheumatoid arthritis. The first 3 patients were examined by radiograhpy, MRI and biopsy at 3, 6 and 12 months respectively. From the fourth patient, axial sections with CT and MRI were obtained at 1/2, 3, 6, 12 and 18 months. A biopsy was taken at 12 months. The course of graft incorporation was shown by CT as a partial resorption of that part of the graft which was bulging into the pelvic cavity. MRI showed an initial oedema with low T1 and high T2 signals. Within one year, the signals changed to that of normal marrow. At 6 months, contrast infusion of Gd–DTPA confirmed blood perfusion into the graft. Proton density examination had initially an intermediate signal as the normal bone, but the signal had decreased after one year. This decreased signal was only found in the centre of the implantat at 18 months. Biopsy showed occurrence of new bone in all parts of the implant. The results support the implantation of defatted bank bone in the iliac crest, in order to produce new bone for future autografts. MRI, especially in combination with CT, could be a useful clinical tool to monitor graft incorporation.

FRACTURES

Neural ingrowth into tibial fracture tissues in rats with sciatic nerve section

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Neural influences have been implicated in fracture healing by clinical observations and by experimental procedures on peripheral nerve sectioning, neurotoxins and nerve stimulations. However, denervation studies have provided conflicting results, both decreased and increased bone gross growth and fracture healing have been reported. This work was intended to assess the reliability of sciatic nerve section as a model of denervation of tibial fracture.

Materials and methods: Rats were subjected to a standardized tibial fracture with (n 7) or without simultaneous sciatic nerve sectioning (n 7). After 25 days, tibiae were dissected out, decalcified and immunocytochemistry was used to localise immunoreactive epitopes of neuronal proteins and peptides of interest.

Results: In a healing fracture at day 25, nerve fibres, as identified by their PGP 9.5 expression, were seen in the periosteum, callus tissue, fracture gap and bone marrow. Neuronal growth associated protein GAP–43/B–50 was expressed intensely by nerve fibres suggesting actively ongoing neuronal regeneration. Further characterization of the type of the fracture innervation revealed an extensive distribution of CGRP-containing sensory fibres. Some of the fibres were characterized also by their sensory neuropeptide substance P-content, whereas sympathetic nerve fibres, as was assessed by their neuropeptide Y and vasoactive intestinal peptide contents, were very few. Sciatic nerve sectioning reduced all free but not perivascular CGRP-containing nerve fibres and nerve regeneration, as was evidenced by PGP 9.5 and GAP–43/B–50, was evident in muscle, periosteum, callus and bone marrow.

Conclusions: The results show that sciatic nerve sectioning is not a model of total denervation of tibial fractures, the femoral nerve might contribute by targeting its collaterals to the site of injury. The results indicate the involvement of neural influences in bone growth and healing processes.

Bone loss after fracture is partially nerve-mediated

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After tibial fracture boneloss is found in the ipsilateral femur (2). This is caused by an increased metabolism in the bone, and occur early after fracture (4). The skeleton seems to be richly innervated (3), and normal innervation may be important for the response of the bony tissue to injury (5). In the present investigation we studied the effect of sciatic nerve resection on boneloss in the femur after a tibial fracture.

Materials and methods: In 45 male Wistar rats, mean weight 253 g, the right tibia was fractured and stabilized with an intramedullary nail. The animals were randomly allocated to 2 groups, right sciatic nerve resection (SNR-group), or sham operation. The hindlimb was immobilized in a plaster cast during the healing period. After 25 days the rats were killed, and both femora removed. Incorporation of ^{85}Sr was measured. Bone mineral content (BMC) was measured using dual energy x-ray absorptiometry (DEXA).

Results: The femur ipsilateral (IL) to the tibial fracture showed a higher ^{85}Sr incorporation in the sham operated group compared to the SNR-group ($p < 0.05$). BMC was lower in the sham group in both the IL and the contralateral (CL) femur compared to the SNR-group (Table 1). When comparing the IL femur to the CL femur, the BMC was 19% lower in the SNR-group, but 25% lower in the sham-group ($p < 0.01$). The femoral area was 9% lower on the IL compared to the CL side in the SNR-group, significantly lower than the 14% difference in the sham-group ($p < 0.05$).

	BMC (G)		
Group	IL-femur	CL-femur	Ratio IL/CL
SNR	0.195[a] (0.015)	0.241[b] (0.019)	0.81[a] (0.06)
Sham	0.169 (0.016)	0.227 (0.014)	0.75 (0.07)

Mean (SD). [a]$P < 0.01$,[b]$P < 0.05$ SNR vs Sham

Discussion: Our results show that sciatic nerve resection partially protects the femur against the immediate boneloss normally occuring after an ipsilateral tibial fracture. This effect is partly due to a lower bone metabolism, which may be explained by changes in the release of neuroendocrine substances inflicting bone metabolism (1).

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Types I and III collagen turn-over following tibial fractures

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The aim of the present study was to decribe the synthesis and degradation of types I and III collagen following tibial fractures by measuring the serumconcentrations of the carboxy-terminal propeptide of type I procollagen (PICP), the amino-terminal propeptide of type III procollagen (PIIINP) and the pyridinoline cross-linked carboxy-terminal telopeptide of type I collagen (ICTP).

Patients and methods: 8 patients with fractures in tibial condyles and 16 patients with mid-shaft tibial fractures were included. Bloodsamples were collected at admittance and during fracture healing and analysied for PICP, PIIINP and ICTP with RIA-technique.

Results: Condyle fractures: PIIINP increased after 4 days with maximum after 2 weeks. PICP increased after one week with maximum after 6 weeks. Mid-shaft fractures: PIIINP increased after 1 week with maximum after 2 weeks. PICP increased after 1 week with maximum after 2 weeks. Treatment and speed of healing was not related to changes of the parameters in mid-shaft fractures. The changes of ICTP in the 2 groups were similar with an increase after 4 days and maximum after 2 weeks. No parameters were elevated after 26 weeks.

Conlusions: In tibial fractures type I and III collagen synthesis reaches maximum after 2 to 6 weeks. Delayed healing could not be related to quantitatively defficient collagen synthesis. The changes of ICTP is probably related to both fracture and general bone resorption following tibial fractures.

Healing of tibial fractures after ccute ischemia in the rat hindlimbs

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It is known from clinical studies that arterial injuries com-

plicating tibial fractures delay the fracture healing. This effect may be a result of the often advanced combined soft tissue damage, or the ischemia of the bone itself. The purpose of this study was to investigate the effect of transient circulatory arrest on the fracture healing in closed tibial fractures with little additional soft tissue damage in rats.

Materials and methods: 24 male Wistar rats (250 g) were randomized into 3 groups. In all rats the left hindlimb was fractured with a special forceps after insertion of a thin mandrin, and then fixed with an intra-medullary nail 1. Groups: ISCH: Acute ischemia was induced with a modified tourniquet technique in the left hindlimb proximal on the thigh just prior to making the fracture 2. Neurapraxia was induced by crushing the femoral and sciatic nerves between forceps. Reperfusion was established after 4.5 hours; NA: Neurapraxia of both femoral and sciatic nerves, no ischemia; CON: No other intervention than the fracture. The rats were killed after 6 weeks. The circulation in bone and musculature and bone mineralization were estimated with radioactive microspheres and 85strontium. The fracture strength was tested in three point bending after removal of the nails.

Results: After three to 4 weeks the NA and ISCH rats resumed weight-bearing, while the CON group ambulated normally after 3 to 4 days. Most fractures demonstrated external callus on radiographs. The weight of the musculus tibialis anterior was reduced in the NA and ISCH groups (Table). The weight of the fractured tibia was lower in the NA group, and the bone mineralization was lower in the ISCH group (Table). No differences between groups could be found for the circulation of the tibia by microsphere counting.

Group	Weight tibia (g)	Weight m.tib.ant (g)	^{85}Sr tibia (c/min/g x10^3)
ISCH	0.94 (0.06)	0.59^b (0.08)	43.5^c (5)
NA	0.85^a (0.13)	0.51^b (0.09)	57.9 (12)
CON	1.0 (0.11)	0.69 (0.06)	52.6 (12)

Mean (SD). $^aP < 0.05$, $^bP < 0.01$ vs. CON. $^cP < 0.05$ vs. NA

Also, there were no significant differences in mechanical strength between the three groups for the bending moment, energy absorption, and bending stiffness.

Discussion: In prior studies we have shown that 4.5 hours of ischemia with the present model induces nearly complete necrosis in the musculus tibialis anterior 2. In the present study most of the fractures healed by external callus. The extended period of acute ischemia did not seem to interfere with this type of fracture healing.

Conclusion: Circulatory arrest without severe soft tissue damage around the fracture does not cause delayed fracture healing in the rat tibia.

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CIRCULATION

Tourniquet ischemia induces periostal proliferation in the rat tibia

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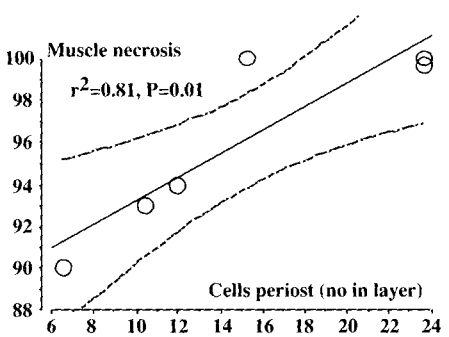
Healing of bone is complex and usually requires the transformation of one tissue type to another. New bone forms from pluripotential mesenchymal cells derived from muscle, fascia, periosteum, endothelial or perivascular cells, marrow cells and circulating cells. These cells are thought to be activated by local tissue trauma such as bending or compression of bone, local interruption of blood vessels and fibrin clots. The aim of this study was to investigate whether transient hindlimb ischemia could induce proliferation of the periosteal cells in rat tibias.

Materials and methods: Left sided hindlimb tourniquet ischemia was induced for 4.5 hours in 6 male Wistar rats [1] 72 hours later the animals were anesthetized, the hindlimb amputated, fixed in formaldehyd, decalcinated and embedded in paraffin. Complete cross sections of the lower legs were stained with hematoxylin and eosin and microscopically investigated. The extent of muscle necrosis in the anterior tibial muscle [1] and the thickness of the periost was measured by morphometry. 5 rats without ischemia were used as controls.

Results: The histological investigation showed extended post ischemic muscle necrosis, varying from 90–100 %. Cross sections from the control animals showed 2–4 layers of fibrous periostal cells. The osteogenic layer was not detectable. Corresponding sections from the post ischemic lower legs showed distinct changes in the periost, with marked hyperplasia and hypertrophy of the osteogenic inner layer. The cells closest to the bone had differentiated into osteoblasts with formation of new immature bone. The number of cell layers was increased to 15 ($p < 0.05$). The



correlation between muscle necrosis and periostal proliferation is demonstrated in Figure.

Discussion: In this study all surgery was done in the groin, and the stimulus to changes in the periost of the tibiae was therefore the ischemia.

Conclusion: Transient ischemia without any other local tissue injury induces periostal proliferation.

Reference: 1. Skjeldal S, Grøgaard B, Reikerås O, Müller C, Torvik A, Svindland A. Model for skeletal muscle ischemia in rat hindlimb. Evaluation of reperfusion and necrosis. Eur Surg Res 1991; 23: 355–365.

Hyperoncotic hemodilution does not reduce ischemic necrosis in skeletal muscle

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After prolonged ischemia in skeletal muscle reduced perfusion is seen despite increased tissue demands. Hemodilution with albumin in the early post-ischemic period has beeen shown to produce a significantly increased reperfusion rate measured by 133-Xenon clearance technique (1). The aim of this study was to examine the influence of albumin infusion on postischemic muscle necrosis.

Material and methods: In 16 male Wistar rats (250 gr), total hind foot ischemia was induced (2) and maintained for 3 h 30 min at 27 °C. Arterial blood pressure was monitored during ischemia and early reperfusion by catetherisation of the carotid artery. The anterior tibial muscle was dissected after 72 h's survival and prepared for histological examination. 2 different zones of muscles necrosis was found. A central zone of "no reflow" showed capillary damage and absence of macrophage invasion. An outer zone showed partial fiber damage, intact capillaries and macrophage invation (2). Both zones were mesured by morphometric methods.

The animals were randomised in 2 groups. In the treatment group, 0.5 mL 20% albumin corresponding to 0.40 g/kg were given intraarterially immediately before reperfusion and repeated 1 hour later. The control group had no infusion. The areas of muscle necrosis were compared statistically by Mann-Whitney U-test; the blood pressure measurements by ANOVA repeated measures.

Results: No significant increase in blood pressure was found in the albumin treated animals (Figure). Approximately 70% of the anterior tibial muscle was necrotic in both groups and there were no significant differences in either of the 2 types of necrosis (Table).

Conclusion: Our study demonstrated that hemodilution by albumin infusion during intital reperfusion did not affect postischemic muscle necrosis.

Table. Necrosis in the anterior tibial muscle

Albumin		Control	
% necrosis	% no-reflow	% necrosis	% no-reflow
40	2		
51	0	88	0
81	34	91	30
59	0	62	0
78	7	77	49
93	48	80	4
77	33	65	5
45	20	46	3
Mean 66	18	73	13
SD 19	19	16	19

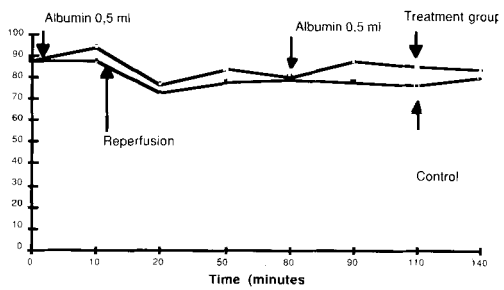

Figure. Mean arterial blood pressure during initial reperfusion.

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1. Gidløf A, Lewis D H. Int J Microcirc: Clin Exp 1990; 9: 267–284.
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Color monitoring in microsurgery

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Appropriate blood circulation is one of the most decisive factors in the successful microsurgery, whereas vascular insufficiency after the operations sometimes results in reexplore and vascular revision. The diagnosis of postmicrosurgical vascular insufficiency in the early phase is important and mostly depends on empirical inspection of skin color by trained microsurgeons.

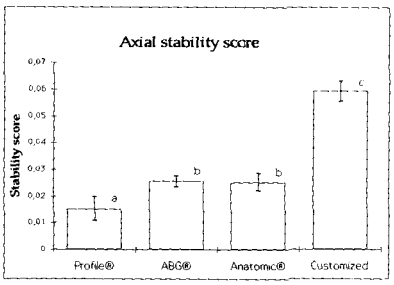
Aim of study: The qualitative skin colors can be converted into and expressed as numerical values by using color monitoring system. Quantitative analysis of skin color was performed with this system in order to examine its practicability for the diagnosis of postmicrosurgical vascular insufficiency.

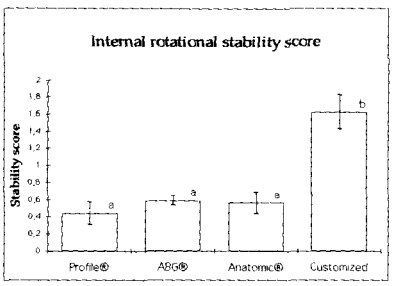
Materials and methods: 22 replanted fingers of 12 patients after traumatic amputation were examined.The skin

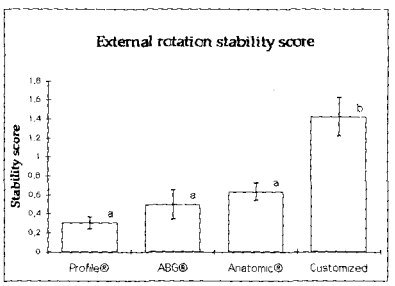
color was periodically monitored by MINOLTA-CR 200 CHROMA METER and assessed by L*a*b* COLOR NOTATION SYSTEM [Value:L*, Chroma: (a*2+b*2)1/2, Hue: tan-1(b*/a*)](MINOLTA, Japan).

Result: After the replantation of traumatic fingers. 12 fingers were uneventful (no complication), whereas 10 fingers revealed vascular complications and 5 of them showed necrotic change. The color monitoring analysis reflected their clinical courses and showed 4 types of characteristic pattern, namely, "uneventful", "acute arterial obstruction", "venous congestion", and "necrosis".

Conclusions: The skin color after the microsurgical operations can be quantitatively evaluated by color monitoring. It is useful for the diagnosis of postmicrosurgical vascular insufficiency.







PROSTHESES

Mechanical stability of custom-made and anatomical femoral implants; stability score based on implant-bone geometry

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The purpose of this paper is to apply a theoretical model, based on implant-bone geometry, for evaluation of femoral implant stability.

Material and methods: 15 anatomic, non-cemented and 5 custom-made femoral prostheses were inserted into cadaveric femurs. The 15 off-the-shelf prostheses consisted of 5 Zimmer Anatomic®, 5 DePuy Profile® and 5 Howmedica ABG®. The custom prosthesis were manufactured using CT imaging and CAD/CAM technique. After insertion the original prostheses were replaced by copies made of radioopaque PMMA equivalent to a CT-density of 3000 HU. Transverse CT-scans with thickness 2 mm were taken and the CT-data were read into a computer program. Contours were drawn along the implant and inner cortical surfaces, the latter contour following the pixels representing 700 HU. 100 points were distributed along the implant and inner cortical contours. Each of the points at the implant contour can be assigned a "geometry factor", reflecting the resistance to displacement. Finally, the fit of the prosthetic surface area contributing to resistance of motion is taken into consideration, and a "stability score" for a certain displacement can be derived using the following equation:

$$\text{Stabilityscore} = \frac{\text{GeometryFactor}}{K^{fit}}$$

K is a chosen number indicating the importance of fit. In these calculations, K is given the value 2.

Results: The stability scores for axial displacement and internal and external rotation are listed in the following figures.

The results have been statistically analyzed using the ANOVA test. Significant higher stability scores were shown for the customized prosthesis compared to the standard prostheses ($p < 0.001$). Comparing the standard prostheses, significant difference was shown between Profile® and Anatomic®/ABG® for axial stability and between Anatomic® and Profile® for external stability ($p < 0.03$).

Conclusion: A new method for evaluating femoral implant stability is described. The relative importance of implant-bone geometry and fit is considered and a stability score for a given translation or rotation is calculated. The stability scores for the customized prosthesis were significantly higher than the scores for the standard prostheses.

Resorption of hydroxyapatite coating during continuous implant loading

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The purpose of the present study was to quantitate the resorption of plasma-sprayed HA on porous coated titanium (Ti) alloy implants and to correlated the resorption of HA to the duration of the micromotion period.

Materials and methods: An implant device allowing controlled micromovements of 150 µm during each gait cycle was inserted unilaterally into the medial femoral condyles of 14 mature labrador dogs. The thickness of the HA coating was intended to be 50 µm. Four weeks after surgery, 7 of the dogs had the implant immobilised, group A; the other 7 dogs had a sham operation, i.e. the implants were still subjected to micromotion, group B. 16 weeks after the first operation the dogs were terminated. Histological cross sections were studied in the scanning electron microscope using backscattered electron image. The surface area covered with HA, the volume of HA, the mean thickness of HA, and the bone apposition were calculated using stereological methods.

Results: 73% of the surface area of two non-inserted control implant was covered with HA. This was significantly reduced to 26 and 16% in group A and B, respectively. The difference between group A and B was not significant (NS). The volume of HA was significantly reduced to 0.23 and 0.14 mm^3 per mm implant in group A and B, respectively. The difference between group A and B was NS. The mean thickness of HA on the control implants was 24 µm. On the test implants the thickness was reduced to 18 and 12 µm in group A and B, respectively (NS). Bone apposition defined as bone in direct contact with the implant surface or HA was 46% for group A, and 36% for group B (NS).

Conclusion: The HA as volume and surface area at the implants were reduced, significantly. There was a tendency towards greater resorption, when the implant had been subjected to continuous micromotion compared to immobilisation after 4 weeks. The resorped HA was partly replaced by bone.

Osteoblastic activity following cementless knee arthroplasty

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Fracture healing and bone ingrowth into the porous coating of joint prostheses are usually monitored only by use of radiographs. A simple and more reliable method for measuring bone formation following fracture or arthroplasty would be beneficial. Osteocalcin [=gamma-carboxyGLutamic Acid (GLA)] is a protein produced by osteoblasts only. A fraction of the osteocalcin produced by the osteoblasts can be measured in serum, where increased levels are a sign of increased osteoblastic activity and consequently increased bone formation. The aim of this study was to describe the changes in se-osteocalcin following a standardized major bone trauma, ie. the cementless total knee arthroplasty.

Materials and methods: 20 patients with primary arthrosis of the knee joint were treated with a unilateral cementless total knee arthroplasty (AGC 2000, Biomet Inc.). Venous blood samples were drawn pre-operatively and at post-operative day 1, 7, 14 and 30. Se-osteocalcin was measured using the DAKO Osteocalcin ELISA-kit (DAKO A/S). Data was compared with various procollagens (PICP, ICTP and PIIINP).

Table. Results (µg/L)

	pre-op	day 1	day 7	day 14	day 30
Osteocalcin	5.3	3.6	4.25	4.3	5.35

Page test for trend: Increasing tendency day 1 to 30, ($p < 0.001$).
Wilcoxon: Fall from pre-op to day 1, ($p < 0.001$).

Conclusion: The immediate post-operative drop in se-osteocalcin, followed by a continuous increase to approximately the pre-operative level, indicates initial decrease in post-operative bone formation (perhaps a stress response), followed by increasing osteoblastic activity. Serological bone markers may become usefull in evaluation of bone ingrowth and prosthesic loosening.

The toxicity of metals used in orthopedic prostheses—experimental studies using human osteoblasts metabolism in vitro

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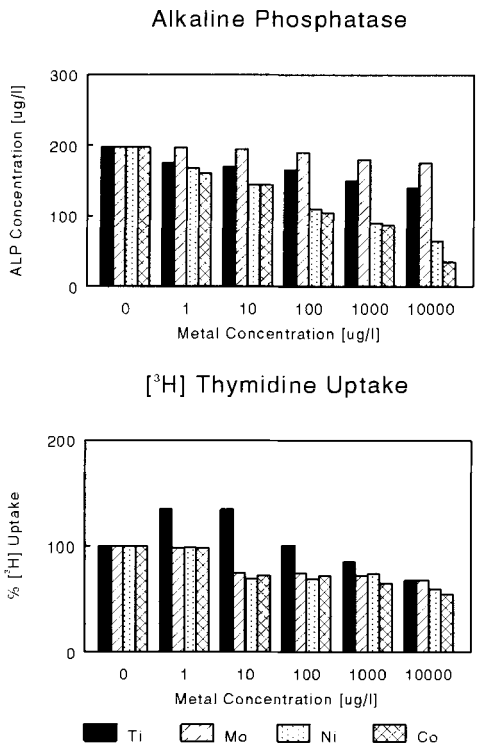
Various studies have shown that some components metals of the alloys used for total joint prostheses are toxic and dissolve in the body fluids. The potentially most harmful components cited are cobalt from cobalt chromium alloy, nickel from stainless steel and vanadium from titanium alloy. The isolation and culture of human bone cells was performed as described by Beresford et al (1984). In this tissue culture model of osteoblasts we exposed the cells to various concentrations of (1–10,000 mg) of metals such as titanium

(Ti), nickel (Ni), cobalt (Co) and molybdenum (Mo). The indices of osteoblast function measured were alkaline phosphatase (ALP) and [3H] thymidine to assess cell proliferation.



Ti and Mo were found to be least inhibitory towards the release of ALP whilst Ti had a significant stimulatory effect on [3H] thymidine uptake in relation to cell proliferation. These beneficial effects of Ti are consistent with the in vivo findings in relation to use of Ti containing prostheses which are tolerated and accepted by the patient's body much better than other metal prostheses. The mechanism involved in the action of these and other metals in joint tissue pathology is under further investigation in our laboratories.

Interstitial collagenase and TIMP-1 in loose THR endoprostheses

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Interstitial collagenase has been suggested to play an important role in the loosening of THR endoprostheses,Ref. but the relationship between interstitial collagenase and its inhibitor, tissue inhibitor of metalloproteinase (TIMP)-1 in loose endoprostheses is still unknown. The aim of study is to examine if the collagenolytic potential in tissues surrounding loose endoprostheses can be expressed or if it is inhibited by the endogenous inhibitor TIMP-1.

Materials and methods: Tissue extracts were prepared from both interface tissues (IFT) and pseudocapsular tissues (PCT) obtained from 9 cases of revision THR. Pseudosynovial fluids (PSF) samples were also collected. TIMP-1 and interstitial collagenase levels were measured by ELISA method. Collagenolytic activity, uninhibited by TIMP-1, was measured by % degradation of synthetic DNP-S substrate with reverse phase high performance liquid chromatography and on-line recording.

Results: TIMP-1 level was low in IFT (795 ± 203 ng/mL) compared to PCT (1267 ± 494 ng/mL) and PSF (2026 ± 584 ng/mL, $P < 0.05$). Interstitial collagenase level was higher in IFT (196 ± 41 ng/mL) than in PCT (90 ± 22 ng/mL, $P < 0.05$) and PSF (80 ± 35 ng/mL, $P < 0.05$). Degradation rate of the substrate was higher in IFT (63 ± 6 %) than in PCT (38 ± 4%, $P < 0.01$) and PSF (6 ± 2%, $P < 0.01$).

Conclusions: Low TIMP-1 level combined with high interstitial collagenase level seems to lead to a relatively high collagenolytic activity in IFT. This may in part explain the weakening of periprosthetic connective tissue bed, which weakening combined with a cyclic mechanical loading leads to loosening of THR endoprostheses.

Reference: Santavirta S, et al. Clin Orthop 1993; 290: 206-215.

Synovial fluid from patients with loosened total hip arthroplasty contain bone resorbing activity

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Bone resorption is considered to be a prerequisite for aseptic loosening of stable fixed prostheses. The mechanisms by which loosening is initiated are, however, not understood. We previously reported a higher bone resorbing activity (BRA) occurring in the newly formed capsule of total hip arthroplasties (THA) than in the bone-cement membrane (1). We have hypothesised that mediators constituting BRA might be released to the joint fluid and by means of fluid transport mechanisms eventually reach the bone cells in the bone-implant interface. The aim of the present investigation was to study BRA in joint fluids collected during exchange operations of aseptically loosened THA.

Materials and methods: Synovial fluid and periprosthetic

tissue were collected from 9 patients, with the primary diagnosis osteo-arthrosis of the hip, operated on due to aseptic loosening of THA (8 cemented, 1 uncemented). The fluids were stored at –70 °C prior to tests. For comparison, specimens of the joint capsule were harvested in 5 out of 9 cases to assess the production of BRA at these sites. These specimens were cultured and the collected supernatants of media (conditioned media) were stored at –20 °C prior to tests.

Experiments: a. The mouse calvariae bioassay technique modified by Lerner (2) was used, assessing the release of ^{45}Ca from prelabelled mice skeleton. In kinetic experiments, the release of ^{45}Ca at stated times was analysed by withdrawal of aliquots of culture media. b. The percentage breakdown of organic bone matrix of calvariae prelabelled with [3H]-proline was also studied. Otherwise these experiments were performed as above (a). Statistical analysis was performed using Student's *t*-test for unpaired samples.

Results: Synovial fluids of different final concentrations (5–20%) added to mouse calvariae cultures, caused in 9/9 cases a significant dose and time dependent stimulation of ^{45}Ca release. Conditioned media from capsule cultures obtained from 5/9 patients all contained factor(s) capable of significantly stimulating ^{45}Ca release. The stimulatory action of the synovial fluid on mineral mobilisation was inhibited by addition of CT (30 ng/mL). The release of 3H from [3H]-proline labelled bones was significantly stimulated by synovial fluid. The joint fluid of the patient which had an uncemented prosthesis with a loosened socket did not differ from the others regarding the BRA of joint fluid, assessed as ^{45}Ca release.

Discussion: This study shows the presence of BRA in 9/9 synovial fluids obtained at exchange operations due to aseptically loosened THA. The presence of wear particles causes a foreign body reaction and macrophage activation with release of BRA from the synovium to the joint fluid. Whether or not this BRA is responsible for the initial events underlying the loosening process can not be answered by this study. Our previous (1) and present observations focus the interest to the joint capsule and joint fluid as tissues probably involved in the initial processes of periprosthetic bone resorption underlying loosening of previously stable fixed joint arthroplasties.

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MOLECULAR BIOLOGY

Effects of ageing on rat sensory neurons in dorsal root ganglion and their terminals in spinal cord and knee synovium

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We have shown in our previous studies that inflammatory arthritis is accompanied by radical reduction of synovial vasoregulatory nerve fibres in both humans and experimental models. In this study we have investigated changes in primary sensory neurones, dorsal horn of the spinal cord and knee synovium in order to elucidate changes in the sensory nervous system during the ageing which might have relevance in the mechanisms of chronic joint diseases.

Materials and methods: Dorsal root ganglia and spinal cords from L4–L5 levels and knee joint synovium from 2 month (n 7) and 12 month (n 7) old Sprague-Dawley rats were studied using immunocytochemistry and antisera to growth associated protein GAP–43/B–50 and neuropeptides substance P and CGRP.

Results: In dorsal root ganglia, substance P was present in 20–25% of small sized neurones and CGRP in 42–51% of small and medium sized neurones, there being no significant differences between young and old animals. GAP–43/B–50 was upregulated in aged animals at L5 level from 35% to 53% of small and medium sized sensory neurones ($p < 0.01$). Computerized image analysis quantification revealed that in spinal dorsal horn laminae I–III, both substance P- and CGRP-containing sensory terminals were fewer in aged animals than in controls ($p < 0.05$ and $p < 0.01$, respectively). In knee synovium, GAP–43/B–50–, CGRP- and substance P-containing fibres were found mostly in sublining tissue but sometimes also interspersing with lining synoviocytes. GAP-43/B–50-containing nerve fibres were increased in aged animals whereas CGRP- and substance P-containing fibres were fewer compared to young controls.

Conclusions: The results show a correlation between ageing and degeneration of sensory nervous system. Cell bodies and synovial nerve endings immunoreactive for GAP–43/B–50 were increased in aged animals. This implies neuronal degeneration and a mechanism whereby cell function is directed for its own survival. Reduction of CGRP- and substance P-terminals in spinal cord is a reflection in central nervous system which may be involved in reduced tactile sensation. Reduced perivascular CGRP- and substance P-immunoreactive fibres in synovium may reflect decreased synovial metabolism in aged animals which cor-

relates with increased susceptibility of arthritis in aged population. The results indirectly suggest a role for sensory nervous system in the pathogenesis of arthritis.

Sensory innervation of vertebral end-plates and bodies in patients with lumbar disc resorption

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The mature intervertebral disc receives its nutrition largely by diffusion via the end-plate, from the capillary bed in the subjacent cancellous bone. This study was undertaken to test the hypothesis that neurovascular changes are associated with disc resorption.

Materials and methods: Intervertebral discs, with end-plate and cancellous bone of the vertebral bodies, were obtained from patients with internal disc disruption (n 7) or isolated disc resorption (n 11). Immunocytochemistry was used to localise the neuronal ubiquitous protein gene product 9.5 (PGP 9.5) and GAP–43/B–50, a protein associated with neuronal regeneration. Sensory nerves were identified according to their calcitonin gene-related peptide (CGRP) and substance P contents.

Results: In patients with still relatively high disc space, the neuronal profile resembled that observed in internal disc disruption. PGP 9.5– and GAP–43/B-50-containing fibres were seen in close proximity to blood vessels, some of the fibres exhibiting neuropeptides CGRP and substance P. In the most affected discs there was a proliferation of blood vessels and accompanying nerve fibres immunoreactive for PGP 9.5, GAP-43/B-50, CGRP- and substance P in the end-plate interface and vertebral body. In addition, many CGRP- and/or substance P-containing free nociceptors were observed throughout the vertebral bodies.

Conclusions: The neuronal profile of most affected cases suggests a chemotactic response to products of disc breakdown metabolites. Neuropeptides CGRP and substance P have potent vasodilatory effects in addition to their role as pain transmitters. This indicates an increased blood flow probably as a final neurovascular reparative attempt to increase the disc nutritional status. Such a changed profile and increase of sensory nerve fibres, indicates the end-plate, and vertebral body, as a source of pain production. This, taken together with the end-plate defects, suggests that chemical sensitisation of nociceptors and pressure changes caused by motility may partly explain the extreme pain experienced by patients with degenerative disc diseases.

Localization of bone sialoprotein and osteopontin mRNA in rat epiphyses by in situ hybridization

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Bone sialoprotein (BSP) a phosphorylated acidic glycoprotein found in mineralized matrix, may have a role in osteogenesis and in biological mineralization. Osteopontin (OPN) has similiar molecular characteristics, and in addition to a role in mineralization, OPN is most likely also involved in bone resorption. This study was undertaken to determine the localization of BSP and OPN production at the epiphyses by employing in situ hybridization with RNA probes.

Materials and methods: Proximal tibiae from 21-, 32-, and 84-day-old rats (n 2) were prepared as for conventional light microscopy. Following extensive digestion the sections were hybridized in situ with 35S labeled cRNA probes for BSP and OPN, and detected by autoradiography. The distributions of mRNA for BSP and OPN in three different compartments, i.e., the interface between articular cartilage/subchondral bone, epiphyseal bone and the proximal bone/cartilage interface of the epiphyseal growth plate, was evaluated from coded sections and labeling intensity quantitated on a four-graded scale.

Results and discussion: BSP mRNA labeling was highest in the articular cartilage/subchondral bone interface and in the bone/cartilage interface of the epiphyseal growth plate. The labeling in the midepiphyseal bone was low, with a similiar pattern in all 3 age groups (Table 1), labeling for OPN mRNA was similar, except for the 84-day-old group, which was somewhat lower in the proximal bone/cartilage interface of the epiphyseal growth plate. No differences between the age groups were observed in the distribution pattern (Table 2).

Table 1. BSP mRNA labeling

Age (days)	Articular cartilage/bone	Epiphyseal bone	Growth plate
21	2.25	0.5	1.75
32	2	0.05	1.25
84	1	0.05	1.5

Table 2. OPN mRNA labeling

Age (days)	Articular cartilage/bone	Epiphyseal bone	Growth plate
21	2	2	1.25
32	2	2	2
84	2	2	0.5

The different patterns of synthesis and expression in the epiphyseal area suggest that the 2 proteins may play differ-

ent roles in bone turnover. The present study coroborates previous results from metaphyseal bone where BSP synthesis and expression were observed closer to the growth plate than that of OPN, indicating that BSP has an earlier onset than OPN in osteogenesis. An additional role for BSP in the epiphyses may be to regulate processes at the osteocartilaginous interface, possibly by anchoring components of subchondral bone to the surface of calcified articular cartilage. Changes in this area may be of importance for the development of osteoarthrosis.

The effect of misoprostol, a prostaglandin E_1 analogue, on human osteoblast metabolism in vitro

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Rheumatoid arthritis and osteoarthritis are diseases which cause severe inflammation of the joints and leads to tissue injury ,loss of function and sever pain.First line treatment is with non-steroidal anti-inflammatory drugs (NSAIDs) which reduce inflammatoin and pain. However a major side effect of NSAIDs is that 10–25% of patients will develop ulcers.This side-effect has been shown to be reduced to 1.4% with the co-administration of 800 mg/day misoprostol, a prostaglandin E_1 analogue.

The isolation and culture of human bone cells from trabecular bone was performed as described by Beresford et al. Misoprostol and indomethacin were the drugs tested, both separately and together. The concentration of drugs used was between 0–1000 mg/L and osteoblasts were incubated for 6 days befor undergoing analysis.The end points measured were proteoglycan synthesis,degradation and alkaline phosphatase secretion. The results are shown below. Misoprostol on its own did not cause either synthesis or degradation except at 1000 mg/L where there was an increease in both synthesis (228%) and degradation (209%) and therefore a net increase of 19%. Indomethacin combined with misoprostol showed a decrease in GAG synthesis and an increease in degradation.There was also decrease in ALP secretion showing that the osteoblasts were not undergoing proliferation.

Indomethacin works by irreversibly binding to cyclooxygenase and thus prevents the production of PG. Interleukin 1 (IL-1) is involved in cartilage breakdown and PGE is believed to feedback on IL-1 and down regulate it therefore preventing further destruction. A Possible mechanism why misoprostol in conjunction with an NSAIDs does not appear to cause cartilage protection is that misoprotol may not feedback to inhibit IL-1.

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3. Beresford J N et al Metab Bone Dis Rel Res 5: 229–234 (1984)
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Osteoblasts express nitric oxide synthase in response to stimulation with cytokines

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Nitric oxide (NO) is a newly described free radical messenger molecule with several basic physiological and pathophysiological functions. NO acts as a potent inhibitor of osteoclastic bone resorption in vitro indicating its role in bone metabolism. We have sought to investigate whether inducible NO synthase is expressed by osteoblast cell lines and whether NO exerts effects on osteoblast function.

Gene expression studies: In situ hybridisation, using cRNA probes for inducible rat macrophage NO synthase, showed dense labelling of IFN–g, TNFa and IL–1ß stimulated murine MC3T3 osteoblasts. Unstimulated cells had only weak labelling compared to stimulated ones. PCR amplification of ROS 17/2.8 derived osteoblast inducible NO synthase mRNA showed basal mRNA expression which was elevated by stimulation with IFN–g.

Nitrite production: Cultures of rat derived ROS 17/2.8 osteoblast-like cells were exposed to IFN–g, TNFa, IL–1ß with or without L–arginine analogue NG–monomethyl–L–arginine (L–NMA), a prototypic inhibitor of NO synthase, and inhibitors of protein and RNA synthesis cycloheximide, actinomycin D and dexamethasone. IFN–g caused a dose and time dependent production of nitrite, an end–product of NO, which was synergised by IL–1ß and more potently TNFa. IFN–g–induced nitrite production was inhibited by cycloheximide and actinomycin D and attenuated by glucocorticoid dexamethasone. L–NMA had a dose dependent inhibitory effect on IFN–g–induced nitrite production which was reversed by L–arginine.

DNA replication and cell proliferation: In further functional studies the effects of IL–1ß and L–NMA on the proliferation of human MG–63 cells was tested. Mid log–phase cells were stimulated with IL–1ß±L–NMA for 24 hours, and pulse labelled with bromodeoxyuridine for 2 hours. IL–1ß caused a 43% reduction in labelled cells but this effect was reversed to control level by L–NMA.

Conclusions: The results show that osteoblasts derived from murine, rat and human sources express inducible NO

synthase in response to cytokine stimulation. The results suggest that NO functions as an intracellular mediator of osteoblast activity. Rank order of nitrite production between the different cell types was MC3T3 > ROS 17/2.8 > MG–63 indicating species specific inducible NO synthase gene transcription and protein synthesis. Osteoclastic resorption activity is partly regulated by locally produced factors which act via osteoblasts. This suggests that osteoblast derived NO, induced by various cytokines, may exert effects on osteoclast function. Production of NO by osteoblasts in chronic inflammatory diseases may have a crucial role in the pathophysiology of affected bone and joint.

BONE MINERAL MEASUREMENT QUALITY

Pairwise relationships among cortical and cancellous bone strength parameters in human femur at autopsy

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In previous studies, we showed that the strength of femur in one legged stance and torsional loading correlates with bone mineral mass in various locations of the lower extremity (1–4). By using different mechanical tests, we wanted to study such relationships further.

Material and methods: 14 pairs of elderly femurs at autopsy, age 59–92 years, body weight 56–76 kg, height 158–178 cm, were retrieved at autopsy. Bone mineral was measured by single energy quantitative computed tomography (Philips Tomoscan, 100 mAs, 120 kV, clinical parameters, no phantoms) (5). CT mass was defined as CT density x slice volume. Distal femoral shafts were subjected pairwise to 3-point bending and pull-out of screw tests. Condylar cancellous bone was studied by using punch and cube compression tests, one performed on the right and the other on the left femur.

Results: In 3-point bending, CT mass of the femoral shaft and condyles correlated with bone strength (R^2 0.50 and 0.42, resp.), while CT density did not. In compression of cancellous cube and punch test of the lateral condyle, correlations were found between bone strength and mineral, both CT density and mass (R^2 0.60–0.82). In pairwise comparisons of bone strength, we found highly significant correlations between the maximal load in 3-point bending of one femur and pull-out test of the other (R^2 0.68). Similar correlation was found between the maximal load in punch test of one femur and cube compression of the other (R^2 0.69). On the other hand, no correlation was found between 3-point bending and cube compression in tests performed on the same femur. Nor did we find correlations between pull-out and punch tests performed on the other femur of a pair.

Conclusions: Bone mass measures in femoral shaft and condyles correlated with bone strength in all 4 mechanical tests. However, the cortical and cancellous bone mechanical properties were not interrelated which suggests a separate regulation of the strength of these two types of bone.

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Calcium concentration of bones related to single energy quantitative computed tomography

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Quantitative computed tomography (QCT) has become an important noninvasive tool in the studies of osteoporosis and bone strength (1,2). Therefore, the relationships between QCT and calcium in different sites of bone are important. The present study is an extension of a previous report (3).

Material and methods: Diaphyseal cortical and distal metaphyseal cancellous bone was harvested from 38 elderly normal femura at autopsy and stored at –20 °C. Single energy QCT was measured at cortical and cancellous levels with a Philips Tomoscan (1) from 100 to 3000 CT units (HU). Slices of 1 cm thickness were cut from all tomographed areas. The calcium content was measured by atomic absorption spectrophotometry.

Results: The correlation (R^2) between ash density and Ca/mL bone was 0.99. R^2 Ca/mL bone vs. CT density was 0.91. Transforming CT density to logaritmic numbers, the correlation was 0.95. Regression analysis showed a slight nonlinearity.

Calcium concentration (mmol/g) = 11.88 log CT density - 27.8.

Conclusions: Improved correlations between bone calcium and QCT measures were obtained in the present study (3). Bone mineral as measured by single energy QCT gives a accurate expression of calcium in various bone sites.

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Different skeletal responses to bisphosphonate and indomethacin in oophorectomized rats

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Bisphosphonates have antiresorbtive effects on bone. Prostaglandin E_2 stimulates bone formation. Oophorectomized rats on a low calcium diet develop cortical and trabecular osteoporosis (1). Can the second generation bisphosphonate, clodronate and the prostaglandin-inhibitor, indomethacin, affect this process?

Material and methods: 48 female Wistar rats were randomized into 5 groups: 3 were oophorectomized (Ovx) and 2 were sham-operated. The Ovx- and the Sham-Ca groups were fed a low-Ca diet (Ca 0.01%), and Sham+Ca a normal diet (Ca 1.1%). Ovx-I had daily i.p. injections of 3 mg/kg indomethacin, Ovx-B got 10 mg/kg clodronate s.c., and the Ovx-C (control) and Sham-groups saline water s.c.. ^{85}Sr was injected 4 days prior to sacrifice, and after 9 weeks the right femora were tested in 3-point bending until fracture. The left femora were ashed.

Results: The femoral ultimate bending moment was significantly lower in Ovx-C compared to Sham-Ca, and bending moment and energy absorption were lower in the Ovx-as in the Sham-Ca-groups compared to the Sham+Ca group ($p < 0.0001$). Stiffness was significantly higher in Sham+Ca except compared to Ovx-B. Ovx-B had significantly higher stiffness than Ovx-C. Dry and ash weight, Ca and ^{85}Sr, see table.

Group	Dry weight (mg)	Ash weight (mg)	Ca (mmol)	^{85}Sr x10^3 (C/mg/min)
Ovx-C	522 (40)[a]	269 (20)[a]	2.61 (0.15)[a]	48.7 (10.2)[a]
Ovx-B	487 (24)[ab]	267 (13)[a]	2.46 (0.19)[a]	50.5 (14.9)[a]
Ovx-I	482 (28)[ab]	243 (30)[ab]	2.47 (0.14)[a]	62.4 (21)[ab]
Sham-Ca	488 (19)[ab]	277 (16)[a]	2.65 (0.19)[a]	62.3 (14.2)[ab]
Sham+Ca	567 (44)	346 (41)	3.13 (0.31)	27.1 (6.5)

Mean (SD). $P < 0.01$ [a]compared to sham+Ca, [b]compared to Ovx-C.

Discussion: Indomethacin increased the boneloss and reduced femoral fracture-strength seen 9 weeks after oophorectomy. Bisphosphonate did not reduce the boneloss assessed by ashing, but the femoral stiffness was significantly increased compared to the ovx-control femora.

Conclusion: Indomethacin increased the development of femoral osteoporosis, while bisphosphonates had an uncertain effect.

Reference: Nordsletten L, Kaastad TS et al. J Bone Miner Res 1993; Accepted.

Dual energy X-ray absorptiometry for prediction of bone mineral content and fracture strength in femora, and correlation to tibial histomorphometry

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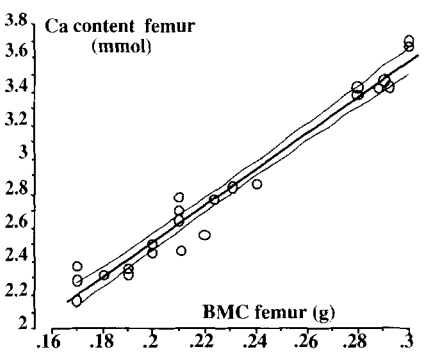
The ability to evaluate bone mineral content (BMC) and density (BMD) non-destructively leaves the opportunity also to measure the mechanical strength or to do histomorphometry in the same specimens. Single photon absorptiometry (SPA) has been used for BMC measurements 1, and recently dual energy X-ray absorptiometry (DXA) has been introduced for small animals with higher precision than SPA 2.The precision of DXA for measuring bone mineral and mechanical strength in rat femora is reported.

Material and methods: 23 femora from an experiment of training effects on osteoporosis in adult rats were used. The BMC (g), BMD (g/cm^2) and the area of the whole femur were assessed by DXA on a Lunar DPX-l, applying the forearm software in the detail mode. Both femora from each rat were scanned once immersed in water. The DXA precision for rat femur was estimated by duplicate measurements on different days of 30 femora not related to the present study. The coefficients of variation were 2.5% for BMC, 1.9% for BMD and 1.8% for area. The left femora were ashed after volume determination, and the ash weight and the calcium content measured. The mid-shaft of the right femora were fractured in 3-point cantilever bending. Static histomorphometry of the distal tibial diaphysis and metaphysis was done on cross sections. BMC and BMD by DXA were compared with ash results, histomorphomety and mechanical results by linear regression analysis.

Results: The accuracy of BMC measured by DXA was very high when compared to calcium content ($r = 0.98$, $p < 0.001$, Figure) and ash weight ($r = 0.96$, $p < 0.001$). DXA



overestimated the BMC of the femur by 27% as compared to ash weight. BMC was also highly correlated to fracture strength of the shaft measured by the ultimate bending moment ($r = 0.85$, $p < 0.001$) and the energy absorption ($r = 0.64$, $p < 0.01$). BMC and BMD were correlated to trabecular bone volume ($r = 0.8$ and $r = 0.83$, $p < 0.001$) of the distal tibial metaphysis, and to medullary area of the distal tibial diaphysis ($r = 0.6$ and $r = 0.66$, $p < 0.01$).

Conclusion: This study shows that DXA is a very precise tool for prediction of bone mineral content of the whole femur, and for fracture strength of the midshaft.

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The development of femoral osteopenia in ovariectomized rats is not reduced by high intensity treadmill training

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Only a few training studies have been undertaken in ovariectomized animals. In the present study the effect of treadmill running on the development of osteopenia was investigated in adult ovariectomized (OVX) rats compared to sedentary OVX and sedentary sham operated rats.

Material and methods: 25 female Wistar rats (214 g) were randomized to 3 groups: Ovariectomy-training (OVX-T), ovariectomy-sedentary (OVX-S) and sham operated-sedentary. The 9 weeks training program consisted of running on a treadmill with 10% inclination. 4 days after the operation rats were conditioned to running for 12 days until a final speed of 27 m/min for 30–60 min 5/7 days per week. The ovariectomized animals were given a diet deficient in calcium (Ca 0.01%), while the sham operated animals were fed a normal diet (Ca 1.1%).

Results: Comparing the 2 OVX groups training had no significant effects on the development of femoral osteopenia as assessed by mechanical testing of the shaft and neck, and by BMC (g) and BMD (g/cm^2) measured by DXA. BMC and BMD were reduced by more than 40% in both the OVX groups compared to the sham operated rats ($p < 0.001$). Femoral volume and length were 10% higher in the sedentary OVX animals compared to the trained ($p < 0.05$). The fracture strength of the femoral shaft was reduced by 26% and 22% in the trained and sedentary OVX rats, respectively, compared to the sham operated group ($p < 0.001$). The fracture strength of the femoral neck was reduced by 18% and 15%, but due to one very weak neck in the sham group this difference was not significant.

Discussion: Training animals had lower femoral volume and length than sedentary OVX rats indicating that the training had had a negative effect on the growth changes induced by ovariectomy. Although no positive training effects were found, it is possible that effects on the surrounding muscles and soft tissues may be protective against fracture, as we have shown previously to be the case for muscle contraction during fracturing of trained male rats.1

Conclusion: This study shows that high intensity training had no positive effect on the development of osteopenia in rats.

Reference: 1. Nordsletten L, et al. J Bone Miner Res 1993; 8: 1089–1095.

In vivo bone mineral measurement of the cranium indicates loss of bone mineral density with age regardless of physical activity.

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There are numerous papers proving that physical activity can, at least for a short period, maintain skeletal integrity. However, loss of sexual hormones with age is also a factor that induces bone loss. It is of interest to study to what extent hormonal withdrawal influences the bone mineral density, regardless of alteration in physical activity with age. The upper part of the cranium is the only region not involved in physical activity, and changes of bone mineral density with age is therefore of interest in this region.

Material and methods: The bone mineral density (BMD) was measured in 324 residents, of both sexes, from the city of Malmö by DEXA technique. Standard regions such as total body, spine and hip were measured as was a special region of interest defined as all skeletal parts above the lower parts of the orbitae.

Results: The BMD in the upper skull was considerably higher than all other measured regions in both sexes. The women had 6% higher BMD in the skull than the men ($p < 0.001$). In women the peak bone mass in the skull occured soon before menopause while in men there was a slow loss of bone throughout all ages from early adulthood. The percentage loss of bone mineral was in both sexes higher in the weightbearing regions than in the skull.

Conclusion: Measurement of BMD in the upper part of the skull can serve as a model for studying the effect of age on BMD, after withdrawal of the confounding factor of physical activity. There are considerable differences in bone loss with age between the 2 sexes. This is the first time data are presented revealing higher BMD in women than in men.

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Radiological demarcation as a diagnostic sign in loosening of uncemented screw cups in total hip arthroplasty

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Introduction: The fixation of an uncemented acetabular screw cup was studied radiologically and histologically in goats in order to demonstrate the relationship, if any, between the radiological features and the histological interface, and to assess the fixation technique.

Materials and methods: Uncemented acetabular screw cups type Mecron, combined with cemented femoral stems were implanted in 20 young fully grown dwarf goats. The goats were killed after mobilization periods of 6 weeks (n 8), 6 months (n 6) and 12 months (n 6). Also, in 3 of these goats just before the end of the experiment a control screw cup was placed on the contralateral side (the 0–week group). Anteroposterior and axial radiographs were obtained of the pelvis and of the operated hip. Then, the total acetabulum was resected en bloc from the pelvis and fixed, dehydrated and imbedded in methyl methacrylate. Contact radiographs were made of the bone-implant contact area, in order to obtain a good profile image of the thread of the screw cup in the bone. The radiographs were scored for demarcation as a sign of loosening. Subsequently, the study material was processed for and photographed with the backscatter electron microscope (Philips 525 M). In addition, one-half was processed for histological evaluation. The optic microscope and electron microscope were used to assess the degree of osseo-integration and the quality of the bone-implant interphase. Furthermore, the synovium was examined for presence of polyethylene particles and rests of foreign-body reaction of the cells. The material was analysed statistically. Kendall's Tau-c was calculated as the correlation coefficient. *P*-values smaller than 0.05 were regarded as significant.

Results: Only 3 goats showed no demarcation, 1 in the 6-week and 2 in the 26-week implantation group. Slight demarcation was seen in 4 goats. The remaining 13 goats all displayed extensive demarcation with migration of the cup. No migration was seen in cases with little or no demarcation. The 3 control acetabula containing a screw cup (0-week group) on contact radiographs showed an incomplete bone-implant contact. Histological assessment revealed good osseo-integration in only 3 goats, 1 in the 6-week and 2 in the 26-week group. This was confirmed electron-microscopically. The remaining 17 goat preparations showed a fibrous membrane interface between bone and implant. Two types of this could be distinguished: a thin interface rich in collagen and a thicker interface low in collagen.

Preparations taken of the synovium showed giant-cell reaction and polyethylene particles. No such picture was seen in the interface membrane.

Conclusions: Goats without radiological demarcation (n 3) histologically showed good osseo-integration, while goats with demarcation (n 17) showed a fibrous membranous interface. Migration was only observed in combination with a fibrous membranous interface low in collagen. Histological examination of the 0-week (control) group and 6-week groups of goats showed that primary fixation in general was inadequate. Our study demonstrates:

1. very good reliability of demarcation as a radiological sign of loosening of uncemented acetabular screw cups ($p = 0.035$);
2. osseo-integration excludes radiological demarcation;
3. a fibrous membranous interface rich in collagen provides a more stable implant fixation than a type low in collagen;
4. press-fit fixation was only obtained in exceptional cases if this implant was used.

The development of a bioresorbable cement plug—in-vitro study, animal experiments and first clinical results

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Introduction: It is a known fact that poor cementing technique may give rise to early failure of a prosthesis. Retrospective analysis of the polyethylene 'Thackray' cement plug used in our clinic showed that complications had occurred with 30–40% of these plugs (migration of the plug, leakage of the plug, disintegration of the plug, osteolysis round the plug, problems with removal during revision surgery). This prompted us to design a new cement plug, which not only had to be bioresorbable but also resistant to the high pressure required for adequate cementing technique.

Design and testing of the new plug: As material for the plug we selected 'polyactive' (PA) in a well-resorbable form (3–6 months). This biological material has the added advantage that after contact with moisture it swells rapidly so that it becomes fixed in the medullary canal. A conical shape was selected. In trial femurs, the femoral canal was reamed out to diameters of 13 and 16 mm, respectively. PA plugs with bottom diameters of 10, 12 and 15 mm, respectively, were inserted and kept moist for 15 minutes using physiological saline, the Thackray plug serving as a control. High-viscosity cement was put on top of the plugs under maximal pressure, and the actual intramedullary pressure was measured via a pressure cannula.

Table. The left-hand column of the table lists the reamer sizes. For every diameter listed of the polyactive plug and of Thackray plug, the table shows the pressure in KPa measured during the experiment. The symbol between parentheses shows plug migration during the experiment

	polyactive			Thackray
size	10 mm	12 mm	15 mm	standard
13 mm reamer	18.6 (+)	18.6 (+/–)	21.3 (–)	2 (++)
15 mm reamer	9.3 (+)	18.6 (+/–)	18.6 (+/–)	2 (++)

Plug migration: – none, +/– < 1 cm, + 1–3 cm, and ++ 3–6 cm.

Result: The table shows not only that the cementing pressure of the PA plug is far higher than that of the Thackray plug, but also that migration and/or leakage occur much less readily.

Clinical analysis: The newly developed plug was implanted in a pilot study in 21 patients, the canal diameter measured on the AP radiographs serving as a measure of the plug. Radiographic analysis with a minimal follow-up of 3 months showed migration (1 cm) and leakage from the plug in one patient, distinct leakage in one other patient and slight leakage from the plug (not more than 0.5x0.5 cm) in two more patients. In the two patients with distinct leakage it was found that the femoral canal was much wider in the axial direction than in the AP radiograph in other words the femoral canal had an oval shape. Statistical analysis using the unpaired *t*-test shows that an absolute difference of 4 mm or more is associated with leakage ($p < 0.01$), while an oval shape of the femoral canal (ap diameter/ax diameter < 0.75) statistically also causes a markedly increased risk of leakage ($p < 0.001$). To conclude, the newly devised cement plug appears to be clinically satisfactory, but it is advisable before inserting the plug to measure the diameter of the femoral canal in the lateromedial as well as in the anterioposterior direction. For this purpose, a new instrument has been developed.

Analysis of the osteoconductive properties of the biomaterial Polyactive in the rabbit

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In orthopedic surgery larger bone defects usually are filled with autologous bone (to the extent available) supplemented with allogenous frozen bone. Allograft bone has a limited osteoconductive potential, while transmission of infectious diseases cannot be excluded. The purpose of the present study was to analyse the osteoconductive properties of a new biomaterial, Polyactive (PA).

The biomaterial: Polyactive is a copolymer consisting of polyethylene oxide and polybutyleterephtalate. By changing the proportion of the two elements, both the resorbability and the osteoconductivity of the polymer can be varied. For this experiment, polyethylene oxide/polybutyleterephtalate ratios of 70/30 and 60/40 were chosen. One-half of the biomaterial plugs were preincubated with allograft bone and then frozen at –20 °C, so that only the bone growth stimulating factors remained.

Material and method: 40 rabbits, aged 6 months, were used for this experiment. A defect with a diameter of 4 mm and a depth of 6 mm was made in the lateral cortex distal of the greater trochanter on both sides. The defect in the right femur was filled with a cylinder of the biomaterial, while the defect on the left was left untreated. The rabbits were killed 4, 8 and 26 weeks, respectively, after the operation. The osteoid deposition and the calcification of the biomaterial were analysed using the Dual X-ray Absorptiometric Analysis (DEXA) and histological methods that allow quantification of the amount of newly formed bone (Quantimet).

Results: After as little as 4 weeks distinct osteoid deposition could be observed on the side treated with the biomaterial. It was found that the osteoid deposition is preceded by calcification of the biomaterial which is then replaced by bone. Primary bone formation takes place in the medullary canal as well, but after 26 weeks this was found to be disappearing. After 26 weeks the diaphyseal cortex showed very

good repair, while on the control side there was only a thin layer of fibrous material. Quantitative histological analysis proved that the side fitted with a PA plug formed more bone than the control side, even after 4 weeks but also after 8 and after 26 weeks ($p < 0.01$). It was found, however, that the 70/30 PA induced more bone formation than the 60/40 material. After 26 weeks, about one-third of the biomaterial is still present. Only sporadic giant cells were seen in the material and there were no signs of acute inflammation. The biomaterial plugs loaded with allograft bone on the other hand, were seen to bring about a very distinct inflammatory reaction in the host. Also, the amount of newly formed osteoid is clearly less than if no allograft bone is added.

Conclusion: Polyactive is a suitable material to accelerate bone formation and may serve as a substitute for allograft bone. The addition of allograft bone factors to the biomaterial leads to a distinct inflammatory reaction, as also observed after use of a mixture of autograft and allograft bone. This impairs deposition of new bone on the biomaterial.

Two forms of local application of antibiotics compared with systemic administration in the treatment of experimental chronic osteomyelitis

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Definition of the problem: Since the introduction of local antibiotics, usually in the form of gentamicin-PMMA beads, one of the major drawbacks has been that the delivery substance had to be removed at a later stage. In recent years there has been much research into soluble delivery substances for antibiotics, of which the collagen membrane is one.

It has been demonstrated earlier that local antibiotics cause much lower serum levels than systemic administration, with a much higher concentration of the antibiotic at the site of the inflammation. A gentamicin collagen membrane introduced in the late eighties was found to release its gentamicin in a relatively short time. To prevent this, part of the gentamicin was added in a hydrophobic rather than in a hydrophilic form (Septocoll, Merck, Darmstadt). Such a gentamicin membrane was available for study. Our question was if the action of the new collagen membrane was comparable to that of gentamicin beads.

Study design: Animal experiment, using a sheep model for chronic osteomyelitis: a local osteomyelitic process was created in the proximal tibia by surgical intervention. 36 sheep with a proved (culture) chronic osteomyelitis of 3 months' standing were cleansed surgically, and then subdivided into four groups. One group (n = 10) were treated with parenterally administered antibiotics. One group (n = 10) with a chain of 10 minibeads (= 34 mg gentamicin). One group (n 8) with gentamicin collagen membranes; one-half membrane (= 35 mg gentamicin) was introduced into 5 sheep and a whole membrane (= 70 mg gentamicin) in 3 sheep .In addition there was a control group (n 7) subjected only to surgical cleansing, without antibiotic treatment.

Parameters were clinical observations, laboratory investigations, radiographs, histological and pharmacokinetic studies.

Results: The animal model proved to be consistently well suitable for study of chronic osteomyelitis.

Regarding the pharmacokinetic properties (serum and urine concentrations, 24 hour gentamicin excretion), the sheep treated with gentamicin collagen and with minibeads showed comparable findings. In the group treated with collagen membranes, the serum gentamicin level was measurable (0.4 g/mL) in only one sheep; in the sheep treated with the minibeads, the concentration was always below the limit of demonstrability. The mean urine concentrations for the groups were as follows: minibead group up to 4.5 g/mL, half collagen membrane up to 8.2 g/mL, whole collagen membrane up to 84 g/mL. In the treated groups, cortical bone concentrations were still measurable 3 months after implantation of membranes as well as of minibeads.

Clinical and laboratory parameters (temperature, leukocytes) showed few differences. Radiographs examined blindly and independently by three orthopedic surgeons showed no differences between the four groups, and the histological findings were comparable as well.

In sheep treated with collagen membranes we did not find the increased secretion sometimes reported in clinical treatment.

Conclusions: The collagen membranes with the hydrophobic gentamicin and the mini gentamicin-PMMA beads were pharmacokinetically comparable. Measurable concentrations of gentamicin in bone were still found relatively long after the treatment.

The group sizes were too small to allow reliable conclusions on therapeutic efficacy from clinical recovery, bacteriology or histology.

Synthesis of collagen type X by human chondrocytes in culture

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Introduction: Hypertrophic chondrocytes play an important part in calcification of cartilage, as occurring in normal physiological circumstances in the epiphysis, but also under pathological conditions in arthrotic cartilage and perichondrial transplants. We are searching for methods to counteract calcification of perichondrial transplants and have attempted to develop an in-vitro model in which hypertrophy of chondrocytes occurs and can be studied. Collagen type X

and alkaline phosphatase can be used as markers for hypertrophic chondrocytes.

Methods: Chondrocytes were isolated from human arthrotic cartilage obtained at implantation of a hip or knee prosthesis. Cartilage was digested with a crude collagenase preparation for 17 to 24 hours at 37 °C. The cell suspension was diluted to 300,000 cells/mL and distributed over sterile conical centrifuge tubes in amounts of 1 ml. The cells were pelleted briefly and then cultured in DMEM containing 10% fetal calf serum and vitamin C. The cultures were kept for 5, 8, 12, 15 or 20 days. During the last 24 hours of the culturing H3-proline was added to the medium for radioactive labelling of the collagens synthetized during that period. Subsequently collagens were isolated from the culture medium and from the cell pellets by means of ammonium sulphate precipitation and analysed by polyacrylamide gel electrophoresis and fluorography. The amounts of collagen synthetized were determined semi-quantitatively by means of densitometry. Alkaline phosphatase was determined in the cell pellets using a commercially available kit for alkaline phosphatase.

Results: It was found that chondrocytes isolated from human arthrotic cartilage and cultured synthetized a protein with a molecular weight of approximately 60,000 Da that was highly sensitive to very pure collagenase. This protein in all probability is collagen type X. It was found that collagen type II was synthetized as well, but in far smaller quantities than collagen type X. Cultured chondrocytes after approximately 12 days were found also to produce measurable quantities of alkaline phosphatase.

Conclusion: Chondrocytes from human arthrotic cartilage when cultured synthetize collagen X and alkaline phosphatase. In this culturing system, therefore, terminal differentiation of chondrocytes occurs. The markers of hypertrophic chondrocytes can be quantified. Consequently, the model appears suitable for the study of hypertrophy of chondrocytes.

Reconstruction of the flexor tendon sheath A study in experimental animals

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After injury of the flexor tendons of the hand loss of the sliding function is still one of the most redoubtable complications. Development of adhesions remains unpredictable, in spite of the evolution in the treatment of flexor tendon injuries in the last few decades. Reconstruction of the tendon sheath contributes to recovery of the sliding function of the tendons.

In this investigation the use of autologous parietal peritoneum and preserved porcine collagen for reconstruction of the tendon sheath was studied. The preserved porcine collagen (PPC) consists predominantly of untanned type I collagen. The material was sterilized with ethylene oxide.

The test animals (n 54) were female white New Zealand rabbits of approximately 2.5 kg. For the experiments use was made of the intrasynovial flexor tendons of the second ray of the front paws. There were eight study groups. *Group 1:* resection of the tendon sheath. *Group 2:* reconstruction of the tendon sheath using autologous peritoneum. *Group 3:* reconstruction of the tendon sheath with PPC. *Group 4:* repair of the two tendon sheaths after transection. *Group 5:* tendon repair and reconstruction of the tendon sheath with peritoneum. *Group 6:* tendon repair and reconstruction of the tendon sheath with PPC. *Group 7:* excision of a wedge from the two tendon sheaths. *Group 8:* excision of a wedge from both tendon sheaths in combination with reconstruction of the tendon sheath with PPC.

In 6 rabbits, a flap of PPC measuring 1x1 cm was implanted into the interscapular subcutaneous tissue as well and assessed after 3 months.

The animals were killed after 1 day, 1 week, 7 weeks and 3 months and the results of the experiments were assessed. Assessing was done macroscopically for formation if any of a new tendon sheath and development of adhesions. For histological examination the tendons were removed en bloc with the newly formed tendon sheath and fixed in 3.8% formalin. The sections were stained with hematoxylin-azaphloxin/eosin and elastica-Van Gieson. The sections were examined with regard to the tendon sheath, the lining of the flexor tendons, the repair of the flexor tendons and, of course, the development of adhesions. The reactions surrounding the materials, including the suturing materials, were examined as well.

Conclusion: Use of autologous peritoneum and PPC for tendon sheath reconstruction does not lead to development of adhesions. Combination with a tendon suture, also, is followed by formation of a neo-tendon sheath clearly separated from the flexor tendon. PPC gives rise to a slight inflammatory reaction largely consisting of mononuclear cells. Subcutaneously implanted PPC is resorbed more quickly than PPC used for tendon sheath reconstruction.

Quantitative bone scintigraphy as a method of measuring local epiphyseal growth activity—clinical and animal-experimental study

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Significant differences in leg lengths in children are mostly the consequence of a growth disorder in one or several epiphyseal disks of femur and/or tibia. The degree of difference in length growth between the two legs can only be estimated after 1.5 years, by means of repeated leg length measurements. However, which epiphyseal disk is abnormal is rarely visible radiographically. The value of quantitative bone scintigraphy (^{99m}Tc-HDP) as a method of measuring epiphyseal growth activity was evaluated in a clinical study. The skeletal scintigrams of 25 children without known difference in leg length, average age 11 (2–16) years, were evaluated. A region of interest was selected over the epiphyses of the proximal (PF) and distal (DF) femur and the proximal (PT) and distal (DT) tibia. The same procedure was repeated in 25 children with a congenital difference in leg length, average age 10 (4–16) years. For all children, the R/L and the Min/Max count ratios were calculated as well as the relative contribution of every epiphysis (in percent).

Table. Normal values, 95% percentile

	R/L ratio	Min/Max count ratio	Uptake contribution in %
PF	0.92–1.06	> 0.92	10–18, mean = 13
DF	0.92–1.07	> 0.92	37–46, mean = 41
PT	0.94–1.06	> 0.93	22–32, mean = 28
DT	0.93–1.07	> 0.92	13–21, mean = 18
Total	0.94–1.06	> 0.95	

90% of the children with a congenital leg length difference had a Min/Max ratio (total) below 0.95, a significant difference from the group of normal children. In the normal as well as in the abnormally short legs the relative uptake contribution of every epiphysis in the leg in question was found to equal contribution to total leg length growth known from the literature.

In order to study the relationship in time between the local epiphyseal uptake and local length growth, the uptake of ^{99m}Tc-MDP in the proximal and distal tibial epiphyses was measured every week for 14 weeks in 5 New Zealand white rabbits aged 18 weeks. In addition, the tibial length was measured radiographically every week. The uptake in the faster-growing proximal tibial epiphysis was higher than in the distal epiphysis and decreased with the decrease of the length growth until the ultimate bony closure of the epiphysis in question.

Conclusion: The local uptake of 99mTc-HDP appears to be correlated with the local epiphyseal growth activity and may therefore be measured as a diagnostic aid in children with local epiphyseal growth disorders.

Chondrocytes in collagen gel—in-vitro construction of a cartilaginous transplant

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Definition of the problem: Articular cartilage has a very limited potential of intrinsic regeneration. Experimental results obtained with grafting of isolated chondrocytes into a cartilaginous defect were recently reported (1). The delivery substance used should be biocompatible and should not disintegrate too early (2). In order to test the suitability of a new delivery substance, we studied the behavior of chondrocytes suspended in collagen gel for 2 weeks.

Material and methods: Chondrocytes were i isolation the cells solated enzymatically from bovine MCP joints. After were cultured three-dimensionally in a gel of collagen type I for 14 days in a concentration of 1 x 10^6/mL. The collagen used was isolated from rat tail tendon or fetal calf skin. The cell cultures were assessed as to vitality and proliferation and also evaluated by means of histological staining and 35S uptake studies.

Results: Chondrocytes grew three-dimensionally in the gel, after 2 weeks the proportion of survival was 95% and the gel was still intact. The number of cells had doubled and microscopically 80% of the cells had retained the typical polygonal shape of chondrocytes. 20% showed a fibroblast-like morphology, indicating dedifferentiation. Alcian-blue staining revealed the production of matrix components. The same result was observed during incorporation studies: 35S was incorporated within three hours, indicating active proteoglycan synthesis.

Discussion: This study shows that chondrocytes can be cultured three-dimensionally in collagen gel with preservation of their morphological and metabolic properties. Collagen gel is a potentially suitable delivery substance for the transplantation of chondrocytes in vivo.

Intraosseous pressure in the head of the femur after resurfacing prosthesis

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Resurfacing Hip Arthroplasty (RHP) was widely used in the seventies. It was believed that with the RHP the mechanical stress distribution in the femur during weight-bearing would be closer to the normal situation, while also more bone was left for a revision procedure if and when necessary. However, it was found soon that the clinical failure proportion of the RHP was high. One of the hypotheses to explain

this was that a disturbed intva osseous pressure (IOP) disorders the blood circulation in the head of the femur and ultimately might lead to avascular necrosis and osteolysis. The purpose of the present study was to examine the mechanical effect of the RHP on the blood circulation in the femoral head by recording the IOP after intermittent load.

In 6 dwarf goats measurements of the IOP were carried out after dislocation of the hip joint, while dosed intermittent loads were applied to the anterosuperior femoral head. The measurements were repeated after implantation of an RHP.

We recorded characteristic shock wave patterns in IOP consisting of a brief peak as a direct response to the intermittent load applied, followed by a fading vibration of the interstitial fluid phase. However, the peak in the RHP femoral head was higher by a factor of 3 (average 1.5 mmHg) than that in the normal femoral head (average 0.5 mmHg). We concluded that the RHP does indeed change the IOP pattern in the head of the femur, which corroborates the abovementioned hypothesis.

A search for factors playing a part in chronic lateral instability of the foot

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Introduction and definition of the problems: Chronic lateral instability of the foot (CLI) is a clinical picture in which several active and passive factors play a part.

The present study was concerned with the question to what extent the position of the foot during walking at the moment of heel contact in patients with CLI was biomechanically unfavorable (i.e. with an increased inversion position) in relation to that position in control subjects.

It is assumed in the literature that dysfunction of the peroneal musculature plays a part in CLI. In this study, attention was paid to the role of the m. peroneus longus during walking. To what extent do we use this muscle to provide stability of our foot and to what extent to ensure balance?

Patients and methods: Position of the foot. This study was carried out in 21 CLI patients and 14 healthy controls. The patients had been complaining for over 2 years of recurrent inversion lesions and 'a sensation of instability'. With the aid of a video camera and lightreflecting markers the frontal image of the back of the foot and lower leg was filmed during walking on a moving band. The moment of heel contact was recorded using a pressure sensor. The video pictures were digitalized following which the angles between the calcaneus and the vertical line (alpha) and between the lower leg and the calcaneus (beta) at the moment of heel contact were calculated.

Activity of the long peroneal muscle. This study was carried out in 35 CLI patients and 10 healthy controls. The activities of the long peroneal muscle (PL) and the anterior tibial muscle (TA) were recorded by means of surface electromyography (EMG). Electromyograms of both legs (four walking cycles per leg) were made on a running belt at two speeds, with and without external support. The muscle activity was quantified by normalizing the EMG signals after processing. Only activity during the standing phase was analysed. Of every walking cycle, 20 paces were processed in this way. For statistical analysis the standing phase was divided into four equal parts, with calculation of the mean activity and standard deviation per muscle for each part. Subsequently, the effect of external support or walking speed on these parameters was analysed.

Results: Position of the foot. No statistically significant differences in alpha and beta angles were observed between symptomatic and asymptomatic feet (Table 1).

Table 1. Mean alpha and beta angles measured at the moment of heel contact during 50 seconds' walking in 21 persons with bilateral CLI and in 14 control subjects. The figures represent degrees

Angle		mean	SD	range
alpha				
symptomatic	Le	−1	5	−8 to 9
	Ri	1	5	−3 to 9
asymptomatic	Le	0	5	−6 to 9
	Ri	3	3	−4 to 9
beta				
symptomatic	Le	−2	5	−12 to 10
	Re	−2	5	−4 to 6
asymptomatic	Le	−3	5	−12 to 6
	Re	0	3	−5 to 5

Activity of the long peroneal muscle. Walking with external support, the TA was active in the 1st part ($p < 0.001$) and the PL in the third and fourth parts ($p < 0.001$) of the stance phase. Without external support the activity of the PL moved to the 2nd part ($p = 0.006$) and the 3rd part of the stance phase. With external support, the activity of both muscles increased during walking at the higher speed. At identical speeds the activity of the PL increased if no external support was provided any longer ($p < 0.001$) while the activity of the TA did not increase significantly ($p = 0.06$). Without external support, the activity of the PL did not increase during walking at the higher speed ($p = 0.06$) while the activity of the TA did increase ($p < 0.001$).

Conclusions: It appears that the position of the foot (the degree of inversion in the posterior foot) at the moment of making heel contact during walking plays no part of importance in the development of chronic lateral instability symptoms. The long peroneal muscle is mostly of importance to ensure balance during walking and the part it plays during motion varies per individual and per speed. Stability of the

foot appears to be independent of the peroneal function at the moment just before complete weight-bearing on the foot.

Functional assessment of the first ray after Brandes' operation by means of dynamic plantar pressure measurements

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Objective: Determination of the weight bearing on the hallux after recovery from a Brandes' operation. Quantitative and qualitative evaluation of the weight-bearing pattern of the foot during the stance phase of normal gait.

Material and method: The pressure under the sole of the foot was charted in the youngest ten patients mean 54 (45–61) years, of a group of 68 patients in whom in the Maastricht University Hospital a Brandes' operation had been performed between 3.5 and 5.5 years previously.

A comparison was made with a representative control group from the files of TNO Waalwijk. The measurements were carried out using a pressure platform (type: NovelEmed). The walking speed used was 1.2 m/sec. For interpretation of the results the foot was subdivided into the sectors: hallux, medial, central and lateral forefoot.

Results: The means and the standard deviations of the maximal pressure (Pmax) in each sector of the operated and the normal foot of the patients (n = 10) were calculated. The same was done for the control group.

Table. Means and SD of the maximal pressure (Pmax; N/cm^2) in each sector of the foot

	Med	Centr	Lat	Hallux
Operated	44.8	75.5	40.3	26.9
	19.1	*21.9*	*22.2*	*14.9*
Normal	43.4	58.0	27.9	25.0
	15.5	*24.6*	*7.6*	*8.7*
Control	38.0	41.5	22.3	30.7
	10.3	*11.5*	*8.7*	*11.0*

Discussion: The hallux after a Brandes operation still plays an active part in the dynamics of the foot. However, after the Brandes operation there is more weight-bearing on the central portion of the forefoot in particular. The technique and method applied here may be useful for determination of the indications for foot operations and the postoperative evaluation.

Proximal metatarsal osteotomy for hallux valgus and fixation with a Herbert

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95 hallux valgus patients (110 feet) were treated with a proximal metatarsal osteotomy. The osteotomy was fixed with a Herbert screw. Prospective evaluation of all patients was carried out according to the protocol of the Foot and Ankle Society. All patients underwent physical and radiological examination after an average follow-up of 36 (24–50) months.

At the follow-up examination, 7% of the patients still reported pain, 96% were satisfied with the shape of the toe and 98% showed improved gait. Only one patient was dissatisfied with the result. All osteotomies were consolidated after 9 weeks and no loss of correction of the position was seen.

Brandes' interposition arthroplasty in hallux valgus

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Introduction: A hallux valgus in older patients is often associated with degenerative lesions of the MTP-1 articulation. The purpose of resection arthroplasties, apart from bunion resection, is to create a neo-articulation. The Brandes operation for this purpose consists of resection of the proximal part of the basic phalanx with interposition of the capsule. However, according to a number of authors the long-term results of the Brandes operation are disappointing. We have therefore carried out a retrospective study of the results of 41 Brandes operations in 28 patients, with an average follow-up of 7.5 years.

Material and methods: 28 patients subjected to a Brandes operation in 1985 and 1986 were included in this follow-up study. These were all cases of hallux valgus without major functional disorders of the MTP-1 articulation. The patients, 3 males and 25 females had an average age of 55 (45–65) years; there were 7 left-sided, 6 right-sided and 14 bilateral operations. The current symptoms were registered. The position and mobility of the MTP-1 and IP articulations were recorded. The parameters of the pre- and postoperative AP radiographs of the forefoot without weight-bearing were measured.

Results: Postoperative observations.

Patient's assessment: much improved in 23, improved 11, unchanged 4, and worse 3.

Cosmetics: satisfied in 13, moderately satisfied 14, and not satisfied 12.

Symptoms of impaired balance in 18 out of 41.

Function, passive MTP–I, dorsal flexion: 44.5° (10°–80°)
plantar flexion: 28° (–20°–55°)

Radiographic parameters

	pre	post
hallux valgus	28.9	15.2
IP valgus	7.3	9.1
IMT	8.5	7.9
length basic phalanx	29.0 mm	20.5 mm

Conclusion: The functional results of the Brandes operation are highly satisfactory, even in long term. However, the patients are often not very satisfied with the cosmetic results. There is no distinct correlation between the clinical findings, the radiological findings and patient's assessment.

Long-term results of Wilson's osteotomy in hallux valgus

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A previous study showed the short-term results of Wilson's osteotomy to be good. Consolidation of the osteotomy was always achieved in 6 weeks and only minor problems arose. The question was whether the long-term results were favorable as well: is the protuberance gone for good, is the correction of the valgus position lasting, have other problems arisen as a consequence of the procedure?

61 patients (85 feet) were operated during the period 1976–1980. Of these patients, 48 (67 feet) were retrieved. Sixty-feet could be examined.

Average age at the time of operation was 37 (16–62) years, the male/female ratio was 1:11.

The average follow-up period was 14 (13–17) years.

The subjective results were as follows: (feet, numbers and percentages):

no symptoms:	31 (50%)
improved:	19 (31%)
unchanged:	6 (9.5%)
worse:	6 (9.5%)

Analysis of the patients whose symptoms had deteriorated yielded the following findings: none of the patients had a hallux valgus position or painful protuberance. In all cases, some other foot problem was involved: 4 times due to rheumatoid arthritis that had become manifest later and twice due to pain in the first MTP articulation.

In the group 'unchanged' (6), the symptoms also proved to be due to something else than the original abnormality: 3 times osteoarthrosis of the MTP-I articulation and 3 times metatarsalgia due to talipes valgus with depression of the capita II, II and IV.

In the group 'improved' (19), a few other symptoms had emerged: 4 times symptoms of the caput MT-II, once symptoms of the caput of the MTP-I articulation, once 2nd toe too long, once hammer toe, once medial sesamoid, once neurinoma, once metatarsalgia.

The study showed that none of the patients complained of hallux valgus or painful protuberance, that degeneration of the MTP-I articulation is not always prevented, that other forefoot symptoms due to talipes valgus may (of course) occur and that rheumatoid arthritis in the forefoot is not affected favorably by Wilson's osteotomy.

Conclusion: The results of Wilson's osteotomy in the treatment of hallux valgus are favorable in the long run as well.

Arthrodesis of MTP-I for hallux rigidus Uprising of the big toe

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Definition of the problem: Is an arthrodesis an adequate treatment in the long run in osteoarthrosis of the painful MTP-I articulation?

Patients and methods: 60 arthrodeses (34 left-sided and 26 right-sided) were carried out in 47 patients between 1980 and 1990. The operation consisted of 1 plantar or 2 crossed screws, followed by 6 weeks in a plaster cast. There were 28 females and 9 males, average age 58 years.

All patients were invited for a follow-up examination. Attention was paid to walking pattern and footwear, together with clinical and roentgen examination. The mean length of time elapsed since operation was 6 years.

Results: 19 patients required orthopedic shoes and 28 wore normal shoes. The walking pattern was antalgic in 37 and normal in 23 cases. 17 reoperations were performed, 5 for infections and 12 for pseudarthroses. Clinically, the pseudarthroses were painful in 13 cases and painless in one case; a painful interphalangeal articulation was found 32 times and a painful sesamoid 7 times. Radiography revealed 40 pseudarthroses and 27 instances of interphalangeal osteoarthrosis. The angle between the basic phalanx and the floor was less than 10° in 15 patients, 10°–15° in 36 patients and > 15° in 8 patients. 25 arthrodeses caused no complaints, 5 had less than 10° angulation. Moderate symptoms were present in 11 patients; the position of the arthrodesis was found to be incorrect in 5. There were 3 pseudarthroses and 8 cases of painful interphalangeal articulation.

24 patients were seriously impaired in activities of daily life, caused by a painful pseudarthrosis in 10 patients and by a painful interphalangeal articulation in 14. Of these 14, 7 had a painful sesamoid.

Conclusion: The results of 35 of the 60 arthrodeses were moderate to poor. Alternatives such as a Keller-Brandes operation should be considered.

Silicone prostheses in hallux rigidus: moderate long-term results

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Introduction: Implantation of silicone prostheses in patients with a hallux rigidus as a rule results in good alleviation of the pain with preservation of fair articular function and flexion force of the hallux. However, in a follow-up study in our clinic radiographs of the forefoot 5 years after the operation in a large number of cases revealed an osteolytic reaction round the prosthesis and in the head of the first metatarsal1. This alarming observation prompted us to subject the same group of patients once more to an examination, an average of 10 years after implantation of the prosthesis.

Material and methods: Between January 1980 and December 1985, a Swanson silicone hemiprosthesis was implanted in 43 patients (58 feet). One prosthesis was removed one year postoperatively because of persistent pain. At the first follow-up examination, 57 articular implants were examined after an average of 5 (2–7) years. At the second follow-up examination, 10 (7–13) years on average after the operation, one patient had died and one could not be reached. In the meantime, the prosthesis had been removed in another seven patients because of local pain and swelling. Consequently, at this follow-up examination the operative results of 48 feet could be assessed. In addition, the results of the eight revision operations were recorded. Radiographs were obtained of all operated feet and the osteolytic reaction round the implant was scored.

Results: At the first follow-up examination, the MTP-I articulation was not painful in 45 of the 57 feet (79%). At the second follow-up examination, 36 of the 48 feet with a prosthesis in situ (75%) were free from pain. Of the 8 MTP-I articulations from which the prosthesis had been removed, only 2 were free from pain. After an average of 5 years, the MTP-I articulation was not painful on pressure in 51 of the 57 feet (85%); after an average of 10 years, there was local pressure pain in 37 of the 48 feet (71%). The active dorsal flexion decreased in this same period by approximately 10 degrees and the strength of the flexor hallucis was also diminished. Radiography showed a distinct progression of the change of the shape of the silicone prosthesis, as well as a pronounced osteolytic reaction round the prosthesis.

Conclusions:

- A silicone hemiprosthesis gives a reasonable clinical result after an average follow-up of 10 years.
- The prosthesis undergoes considerable wear and tear and the silicone debris induces a marked osteolytic reaction.
- Use of silicone prostheses in patients with a hallux rigidus is not advisable.

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Arthroscopic treatment of the anterior impingement syndrome of the ankle

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Posttraumatic ankle pain is a frequent occurrence. If the pain is localized in the anterior aspect of the articulation and occurs in forced dorsal flexion in the joint, the condition—after exclusion of other diagnoses—may be called an anterior impingement syndrome.

A distinction is to be made between bony impingement and impingement of soft tissues. In bony impingement, there is a bony ridge on the anterior edge of the distal tibia or the front of the medial malleolus while on the talus a socalled talar nose is often visible. These bony ridges as a rule are not manifestations of osteoarthrosis but the result of recurrent micro-injuries. The department of Orthopedics of our hospital late in 1989 started a prospective study in which until mid-1992, 55 successive patients with anterior ankle impingement syndrome were included. For every patient, a standard form was completed before operation, while control examinations according to a fixed protocol were carried out 4 months and one year postoperatively, respectively. The 4-month examination was carried out in all patients, the one-year examination in 46 patients. 9 patients underwent a 'late' one-year control, an average of 2.1 (1.5–2.5) years after the operation. Mean age was 28 years. There were 38 males and 17 females. All 55 patients received arthroscopic treatment because of pain. Resection of osteophytes was carried out in 44 patients. Resection of scar tissue and hypertrophic synovia was done in 11 patients. The vast majority of the osteophytes were localized on the anterior edge of the medial malleolus and on the anteromedial aspect of the tibia. An anterolateral localization of the bony ridge was seen in only 3 patients. A so called talar nose was removed in 14 patients.

There were no complications. Symptoms improved distinctly in 92% of the patients. Ankle function remained unchanged in 42 of the 55 patients. In 9 cases, dorsal flexion increased by an average of 6 degrees. At the 4-month follow-up, 50 patients had a good or excellent subjective result. At the one-year control this was true for 46 of the 55 patients.

Forage of osteochondral lesions of the talus

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Definition of the problem: What are the results of forage of osteochondral lesions of the talus, and can trends or prognostic factors be demonstrated in the various categories?

Study design, material, patients and method: A retrospective study was made of the subjective assessment of and the radiological findings in all patients operated on between 1978 and 1992. No distinction was made between the diagnoses of osteochondritis dissecans and osteochondral lesion. A total of 33 patients were involved, 8 women and 25 men. 27 patients responded, the median age was 17 (13–57) years.

Median duration of follow-up was 5 (1–12) years.

In 5 patients the lesion was localized in the anterolateral and in 22 in the posteromedial talar cupula. All patients had a history of one or several injuries. Forage of the defect was carried out in all patients, with removal of a loose body if necessary. The forage was performed arthroscopically in 10 patients, and in the others by means of a medial malleolus osteotomy. The patients were interviewed by telephone with reference to: pain, swelling, giving way, lock in a phenomena and a subjective assessment of activities such as sports and work. All preoperative radiographs re-examined with grading of the osteochondral lesions (Berndt and Harty grades 1–4) and assessed for degerative lesions. Preoperative delay was determined, counting from the first roentgen examination.

Results: The ultimate results of the operation were classified as follows: 14 patients were well or highly satisfied, 10 fairly satisfied and 3 dissatisfied. Pain was found the only parameter that corresponded with the assessment of the end result. No relationship was found between the end result and age, preoperative delay, duration of follow-up, or localization and extent of the lesion. There was no relationship either between the roentgenological grading and the peroperative findings.

Conclusion: We assess the results as moderate. We have been unable to demonstrate any predicting factors. Results in the literature of the surgical treatment of osteochondral lesions of the talus are more or less similar. The figures vary from 40 to 80% good or excellent results, results being better in younger patients and with a short preoperative period. We have been unable to confirm this. Standard radiographic examination is suitable only to detect an osteochondral lesion, and even then there are false-negative results (11% in this series).

Stress fracture of the navicular bone

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Stress fracture of the navicular bone occurs in running and jumping athletes. If left untreated, the fracture may develop into complete splitting of the navicular bone leading to talonavicular osteoarthrosis. 12 out of 26 patients with 28 navicular stress fractures were operated. A corticospongious graft was implanted 9 times and the lesion was reamed out 3 times. Indications for operation were: a complete or almost complete fracture, failure of conservative treatment or a loose dorsal fragment. Histological examination of the removed bone revealed fibrous tissue in the fracture cleft surrounded by empty osteocyte lacunae and absence of osteoid tissue. One patient, whose complaints persisted, was subsequently subjected to talonavicular arthrodesis. In 2 previously untreated patients, a completely split navicular bone was encountered. 14 patients with a partial stress fracture were treated conservatively. In this group, CTs and MRIs were compared at 3-month intervals. The STIR, i.e. short Tl inversion recovery technique of the MRI examination, in particular showed a band-shaped abnormal signal over the entire width of the navicular bone, compatible with medullary edema. This finding disappeared with healing of the fracture as confirmed by CT. All patients returned to their previous level of athletics after an average of 4 months.

Conclusion: The histological and MRI findings suggest that a circulatory disorder followed by osteonecrosis precedes a stress fracture of the os naviculare pedis.

Long-term results after closed treatment of Lisfranc dislocation fractures

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Introduction: The treatment of Lisfranc fractures used to consist predominantly in closed reposition plus fixation with k wires. A study of the literature showed that this frequently gave only moderate results. This prompted us to evaluate the Lisfranc fractures.

Material and method: 14 patients were treated for a Lisfranc dislocation fracture in our clinic during the period 1978–1992. 9 patients could be followed up 1 to 14 years (5.7) later; mean age 49, male:female ratio 4:5.

The study group included 4 patients who had sustained a high-velocity injury as part of multiple injuries, and 5 patients who were treated for an isolated Lisfranc dislocation. The initial treatment consisted of reposition followed by immobilization in a plaster cast in 2 cases; in 7 cases, the fracture was repositioned and fixed with Kirschner wires, also followed by immobilization in a plaster cast. Persistent pain necessitated reoperation in 3 patients; these patients were subjected to arthrodesis in the Lisfranc articulation. Special shoes had to be prescribed in 3 cases. The remaining 3 patients so far have needed no further treatment.

Results: Only 2 patients were free of pain and functioned without problems 10 years and one year, respectively, after the accident (two times reposition plus k wire fixation, once followed by an arthrodesis); they wear normal shoes. In the other patients pain persisted in various degrees, especially during weight bearing; these include 2 of the 3 patients subjected to an arthrodesis.

The article by Arntz and Hansen showed that in recent

years they have treated the Lisfranc dislocation fractures with open reposition and fixation by means of cortical screws. This gave good results, although admittedly follow-up is still short.

Conclusion: We have studied the Lisfranc fractures treated in our clinic, with the above-mentioned poor results. It may therefore be advisable to follow the principles of Arntz and Hansen.

Treatment of fresh ruptures of the lateral ligaments of the ankle, results of a prospective study

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Damage to the lateral ligamentous apparatus of the ankle is the most frequent injury of the lower extremity. The treatment of such injuries is still controversial. For this reason, a start was made in 1985 with a prospective, randomized and controlled study of 3 methods of conservative treatment of demonstrated rupture of lateral ankle ligaments. In addition to these 3 groups, there was a fourth group of patients who received no stabilizing treatment.

All patients with an inversion injury of the ankle were recorded in a prospective registration system for a 2-year period. The trial group was selected from this group of patients on the following grounds. If the physician on duty in the ER postulated a rupture of the lateral ligaments of the ankle on the usual clinical grounds, there was no recurrent injury, the patient was between 15 and 60 years old and consented to participate in the study, arthrography was carried out. Following arthrography, 243 patients with ruptures of lateral ankle ligaments were divided at random into 4 groups. The patients were treated with an Adidas Adimed Stable shoe®, tape bandage, Aircast® splint of a Struva® elastic stocking (the fourth group). There were no significant differences between the compositions of these groups. Control examinations were carried out during the treatment and after one year. After one year, stress roentgenograms were made to objectivate residual instability, if any. An enquiry was conducted among the patients after 5 years.

Results: On the basis of the data recorded during the first visit to the ER, such as degree and localization of swelling, localization of the pressure pain, axial pressure pain and presence of an anterior drawer phenomenon, no relation with the extent of the injury could be demonstrated. At the end of the treatment, 90% of the patients in all groups were back to work completely. Over 95% also once more had a stable sensation in the ankle. This proportion was slightly smaller in the Struva® group but not significantly. 80% of the patients were free from pain at the end of the treatment. After one year, 90% were free from pain. There were no significant differences between the groups either after one year or after 5 years.

Conclusion: This study appears to confirm once more that functional treatment of ruptures of lateral ankle ligaments leads to excellent results. Considering the results in the 'placebo' group, missing the diagnosis of a rupture of a lateral ankle ligament does not appear to cause problems.

The long-term results of the 'Leiden plasty' for dislocating peroneal tendons

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Recurrent dislocation of a peroneal tendon is a crippling condition, usually the result of a sports injury. The consequences, instability and sometimes pain, impaired engagement in atheletics and normal functioning.

Prof Dr F Duijfjes about 1970 developed a plastic repair for dislocated peroneal tendons, with the calcaneofibular ligament taking over the function of the superior peroneal retinaculum. The present study was concerned with the question whether this 'Leiden plasty' gives good long-term results with regard to recurrent dislocation, resumption of work and sports, ankle function and possible osteoarthrosis.

This was a retrospective long-term follow-up study; all 17 patients operated on between 1974 and 1990 (18 ankles) were re-examined clinically and radiographically. The duration of follow-up was 19 to 3 years, with an average of 10.8 years. The results in general were good. A recurrent dislocation was observed once.

The os trigonum syndrome

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The posterior impingement syndrome of the ankle is frequently caused by the os trigonum syndrome. The os trigonum is an accessory ossification center at the back of the talus. Impingement syndromes may be brought about by forced plantar flexion resulting from an acute injury (especially football) or from excessive strain (especially ballet). We analysed the results of 24 surgical procedures carried out in our department between 1985 and 1993 because of persistent pain on the dorsal side of the ankle due to the trigonum syndrome.

We could distinguish 2 groups of patients. In the typical overstrain lesion (10/24) the results were good or excellent in 90% of the cases. In the posttraumatic impingement group (14/24) the results were less favorable because of additional pathology (subtalar osteoarthrosis, instability of the ankle, tarsal tunnel syndrome).

Conclusion: Extirpation of an os trigonum in chronic posterior impingement resulting from excessive stress is an adequate therapy with a good chance of success. However, if the condition is caused by an acute injury, the result also depends in part on the treatment of the additional pathology.

The Low Contact Stress (LCS) total ankle prosthesis as an alternative to arthrodesis of the ankle

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We have used the New Jersey Low Contact Stress (LCS) total ankle prosthesis since 1988 as an alternative to arthrodesis of the ankle. The reason for this is that this prosthesis is unconstrained and in addition has congruent surfaces due to the use of a freely moving polyethylene bearing.

Between 1988 and 1992, 20 LCS total ankle prostheses were implanted into 18 patients (14 women and 4 men). 16 patients had rheumatoid arthritis, one juvenile chronic arthritis and one osteoarthrosis. Mean age at the time of operation was 58 (26–77) years. Average duration of the rheumatoid arthritis at the time of operation was 21 (4–44) years.

All prostheses were implanted without cement. The after-treatment consisted of weight-bearing mobilization after one week supported by a lower-leg walking cast for 6 weeks.

During a mean follow-up of 3 (1–5) years, the ankle score improved from 38 before operation to 80 at follow-up. Mobility showed hardly any increase: from 4–0–23 to 8–0–25.

Complications occurred in 6 ankles: one case of wound edge necrosis in preexistent arteriopathy, one case of early infection, cured with lavage and i.v. antibiotics, 3 cases of varus instability, always in pre-existent varus deformity of >10°, one case of fracture of the medial malleolus in a pre-existent valgus position. A pseudarthrosis developed in spite of osteosynthesis.

Furthermore, one patient required supplementary debridement because of osteoarthrosis between malleolus and talus.

Radiographically all talar and tibial components showed stable fixation; however, non-progressive partial radiolucent lines were frequently seen, mostly round the stem of the tibial component.

In conclusion it is stated that the LCS total ankle prosthesis gives good clinical and radiographic results when used in ankles with a good axial position. Moreover, the rehabilitation is simple. Applied on the correct indication, therfore, it constitutes a genuine alternative to arthrodesis of the ankle.

Congenital clubfoot

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Definition of the problem: What is the current situation regarding the treatment of congenital clubfoot in the Netherlands?

Method: An enquiry was conducted in 1992 among 434 members of the Association of Parents of Children with Clubfeet. With a response rate of 71% data were collected on 308 children with 495 clubfeet, with regard to familial anamnesis, pregnancy, referrals, diagnostics, treatment and operation. The results were compared with the consensus guidelines of the Task Force Orthopedic Surgery for Children. In addition, the parents' opinion concerning the treatment of their child was requested.

Results: The familial anamneses for foot anomalies were positive in 32% of the cases. No indications of exogenous etiological factors were found. Almost 25% of the children had been referred to an orthopedic surgeon later than 3 days after birth. In 34 children, the first roentgenological examination was carried out after the first year of life, in 29 children it was omitted. There is definitely no uniformity in the treatment yet. The parents reported problems with the plaster-tape treatment in 43% and with the splints in 34% of the cases. Furthermore, they reported 20% postoperative complications. In 71 children, only lengthening of the Achilles tendon was carried out. Many children have persistent complaints of pain, fatigue and impaired movement. Owing to the numerous problems during the treatment, a second opinion is requested in 51% of the cases.

Conclusion: There is considerable diversity in the treatment of congenital clubfoot in the Netherlands. Moreover, the treatment is associated with numerous problems and a high proportion of second opinion requests. It is to be hoped that the guidelines formulated by the Task Group Orthopedic Surgery for Children will find general acceptance.

Surgical treatment of calcaneo-navicular coalitions

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During the period 1984–1992 10 children with calcaneo-navicular coalescence in 16 feet were treated in the Sophia Children's Hospital of Rotterdam. There were 4 girls and 6 boys. Mean age at the time of treatment was 12 (11–14) years. Treatment consisted of surgical excision of the bony link via a dorsolateral approach. The resulting space was filled with the belly of the m. extensor digitorum brevis.

Results: All children could be followed up, after a mean duration of 30 (8–103) months. The children were completely free of symptoms and able to engage once more in athletic activities. Roentgen examination of all operated feet revealed no degenerative lesions. A recurrent coalescence was seen in one patient in one of his two operated feet. A reoperation was performed. In the second patient with symptoms no clear cause of these could be found.

Conclusion: Excision of a calcaneo-navicular bar gives good results in the middle-long term.

The orthopedic shoe

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Definition of the problem: If it proves impossible to achieve an adequate and painless gait with a ready-made shoe, we often prescribe an orthopedic shoe.

We were curious about the grounds on which such shoes are prescribed, about what shoe is made for what abnormality and if the intended purpose was actually achieved.

Patients and methods: All the orthopedic shoes prescribed by the Department of Orthopedics of the De Wever Hospital and made by one orthopedic shoemaker in the year 1989 were studied with reference to age and indication.

Quality and service life of the shoes, as well as intended purpose were evaluated three years after prescription by means of a follow-up using the outpatient clinic records, an enquiry and, in some cases, clinical examination.

Results: 104 pairs of orthopedic shoes were prescribed. The patients' mean age was 61 years (10 months-93 years). The shoes were prescribed significantly (27 times) less often for male patients.

The indications were as follows: metatarsalgia with hallux problems (n 30), pes plano valgus with callus formation (22), neurological disorders (15), osteoarthrosis (injury) (12) and congenital anomalies (8), rheumatoid arthrosis (7), diabetes (6), shortened leg (4) and infection (1). 74 patients were satisfied, of these 65 still wore the shoes and 13 were subjected to operation. 22 patients were not satisfied; 7 of these refused operation. 8 patients had died.

Conclusion: A striking observation was the number of elderly patients with painful, broad feet and callus formation. This group and the post-traumatic patients benefited most from the orthopedic shoe.

Neuroarthropathy in the skeleton of the foot

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The department of orthopedics of Leiden University Hospital since 1977 has had a consulting hour for patients with foot abnormalities caused by neuropathy. Most of the patients seen have diabetic neuropathy. A retrospective examination of the case histories and roentgen files provided indications of a neuroarthropathy in an ankle or foot skeleton in 50 feet of 42 patients. Relatively many lesions were observed in the articulation of Lisfranc and Chopart, sometimes combined with other lesions. It is precisely these locations that may give rise to pronounced malformation of the foot, especially development of an extreme pes planovalgus abductus. These deformed and dysesthetic feet are especially vulnerable: plantar ulcers in the area of the 'inverted arch' are frequent.

Treatment: during the acute stage bedrest is prescribed until swelling and edema are reduced. Subsequently, a plaster boot, in principle suitable for weight-bearing (without weight-bearing too much risk for the other foot?). Plaster treatment is continued until consolidation occurs. Thereafter, a stiff orthosis for approximately one year. Only then orthopedic footwear. In case of major instability and/or deformation: arthrodesis, with spongiosaplasty and internal fixation, followed by plaster boot, stiff orthosis and ultimately, orthopedic footwear.

Stress radiography of the subtalar joint in chronic lateral instability of the foot

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Definition of the problem: It is a known fact that abnormal mobility in the talocrural joint may play a part in chronic lateral instability of the foot. Much less is known about the part played by abnormal mobility in the subtalar joint. In view of the facts that inversion occurs primarily in the tarsus and inverting forces act on the ankle only secondarily, it appears plausible that abnormal mobility of the subtalar joint may play a part in instability of the foot. An attempt was made to demonstrate abnormal mobility in the subtalar joint objectively, by means of stress radiography.

Patients and methods: Stress radiography of talocrural and subtalar joints was carried out in a group of 33 patients with chronic lateral instability symptoms of the foot. 10 persons without foot or ankle complaints served as a control group.

A standardized method with hinged boards and a 40 degree Broden projection was used for simultaneous visualization of tilting of the talus and of the calcaneus. The positioning was checked by fluoroscopy. The examination was carried out in steps. During the first step, the foot was inverted from the neutral position, while 'genuine' stress was only applied during the second step. On the basis of the radiographs obtained after the two steps, the degrees of talocrural and talocalcaneal tilt were measured, as well as the medial shift of the calcaneus in relation to the talus.

Results: The difference in talar tilt between symptomatic feet and control feet was significant ($p = 0.02$) for left and right feet. The mean degree of tilt observed in the talar joint was 10° (*SD* 3.5°) and the mean medial shift 7 (2.5) mm. In this respect, no difference was observed between symptomatic and asymptomatic feet. The maximum difference in subtalar tilt between the two feet of one person amounted to 5°.

An increase of talar tilt between step 1 (inversion) and step 2 (increased 'stress') was observed only in symptomatic feet and in none of the control feet. In addition it was found that the subtalar tilt during step 2 was increased in only one foot, an asymptomatic foot.

Discussion: It appears that the orthopedic literature does not contain a description of a standardized method to demonstrate subtalar abnormal mobility. The spectrum of assessment criteria for pathology ranges from loss of parallelism to over 20° tilt. This implies that results of different studies are compared incorrectly. For instance, application of specific stress to the talocalcaneal joint may lead to other results than tilting of the foot as a whole. Also, there is the clinical problem of interpretation of the tilt in connection with interindividual variation (in our study, 3°–20°). When is the tilt excessive? Comparison with the contralateral foot supplies inconclusive information. A difference of up to 5° from the contralateral foot may be normal, while the literature shows that even a small increase of mobility may be clinically relevant.

By means of the method used in this study, it is possible in a standardized way to visualize simultaneously the tilt of the talocrural as well as of the subtalar joint. By carrying out the examination in steps (or dynamically during fluoroscopy) it may be possible to differentiate between physiological and pathological tilt, in accordance with our findings at the talocrural level.

Scandinavian Sarcoma Group

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Treatment of osteosarcoma

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The COSS group was founded in 1977 and includes institutions from Austria, Switzerland and Germany. More than 700 patients evaluable for metastasis free survival (MFS) have been treated according to the successive studies COSS-77, -80, -82, -86 and -91. Adjuvant chemotherapy was given after amputation in study COSS-77 and neoadjuvant chemotherapy in the following studies aiming at preparing for limb salvage procedures. High dose methotrexate followed by leucovorin rescue (HDMTX) was used throughout all studies and doxorubicin was used in addition in all studies except one arm of study COSS-82. As third treatment elements were used cyclophosphamide (CYC), cisplatinum (DDP), the triple drug combination bleomycin + CYC + dactinomycin (BCD) and ifosfamide (IFO) in different combinations.

2 major steps towards improved metastasis free survival (MFS) could be observed. The first one after doubling the HDMTX dose from 6 to 12 g (and replacing CYC by either BCD or DDP) in study COSS-80 and the other after the introduction of IFO combined with DDP in study COSS-86 (53% vs 63% vs 75% MFS at 6 years).

The late toxicities of osteosarcoma treatment are considerable, the most intriguing ones being cardiotoxicity from DOX, ototoxicity from DDP, tubular damage from IFO and secondary malignancies. Overt cardiomyopathy was observed in 17/785 patients (2.2%), with 5 dying from heart failure. In a small series of patients with cumulative DOX doses of >300 mg/m^2 who could be investigated retrospectively by echocardiography and in part also by radionuclide ventriculography 81 ± 41 months after termination of chemotherapy pathological findings were observed in 27% respectively in 50% of cases. Moreover, pathological findings did not level off but in contrast were found to deteriorate with time. Consequently efforts to control cardiotoxicity were undertaken. 2 trials with reduced DOX dose resulted in poor response. A third trial so far seems to be successful. After termination of patient randomisation for the intra-arterial DDP arm of study COSS -86 because of proven inefficacy of the intraarterial as compared to the intravenous route, the intravenous regimen was continued for all patients but DOX was given as a 48 h continuous instead of short term infusions on each of 2 successive days. Response rate as well as MFS seem essentially unchanged after this modification of application mode. If this holds true after also changing for a continuous infusion of DDP has to be awaited for. Early findings indicate, that switching to a continuous infusion for both drugs may be disadvantageous.

Another means for reducing DOX cardiotoxicity, which we intend to explore in the near future is reduction of the total dose. Observations from study COSS -86, where many patients did not tolerate the scheduled 5 courses cumulating to 450 mg/m^2 of DOX and not so rarely patients even received 3 cycles only, indicate that reducing the total dose may be tolerated without compromising the outcome. In addition, analysing the prognostic impact of absolute tumor volume revealed that patients with tumor volumes below 200 ml had a 10% risk only for developing metastases as opposed to 50% at ≥ 200 mL ($p < .001$). The risk for metastases did not increase further at volumes much higher than 200 ml. However no patient with a tumor volume ≤ 70 mL ever developed metastases so far. In a grouping system based on tumor size and response to preoperative chemotherapy, we plan to reduce drastically the treatment duration in low risk and moderately in standard risk patients. In high risk patients another trial of postoperative salvage treatment is planned, based on our encouraging results in relapsed patients using carboplatinum/VP-16 combination.

Aggressive fibromatosis—clinical experience in a 13-year period

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Aggressive fibromatoses are benign neoplasms mainly arising from fascial sheats and muscolo-aponeurotic structures.

They are locally invasive and have a great tendency to local recurrence, but do not metastasize. We report our experience with aggressive fibromatosis.

Material: In the period 1980–1993, 15 women and 12 men with aggressive fibromatosis were treated. Median age was 35 (2–75) years. Biopsy or tumor excision were performed in 18 patients before admission to our hospital. First operation (biopsy or excision) was performed median 7 (2–120) months after the patients first experience of a tumor. 11 tumors were located to truncus, 7 to upper extremity and 9 to lower extremity.

Results: 2 patients were not treated because of poor general condition and lack of accept. 2 tumors were excised intralesionally. Marginally excision was performed in 11 patients of which 8 were given postoperative irradition. A wide resection was performed in 12 patients of which 2 were amputated, and no adjuvant irradiation was given to these patients. Medium follow up was 5 (1–12) years of the 23 patients with marginal or wide excision. Local recurrence was observed in 6 patients (26%) of which 3 had a wide and 3 a marginal excision. Of these one patient had distant metastasis. Only 2 patients had postoperative irradiation. Only 2 patients have died with tumor left (9%).

Conclusion: The study suggests that wide excision alone is not sufficient for optimal local tumor control and support a policy of a wide excision combined with radiation.

Desmoid tumor—a growth with a peculiar biology
The Gothenburg experience of 52 cases

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The known peculiarities of this fibromatosis, which makes it differ from other soft tissue tumors, are given. Among these features are extreme aggressiveness with no tendency for metastases, influence by trauma and sex hormones, occasional spontaneous regression and association with other abnormalities.

Patients and methods: 52 patients treated in our department were retrospectively studied, 31 female, 21 male. Average age was 43 (4–80) years. Tumor location was: extremities 12, trunk and neck 40 (abdominal wall 13). Average maximum diameter was 7 cm. 48 patients were operated on. 3 inoperable and 8 recurrent tumors were irradiated.

Results: 20 out of 48 operated patients had a recurrence. 15 of these had had marginal or intralesional surgery. Average time for a recurrence to appear was 17 (4–37) months. 16 patients with recurrence had altogether 35 further operations. 8 ultimate surgical failures were recorded. These and 3 inoperable tumors were controlled with 50–60 Gy irradiation. No patient died of desmoid tumor, 5 died of other causes.

Conclusions: Wide resection is associated with a recurrence rate of approximately 25%. Irradiation may be warranted for unresectable tumors or when surgery will result in severe disability or cosmetic deformity. Mortality is negligible.

Chordoma—diagnostic, therapeutic and prognostic aspects

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Chordoma is a rare and slow growing tumor. In the present study 37 patients with histological proven chordoma treated over a period of 25 years were analyzed.

Results: Median age was 59 (1–83) years. Male:female ratio was 2.7:1. The tumors were located in the sacro-coccygeal region in 25, spheno-occipital region in 6 and vertebrae in 6 patients. Radiographically skeletal destruction was seen in 35 patients. Median tumor size was 7 (1–30) cm. Median duration of symptoms before admission was 12 (1–84) months. Dominating symptoms were pain (36) and neurological disturbances (16).

Treatment was surgical resection in 11, radiation in 10 and a combination of the two in 15 patients. Median radiation dose/fractions were 55 Gy (30–80) / 29 (13–50). Symptom relief was obtained in 31 of the patients, and the median time to maximum relief was 6 months. 2 patients were lost for follow-up. At the time of analysis 10 patients were alive. The actuarial 5 / 10-year rates of overall, progression-free and symptom-free survival were 40% / 26%, 31% / 21%, and 20% / 14%, respectively.

Conclusion: Although patients may live for a long period of time with active chordoma, they often suffer from pain and neurological disturbances, and the ultimate prognosis is poor.

5-year treatment results of the Helsinki Soft Tissue Sarcoma Group

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In August 1987 we established a soft tissue sarcoma (STS) group. A treatment protocol was set up. The examination of the surgical margin was emphasized. Postoperative radiotherapy was recommended after marginal surgery.

The results of 146 patients referred with primary tumors of the extremities or superficial trunk are reported. 76

patients were referred after intralesional or marginal surgery and 38 either virgin or after fine needle aspiration biopsy. 115 tumors were in the extremities. Only 7 tumors were intramuscular, 42 were subfascial extramuscular, 59 cutaneous or subcutaneous and 30 additional tumors penetrated the deep fascia. 15 patients had primarily metastatic disease. 80 tumors were of malignancy grade 3–4. 54 tumors were <5 cm, 35 >10 cm in diameter.

132 patients were primary referred, stage M0 and N0 and were treated. 9 amputations were performed. Of 122 patients treated with local excision the surgical margin was intralesional in 7 cases (6 received additional radiotherapy), marginal in 59 cases (RT in 32), wide in 54 (RT in 1) and compartmental in 2 (RT in 1). 7 patients received chemotherapy as part of the initial treament. Of patients with a marginal surgical margin who did not receive radiotherapy 17 were of low malignancy grade.

After a median follow-up of >2 years, 20 local recurrences have been detected. 15 of these had no evidence of local disease at last follow-up. 9 patients had either simultaneous or previous metastatic disease. Altogether 31 patients have had metastases during the follow-up. The estimated 5-year survival, local disease-free survival and metastases-free survival rates are 77%, 83%, and 72% respectively.

These results compare favorably to previously published results from Finland (Rantakokko and Ekfors, 1979) and Helsinki (Gröhn et al. 1979) who reported local recurrences in 32–44% of the patients. The importance of a multidisciplinary sarcoma group and the centralized treatment of these patients is stressed.

Management of bone and soft tissue sarcomas at the Philippine Orthopedic Center An update 4 years later

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At the SSG meeting in Helsinki in 1989 the first Filipino orthopedic oncology fellow at Sahlgren University Hospital (RC) presented the state of the art of musculoskeletal oncology management at the Philippine Orthopedic Center (POC). We present a follow-up to evaluate the progress made following the Scandinavian training experience.

Patients: From 1991–1993, 218 musculoskeletal tumors were seen at POC; 166 (76%) were primary bone tumors, 35 (16%) were primary soft tissue tumors, and the rest (8%) were metastatic tumors.

Results: Ablative surgery is still the most common procedure performed for both soft tissue and bone sarcomas, 71% and 65%, respectively. The number of limb-salvage procedures (about 30%), however, have increased significantly in the last 4 years. The setting up of the Musculoskeletal Tumor Unit in October 1993, was a significant acknowledgement of orthopedic oncology as a subspecialty in the Philippines. Its goal is primarily to organize tumor management through a well-coordinated tumor team, making available affordable diagnostic and treatment resources to patients.

Conclusion: The problems expressed 4 years ago are virtually unchanged, because of the existing realities in a developing country like the Philippines. However, we do hope to overcome the difficulties that face the management of musculoskeletal tumors in the Philippines with the small but decisive efforts started in our institution.

Risk factors of soft tissue sarcoma in Southern Sweden

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Background: Risk factors of soft tissue sarcomas are still only partly known. Suggested factors include exposure to herbicides, radiation exposure and family history. In a ongoing case control study in southern Sweden we have in addition to the above factors analysed height and weight at puberty and diagnosis, a history of previous trauma and a history as a professional athlete.

Methods: A comparison was made between 166 newly diagnosed cases identified through the regional tumor registry and 531 referents from the general population, matched with the cases for age, domicile (parish) and sex. A further comparison was done with 489 referents chosen from the general population but matched with the cases for age, domicile (county) and sex.

Findings: Being tall at early puberty was a risk factor for men with sarcoma. Weight at early puberty or at diagnosis was not associated with sarcoma development.

There was no association between alcohol use and risk for sarcoma. Neither could an association between being an ever smoker and sarcoma risk be seen. However, a protective effect between the amount of smoking on sarcoma development was seen although these results were not statistically significant ($p = 0.20$). The duration of herbicide exposure was not associated with sarcoma risk.

Discussion: Our findings indicate that both family history and the patient height both at puberty and at diagnosis are important determinants of sarcoma risk. These results point to the importance of genetic and probably early hormonal factors for tumor development.

Families with cases of soft tissue sarcoma and other malignancies occurring at young ages—descriptive epidemiology

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Background: In an ongoing case control study in southern Sweden we have calculated the risk of having a first degree and second degree relative with soft tissue sarcoma. Further families with a tumour spectra suggestive of Li-Fraumeni's syndrome have been sought for.

Methods: A comparison was made between 166 newly diagnosed cases identified through the regional tumor registry and 531 referents from the general population, matched with the cases for age, domicile (parish) and sex and 489 referents chosen from the general population but matched with the cases for age, domicile (county) and sex. Both these control groups were combined in the analysis.

Results: 4 cases and no referent gave a history of soft tissue sarcoma in their families. 22 female patients had at least one first degree relative with either brain tumours, breast carcinoma, leukemia or lung cancer and 15 male patients had at least one first degree relative with either brain tumours, breast carcinoma, leukemia or lung cancer. In only one case was a child diagnosed with a tumour (brain tumour).

Discussion: Soft tissue sarcoma development among relatives of patients with soft tissue sarcomas are rare events Likewise are tumour aggregations suggestive of p53 mutations rare.

CT and MRI in the surgical staging of subcutaneous soft tissue tumors

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We assessed the realiability of CT and MRI in the surgical staging of subcutaneous soft tissue tumors (SST).

Patients and methods: The study was based on 54 patients with SST of the trunk or extremities. Surgical staging was based on CT in 32 cases and MRI in 24; both modalities were applied in 2 cases. The staging was performed to assess wether the lesions were confined to the subcutaneous space or involved the underlying deep fascia or/and muscle. The results were compared to findings at surgery and histopathological gross specimens.

Among the 54 cases, 38 proved to be sarcomas (29 MFH), 13 were benign lesions (5 desmoid tumors), and 3 secondary malignant lesions.

Results: Among the 32 cases examined with CT, 26 proved to be subcutaneous and 6 involved the deep fascia. However, on CT, 11 of the 26 subcutaneous lesions appeared to involve the deep fascia. 2 of the 6 lesions which involved the fascia appeared to be purely subcutaneous on CT.

24 cases were examined with MRI. Among 21 subcutaneous lesions, 8 appeared incorrectly to engage fascia. 2 of 3 lesions which involved the fascia appeared on MRI to be only subcutaneous.

Hence, correct staging by CT or MRI was obtained approximately in 60% of the lesions.

Discussion: For CT, the spatial resolution and contrast between tumor and muscle propably accounted for poor discrimination. With MRI the spatial and contrast resolution is better. Other problems such as motion artifacts in elderly non-cooperating patients and concomitant subfascial non-neoplastic changes were encountered. MRI also showed pathological subfascial signal, not found to represent tumor, but most propable reactive hyperemia or edema. In one case subfascial change was characterized as bleeding after fine needle aspiration biopsy.

Conclusion: Desmoids almost always extend through the deep fascia according to histology and CT/MRI. Subcutaneous sarcomas rarely extend through the deep fascia according to histology, but relatively often according to CT/MRI. Does MRI overestimate or does histopathology underestimate extension of subcutaneous soft tissue sarcomas?

Fine needle aspiration of synovial sarcoma A retrospective study of 23 cases

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The cytologic appearance of synovial sarcoma in fine needle aspirate smears is incompletely described. We investigated whether synovial sarcoma in FNA has diagnostic cytologic features.

Material and methods: 32 FNA from 23 patients with synovial sarcoma were reexamined. All aspirations had been performed by cytopathologists and the staining methods were hematoxylin & eosin and MayGrünwald-Giemsa. Adjunctive diagnostic methods were used in 6 aspirations; immunocytochemistry in 3 and electronmicroscopy in 3, respectively. The diagnosis synovial sarcoma was based on histopathologic examination of the primary tumor; in addition to routine stainings immunohistochemistry was performed in 21 and electronmicroscopy of fresh tumor tissue in 10 tumors.

Results: Histopathology: 14 sarcomas were monophasic, 7 biphasic and 2 poorly differentiated. A spindle cell population was prominent in all tumors and the transition

between pale and dark staining cells was characteristic. A hemangiopericytoma-like pattern was present in 8 sarcomas. In the biphasic tumors the epithelial component was never predominant. Atypical mitoses were always present in the spindle cells. Numerous mast cells were found in 10 sarcomas. Cytokeratin positivity was found in 16 tumors, at least in one of the blocks investigated.

Cytologic reexamination: The most common appearance were cell-rich aspirates composed of a mixture of irregular tumor tissue fragments and dispersed cells. The fragments were hypercellular with tightly packed cells. A common observation was branching capillaries in the fragments. The tumor cells were small to medium-sized with mostly rounded or ovoid nuclei with bland chromatin and small nucleoli. The cytoplasm was scanty with small uni- or bipolar processes. Mitoses were common. Less common features were small acinar-like structures in the periphery of the fragments as more or less numerous mast-cells. A typical biphasic pattern (mesenchymal cells and unequivocal glandular structures) were found in only two aspirates; another rare finding was a smear entirely composed of fusiform cells with spindle-shaped, medium-sized nuclei.

Adjunctive methods: Immunocytochemical analysis was not helpful in our cases as keratin-positive cells were not observed. The electron microscopic examination, however, strongly suggested the diagnosis.

Differential diagnoses: Malignant hemangiopericytoma, fibrosarcoma and when the cellular yield was poor, desmoid and fibromatoses were the most important pitfalls.

Conclusion: A technically satisfactory and cellular smear from a synovial sarcoma may be diagnosed as a spindle cell sarcoma but type diagnosis is difficult and demands adjunctive diagnostic methods; first choice is electronmicroscopic examination.

Epithelioid sarcoma in the Scandinavian Sarcoma Group Central Registry (SSG-CR) from 1986–1993

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For the Scandinavian Sarcoma Group

At presentation epithelioid sarcomas are frequently judged as small, superficial, benign tumors with no further work-up than a clinical evaluation. Few are referred to an orthopedic oncology center in a virgin state.

Patients and methods: 22 cases were recorded in the SSG-CR; 14 men, 8 women. The average age was 41 (men 45, women 33). The tumors were located in the upper extremity (10), lower extremity (9) and trunk (3); 11 were superficially located. 10 tumors were smaller than 5 cm.

Only 4 of the 22 tumors were referred in a virgin state. 9 were referred after local recurrence, 5 after incisional biopsy, 3 after incomplete excision, and 1 after aspiration cytology. 11 patients had a local excision, and 10 an amputation as final surgical treatment. One had preoperative radiotherapy but succumbed before surgery.

Results: At follow-up, 10 patients had no evidence of disease; 7 had more than 2 years follow-up (average 59 months). 5 patients were alive with disease (4 less than 2 years after initial treatment), and 7 had a tumor-related death (4 more than 3 years after initial treatment).

Conclusion: Epithelioid sarcomas are frequently misinterpreted as benign lesions. Size seems to be of importance for the prognosis. To gain further information of this rare tumor entity the SSG series will be included in a combined EMSOS study with multivariate statistical analysis.

Gene amplification in soft tissue sarcomas

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DNA amplification, particularily oncogene amplification, is frequent in human cancer. In vitro studies have demonstrated that amplification may confer proliferative advantage to tumor cell clones, and may thereby contribute to tumor progression. Two genes of potential pathogenetic importance for bone and soft tissue tumor development, both on chromosome 12q13–14, have recently been identified: sarcoma amplified sequence, SAS, and the murine double minute type 2 gene, MDM2. The latter functionally interacts with the tumor suppressor protein, TP53.

We studied MDM2 amplification by southern blot in a series of 94 mesenchymal tumors. 3 to 20-fold amplification of MDM2 was detected in 20 tumors: in 10/49 MFH, 1/2 pleomorphic liposarcomas, 6/7 atypical lipomas, and in 3/12 typical lipomas, wheras normal hybridization patterns were seen in all 16 myxoid liposarcomas, 3 leiomyosarcomas, and 5 leiomyomas studied. MDM2 amplification correlated with the presence of ring chromosomes; 5/10 MFH with amplification had ring chromosomes compared to 4/39 without amplification, and all 9 lipomas with amplification were characterized by rings. This correlation suggests that the rings of MFH and of atypical lipoma harbor genetic material derived from chromosome 12.

To determine the extent of the amplification unit (amplicon) and to close in on the target gene, we further examined 16 of the tumors with MDM2 amplification using an additional 12 probes from chromosome 12. The amplicon varied between the tumors and included markers both proximally and distally of MDM2, but was in all but one case confined to 12q13–15. In 5 MFH only MDM2 was amplified, and in 7 tumors SAS was coamplified. Furthermore, 2 tumors showed discontinous amplicons. This study thus indicates that MDM2, or possibly an as yet unidentified gene in its proximity, is the target of the gene amplification in 12q13–15.

DNA ploidy in soft tissue sarcoma A Scandinavian Sarcoma Group study of 777 patients

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For the Scandinavian Sarcoma Group

There is no consensus on how to quantify DNA histograms of soft tissue sarcoma (STS). We have earlier shown that the use of 8 different types of histogram is superior to DNA index. However, earlier series have been too small to permit a definitive analysis of how to group these 8 types to obtain the best prognostic information.

Patients: We included 777 adult patients with STS of extremity and trunk wall. 112 patients were entered from Helsingfors, 164 from Stockholm, 148 from the SSG I-study, and 353 from Lund. Clinico-pathologic data were recorded. Flowcytometric DNA analysis was performed with similar techniques at 2 different institutions, and the histograms were classified in 8 different types.

Results: Classification of DNA histograms into "DNA type 1–2" (narrow or broad Gaussian distribution) versus "DNA type 3–8" (all other types) gave the best prognostic separation. DNA analysis was a univariate prognostic factor in malignant fibrous histiocytoma, liposarcoma, and synovial sarcoma, but not in leiomyosarcoma.

Conclusion: Classification of DNA histograms in to "DNA type 1–2" and "DNA type 3–8" gives the best prognostic separation. The value of this separation varies between different histotypes.

DNA S-phase fraction and ploidy as predictors in musculoskeletal tumors

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Both DNA synthetic activity and ploidy have been considered important for definition of malignancy and for prognosis.

Materials and methods: DNA flow cytometry with S-phase analysis was performed on 24 benign, 11 low grade and 11 high grade malignant bone and soft tissue tumors. After mechanical, RNase, and trypsin preparation , the isolated nuclei were stained with propidium iodine using chicken and rainbow trout red cells as controls. Ploidy and cell cycle fractions were determined using the Multicycle model. The histologic diagnoses were made before the DNA analyses. The follow-up was over 5 years or until death, median 59 (16–87) months.

Results: S-phase fractions were below 14% in all benign tumors. None of them recurred despite of aneuploidy in 7. The S-phase was higher than 14% in 4/6 aneuploid low-grade tumors and in 9/9 aneuploid high grade tumors. 7/9 patients who died of metastatic disease had aneuploid stemlines with high S-phase in a high-grade tumor. 3 patients with high S-phase in a low-grade tumor survived. As a separate predictor of survival, S-phase fraction was as important as histologic grade; ploidy had less importance (Table).

	Nonlethal	Lethal	*P*-Value
Diploid	22	2	0.08
Aneuploid	15	7	
Low S-phase	31	2	0.00
High S-phase	6	7	
Benign	24	0	0.000
Low grade	10	1	
High grade	3	8	

Conclusion: Both high DNA synthetic activity and aneuploidy characterize the malignancy of a musculoskeletal tumor, the highest malignancy presenting as aneuploid populations with high DNA synthesis activity.

Ki-67 predicts metastasis in 182 soft tissue sarcomas

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Introduction: Ki-67 is an important marker of cell proliferation in normal and neoplastic tissue. MIB1 is a monoclonal anti-Ki-67 antibody generated from recombinant fragments of the Ki-67 serie. Our study uses MIB1 to identify Ki-67 in fixed and embedded tissues from soft tissue sarcomas (STS). We have examined associations between Ki-67 expression, primary tumor characteristics, and outcome.

Patients: We examined 182 adult patients with trunk wall or extremity STS who were treated at our institution between February 1980 and August 1992. There were 35 local recurrences and 56 metastases. The median follow-up time for survivors was 6 (1–13) years.

Results: We used a semiquantitative score to rate the percentage of cells which express Ki-67, viz, 0–10% (n 86), >10–25% (n 57), >25–50% (n 30), >50–75% (n 7), >75–100% (n 2). Increasing Ki-67 expression correlated with primary tumor size, malignancy grade, necrosis, vascular invasion, S-Phase fraction, and metastasis. A Ki-67 index (Ki-D) defined 2 groups with Ki-67 expression ≤10% (n 86) and >10% (n 96) who had 85% and 57% 3 year metastasis

free survival, respectively. Tumors with Ki-D >10% were more often large, high grade, necrotic, aneuploid and had evidence of intravascular invasion and a higher S-phase fraction. Tumor necrosis and vascular invasion retained their independence on multivariate analysis. Ki-D improved the separations in metastasis free survival when applied together with primary tumor necrosis and vascular invasion. Ki-D predicted survival independently of DNA ploidy.

Conclusions: Ki-67 strongly correlates with the markers of malignancy. As an histological index of cellular proliferation, Ki-67 expression can be used to predict survival of patients with soft tissue sarcomas.

Prognostic importance of growth rate index (GRI) from 134 local recurrence in soft tissue sarcoma

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Our study combined size and timing of the first local recurrence to create a growth rate index (GRI-ratio of size to timing) which we analysed for an association with metastasis.

Patients: We analysed 134 locally recurrent tumors from a series of 460 adult soft tissue sarcomas of the extremities and trunk wall without concurrent metastases that were diagnosed and treated between 1964 and 1990. The median follow up time was 10 (2–28) years for survivors. One half (74) of local recurrence were from inadequately treated primaries, another half (71) were associated with metastases, and two thirds (89) were non-centre treated patients.

Results: There were equal numbers of patients with GRI ≤0.4 (low) and >0.4 (high). Patients with a low GRI had a better 2 year survival than those with a high GRI (Figure 1). Low GRIs were associated with low grade primary tumors, and a relatively long metastasis free survival. Conversely, high GRIs were associated with larger, high grade primary tumors and a shorter metastasis free interval. Time to local recurrence strongly correlated with the time to metastasis (R^2 = 0.85, *P* 0.0001). Metastasis developing in patients with local recurrence occurred up to 3 times faster in adequately treated patients than others. GRI was a good discriminator of metastasis in patients with both large (> 5 cm) and high malignancy grade (IV) primary tumors.

Conclusion: Our study suggests that clinical characteristics (e g GRI) of local recurrence rather than presence, per se, is important for predicting tumor behaviour. Patients with high GRI may be candidates for chemotherapy.

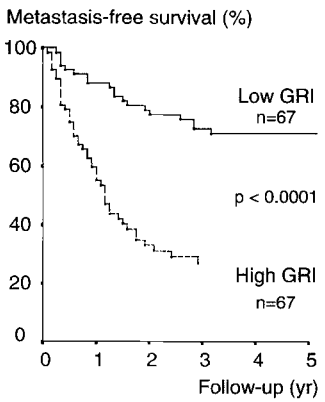

Figure 1.Prognostic importance of growth rate of local recurrence (GRI). Choong et al

Measurement of growth rate of lung metastases in soft-tissue or bone sarcomas

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Tumor doubling time measured from chest radiographs has been shown to be an important prognostic factor for overall survival in both primary and secondary lung tumors.

The most widely used method for the measurement of lung metastases in previous reports has been the graphical method on semi-logarithmic paper. In this study, a more convenient and objecive method based on linear regression is demonstrated, which may be done with an ordinary desktop computer.

The reliability of measurement of tumor doubling times from chest radiographs has previously been only briefly discussed. In this study each metastasis was measured by 2 different investigators and the level of agreement assessed.

Patients and methods: The volume doubling time (T_2) of 52 lung metastases in 21 patients was calculated from measurements done on plain chest radiographs. Follow-up times ranged from 14 to 819 days. The largest longitudinal diameter (d_1) and the largest transverse diameter perpendicular to this (d_2) were measured from chest radiographs by 2 investigators. A regression analysis was performed on the logarithm of the product of the 2 perpendicular diameters versus time. In the calculations of cross-section area an elliptic shape of the metastases with an area of $(*d_1*d_2)/4$ is postulated.

A linear regression equation of the form $y = ax + b$ was calculated for each metastasis, where $y = \ln(d_1*d_2)$, ln = natural logarithm, d_1 = the longitudinal diameter,

d_2 = the transverse diameter, a = the slope of the regression equation, x = the time from baseline, b = the constant term of the regression equation. The volume doubling time of each metastasis (T_2) was calculated from the slope (a) of the regression equation according to the formula $T_2 = 2\ln 2/3a$.

Results and conclusions: The measurements were fairly well reproducible in the majority of patients, although considerable discrepances in T_2 estimates made by two independent observers were found in a few patients.

The median doubling time was 35 days (estimated 95% range 3.9 to 352 days).

The variation of T_2:s between patients was significantly ($p = 0.0001$) larger than that between T_2:s of multiple metastases in the same patients.

The growth of the metastases seemed to be well described by a simple exponential function in all patients with more than two measurements, without evidence of Gompertzian growth.

There seemed to be a linear correlation between the logarithm of T_2 and logsurvival time from diagnosis of metastatic disease, even if only one third of the variation of survival times between patients could be explained by differences in T_2. T_2 was not a significant factor for survival in Cox-analysis ($p = 0.10$).

Free flap reconstruction in soft tissue sarcoma surgery

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27 free microvascular reconstructions were performed in locally advanced soft tissue sarcomas. The excision was considered radical (wide or compartmental) in 11 cases and marginal in 16 cases. 12 tumors were located in the lower extremity, 8 in the upper, 4 in the chest wall, 2 in the head and one in the abdominal wall. Latissimus dorsi muscle was the most common flap used (17 cases), tensor fasciae latea muscle flap was used 4 times; gracilis muscle, fibular osteofasciocutaneous flap and the remnant distal part of the amputated extremity were each used in two cases. 14 patients received postoperative radiotherapy. Free flap reconstruction allows funcional limb-sparing surgery. Free flaps fill extensive cavities after tumor resections and allow early radiation therapy. Also extensive resections of the thoracic and abdominal wall are possible by using an immediate free flap reconstruction.

Complications in soft tissue sarcoma surgery—an update

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The local wound complication rate after our surgical treatment of soft tissue sarcoma 1987–1990 was recently reported to be 38%. We now analyzed our latest results having taken specific measures to reduce the complication rate.

Patients: This prospective study was based on a consecutive series of 108 soft tissue sarcoma patients treated 1991–1993. Comparative figures from the previous series of 97 patients treated 1987–1990 are given in parentheses. There were 47 (22) subcutaneous lesions and 61 (75) deep lesions. All patients were treated by local excision. A wide or compartmental margin was achieved in 62 (49) %.

Results: The overall wound complication rate was 22 (38) %. The complications were 6 (12) % hematomas, 7 (12) % wound necroses, and 9 (14) % infections. Furthermore, half of the hematomas/wound necroses became infected. The median hospitalization time was 10 (12) days.

Subcutaneous lesions: The complication rate was 21 (36) % for patients with subcutaneous lesions. Main differences in management included increased use of preoperative antibiotics 45 (14) % and split skin grafts or musculucutaneous flaps for wound coverage 68 (42) %. The median operative time was 65 (65) min.

Deep lesions: The complication rate was 23 (39) % for patients with deep lesions. Preoperative planning by MRI in 77 (12) % has largely replaced CT 27 (81) %. Other major changes apply to preoperative antibiotics 84 (31) %, peroperative bleeding median 300 (900) mL, and maintenance of drains 3 (2) days. The median operative time remained unchanged 130 (120) min.

Conclusions: Reduced wound complication rate after local surgery in soft tissue sarcoma was achieved by improved preoperative planning based on MRI, surgical technique focusing on less bleeding and better soft tissue coverage in cooperation with plastic surgeons. The reduction in complication rate mostly applied to fewer wound hematomas and necroses. The infection rate was only slightly influenced by routine use of preoperative antibiotics.

Trofosfamide in the treatment of advanced soft-tissue sarcoma (STS)

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Chemotherapy combinations effective in the treatment of soft-tissue sarcoma are associated with appreciable toxicity. Many patients with advanced STS are old and therefore cannot tolerate these regimens. Trofosfamide is an oxazophos-

phorine closely related to ifosfamide, available in oral form and is associated with very little subjective toxicity. Ifosfamide during the last decade has emerged as one of the most potent cytotoxic drugs in STS. We performed a pilot study in order to test whether trofosfamide also is effective in this disease.

Patients and methods: 2 categories of patients were included:

1) patients having failed previous combination chemotherapy (all pretreated with ifosfamide) for advanced disease.
2) patients with first line chemotherapy treatment for advanced STS unable to tolerate more toxic combinations.

Results: 21 patients were included, 10 treated after failure with ifosfamide and 11 given first line treatment. Trofosfamide was given as continuous oral treatment. The starting dose was 150 mg and doses were escalated every third week until occurrence of WHO grade 2 leukopenia. Responses were assessed according to UICC criteria.

The maximum tolerated drug level was 200–250 mg in 13 cases. One patient tolerated 350 mg, and 2 pretreated patients could not tolerate more than 100 mg daily. 3 patients responded (PR) for between 6 and 18 months. Theset patients had high grade sarcoma with multiple lung metastases. None of the patients having received ifosfamide previously responded. The drug was well tolerated. No alopecia, nausea, gastrointestinal symptoms or other subjective toxicity was noted. Leukopenia was the dose-limiting toxicity. 2 patients had serious infections (one pneumocystis pneumonia and one urosepsis), at least the former probably related to the treatment.

Conclusions: Oral trofosfamide is a well tolerated cytotoxic drug with activity in previously untreated advanced STS. No activity was, however, seen in patients relapsing on previous ifosfamide treatment. A larger study is needed in order to determine the response rate more accurately.

Chondrosarcomas—prognostic factors

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Material and methods: 106 patients with borderline and malignant chondromatous bone tumours (1965–1992). Clinical data were retrieved, and the pathological material was reviewed by 3 pathologists, with a conventional grade obtained by consensus. Histopathological factors of possible importance were also graded. Tested with regard to recurrencefree survival (RFS) or overall survival (OAS) by logrank tests in a univariate analysis were: Age, sex, site, size, intra- vs extracompartmental growth, surgical margin, cellularity, nuclear pleomorphism, No of multinucleated cells, mitoses, demonstrable invasive growth, growth pattern, and grade.

Results: In RFS, the surgical margin was the most important factor, with $P < 0.00001$. Size and extracompartmental growth were also significant ($P = 0.04$), as were the number of multinucleated cells ($P = 0.03$). Men fared worse than women, but the difference was not statistically significant ($P = 0.07$). None of the other factors achieved significance. In OAS, age was a natural prognostic factor ($P < 0.001$), and surgical margin ($P = 0.02$). The only other factor to achieve significance was the presence of mitoses ($P = 0.045$).

Conclusion: The most important prognostic factors appear to be the surgical margin, size, and intra-/extracompartmental tumour growth. The histological grading system may benefit from an adjustment with formal weight on factors yielding prognostic information, e g mitoses and multinucleated cells.

Chondrosarcoma of the spine and pelvis The Gothenburg experience

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The only recognized treatment of chondrosarcoma today is surgery. Tumors of the spine and pelvis constitute the greatest surgical challenge. The aim of this study is to evaluate the results of this surgery.

Patients: 53 patients with chondrosarcomas of the spine and pelvis were retrospectively studied, 40 males, 13 females. The average age was 45 years. The average tumor size was 13 cm. 15 patients hat spinal or sacral tumors, 38 had pelvic location.

Results: Histologic subtyping revealed 34 classic, 13 secondary, 5 dedifferentiated and 1 mesenchymal chondrosarcoma. Of the 15 spinal cases, 3 were inoperable, 8 had intralesional or marginal surgical margins and 4 wide. 4 patients had no evidence of disease (NED), 3 were alive with tumor and 7 had tumor related death (TRD). Of the 38 pelvic tumors, 4 were inoperable, 14 had intralesional or marginal surgical margins and 20 wide. 21 patients had NED, 15 patients had TRD and 2 died of other causes. The mean follow-up time was 15 (3–32) years.

Conclusions: The results indicate a 30% long-term survival in spinal or sacral chondrosarcoma, 60% in pelvic chondrosarcoma. Extensive surgery in these cases appears worth-while. This is illustrated with several case reports.

Therapeutic effect of ^{153}Sm-EDTMP in an orthotopic human osteosarcoma model

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This study was performed in order to validate the use of therapeutic doses of the bone seeking nuclide complex samarium-153 ethylenediaminetetramethylene phosponate (^{153}Sm-EDTMP) in an orthopedic human osteosarcoma model in nude rats. Athymic nude rats (Han: rnu/rnu Rowett) of 4-weeks of age were injected intratibially with $1x10^6$ human OHS osteosarcoma cells (1). After 7 days groups of animals were given 200, 400 or 800 MBq/kg of ^{153}Sm-EDTMP or left as untreated controls, and the time until overt tibial tumor was recorded.

The group of 28 untreated OHS injected control animals developed palpable bone tumors after a median time of 20 (12–33) days, with 3 rats that did not develop tumor growth. 16 rats received 200 MBq/kg ^{153}Sm-EDTMP and had a median disease-free latency of 28.5 (20–44) days, and 3 had no detectable tumors at the end of the experiment. 12 rats received 400 MBq/kg and median disease-free latency was 27 (27–44) days and 6 rats had no detectable tumors. The median disease-free latency in 13 rats treated with 800 MBq/kg ^{153}Sm-EDTMP was 45 (23–48) days, with 8 long time disease free animals.

The results show that ^{153}Sm-EDTMP has a significant effect on OHS tibial tumors in nude rats comparable to or even better than that achieved by standard chemotherapy. ^{153}Sm-EDTMP might give an additional effect in the treatment of human osteosarcoma if used as an adjuvant to the present treatment regimen.

Novel deletions and amplifications in osteosarcomas detected by comparative genomic hybridization

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Comparative genomic hybridization (CGH) is a powerful method for detection of DNA sequence copy number changes along the whole genome. In CGH differentially labelled tumor DNA and normal DNA are hybridized to normal metaphase spreads. Deletions, gains and amplifications in tumor DNA are detected as changes in the relative fluorescence intensity ratio of tumor to normal DNA along each chromosome and quantitated by digital imaging.

We have used CGH to study DNA sequence copy number changes in 11 osteosarcomas. These consisted of 2 parosteal osteosarcomas, 8 grade III or IV primary osteosarcomas and one grade IV pulmonary metastasis. 10 tumors showed extensive genetic aberrations (1–20/tumor). Regions most often (4/11, 36%) deleted included 2q, 6q and 8p, whereas gains most often took place at 11q and Xq. In addition, high-level amplifications of several small regions were found. These included the 12q13-14 (SAS-MDM2) locus and several previously unknown regions (e g 17p) that apparently do not involve known oncogenes. The Rb locus 13q14 was lost in 3 tumors (27%).

In conclusion, the overview of the genome provided by CGH makes it possible to rapidly map deleted and amplified regions and thereby highlight chromosomal locations of putative novel oncogenes and tumor suppressor genes.

Clonal evolution in bone and soft tissue tumors

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Cytogenetic clonal evolution in tumors can be evidenced as more than one clone in one sample and as different clones in different samples from the same tumor. Analysis of relapse of a tumor may also be useful to follow the clonal evolution.

Multiple (2–7) samples, from the same surgical specimen or from different occasions, were cytogenetically investigated in bone and soft tissue tumors.

Cytogenetic aberrations were detected in 136 samples from 50 tumors. More than one clone was found in 38 of the 136 samples (30%) and different clones in different samples from the same tumor were present in 23 of 29 informative tumors (80%). Unrelated clones were detected in only 5 of the cases. Evolution in relapsing tumors could be demonstrated in 10 of 12 cases. In all cases in which a tumor type specific, primary aberration was detected this was present in all clones.

We conclude that cytogenetic clonal evolution is common in bone and soft tissue tumors, and that this may be more easily revealed if multiple samples are analyzed. The more detailed cytogenetic information that is obtained through these studies of clonal evolution can be used to identify early or recurrent changes.

Cytogenetic studies of fine needle aspiration samples from malignant bone tumors

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Osteosarcomas have complex, unspecific, chromosomal aberrations and Ewing's sarcoma a specific translocation (11; 22) found in 80% of sarcomas studied. Fine needle aspiration (FNA) can be used in the diagnosis of bone sarcomas. The aspirated material is in most cases sufficient also for electronmicroscopic examination and (immuno)histochemical analysis beside the cytologic evaluation. By these combined examinations diagnostic FNA-criteria for osteosarcoma and Ewing's sarcoma have been defined.

We investigated wether chromosomal analysis could be performed on aspirates from osteosarcoma and Ewing´s sarcoma and whether it contributed to the diagnosis. 17 patients with clinically and radiologically suspected bone sarcomas (6 osteosarcomas and 11 Ewing's sarcomas) underwent fine-needle aspiration. The aspirations were performed according to established methods with 22 gauge (0.7 mm) needles and part of the aspirates were used for short-term cultures (1–3 days).

We could analyze mitotic cells in 5 osteosarcomas and 10 Ewing's sarcomas. Normal karyotypes were found in 2 osteosarcomas and 3 Ewing's sarcomas while abnormal karyotypes were diagnosed in 3 osteosarcomas and 7 Ewing's sarcomas. In 5 out of the 7 Ewing's sarcomas the characteristic (11; 22) translocation was found. The reasons for the 2 failures and the 5 cultures with only a normal karyotype were most probably an insufficient number of tumor cells in the cultures.

The high specificity of the (11; 22) translocation found in the Ewing's sarcomas is important for the diagnosis. In the osteosarcomas, however, the sensitivity was too low to enhance the diagnosis. Recently the t(11; 22) breakpoints have been cloned and sequenced, and molecular genetic analysis, requiring an even smaller amount of cells, regardless of mitotic activity, will be possible, increasing the diagnostic abilities of fine-needle based diagnosis of bone tumors.

Diagnosis of Ewing's sarcoma of bone based on fine needle aspiration The role of electron microscopic examination

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Ewing's sarcoma of bone is uitable for fine needle aspiration (FNA); a soft tissue mass is often present, the tumor cells are not cohesive and the yield is usually rich. Aspirated material is in most instances sufficient for adjunctive diagnostic methods besides routine cytologic examination. Criteria for FNA-diagnosis, based on the cytologic appearance in combination with electron microscopic examination, immunocytochemical and cytogenetic analyses have been established. The other small cell malignant tumors important in the differential diagnosis, (neuroblastoma, primitive neuroectodermal tumor (PNET), rhabdomyosarcoma and lymphoblastic lymphoma) have also, in most cases, typical diagnostic cytologic features in FNA. There are, however, cases which are difficult or impossible to distinguish from Ewing's sarcoma in routinely stained aspirate smears. On these occasions electron microscopic examination is important for the diagnosis although immunocytochemistry and cytogenetics are valuable assets. The presence of large deposits of glycogen and primitive cell junctions combined with sparse organelles and the absence of neurofilament, microtubules and neurosecretory granules in cell processes favors Ewing's sarcoma instead of neuroblastoma and PNET even though a (11; 22) translocation is present at cytogenetic analysis. The absence of sarcomere structures and desmin positive cells excludes alveolar rhabdomyosarcoma and the presence of cell junctions excludes lymphoma. Ultrastructural analysis of fine needle aspirates combined with cytologic examination, immunocytochemical and cytogenetic analyses permits preoperative multidrug chemotherapy of Ewing's sarcoma, omitting open biopsy.

Surgical treatment of tumors in the sacrum and the pelvis

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Introduction and material: We have analyzed 22 men and 9 women, mean age 35 (9–72) years, operated for tumor in the pelvis and sacrum 1986–1993; 15 for malignant, 13 for benign tumors. The patients were grouped: Group 1 (N=11): the benign tumors, giant cell tumors excluded, and group 2 (N=18): all malignant and giant cell tumors.

Treatment: Group 1 were treated by curettage/excision, and bone graft when needed. Group 2 had partial hemipelvectomy with conservation of the extremity (8), partial removal of the sacrum was performed in 5 cases; classic hemipelvectomy in 4 cases.

Complications: After sacrectomy, 2 times intestinal obstruction and 2 times wound necrosis occurred. Group 1 (group 2) stayed in hospital 7 days (46 days); the blood loss was 510 mL (7900 mL) and the operative time was 82 (515) min.

Results: All the group 1 patients had excellent function. After sacral resection all patients had good neurologic function in their legs, but paretic sphincters. After extremity-conserving hemipelvectomi (N 8) the Enneking II patients

were able to walk as a hip arthrodesis. The Enneking I patient is working full time as a carpenter, the Enneking III patient had almost normal function. 9 are alive without disease, 5 are alive with disease, and 4 are dead.

Conclusion: The group 2 patients need a complicated and resourceful treatment with high technical challenge and significant risk of complications. The results are so good that surgery should be offered in addition to effective oncologic treatment. Limb sparing surgery can be applied in 60% of group 2 patients. The patients are rare, and the treatment should be highly centralized.

Massive autografts for bone tumor reconstruction—an old method revisited

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Limbsalvage is now more commonly employed than amputation in bone tumor surgery. Massive allografts or megaprostheses are usually used for reconstruction presently. The complication rate is high and durability may be limited. Reconstruction with autologous bone may serve its purpose better and remain a dependable and lasting construct in long-term survivors.

Patients and methods: 8 consecutive patients with a minimum follow-up of 6 years were studied. They all had reconstructions bridging a major bone defect, using ilium and/or non-vascularized fibula. Complications were recorded and functional outcome according to Enneking et al. (1993) was evaluated.

Results: See Table 1. All complications, except the pseudarthrosis, resolved. No patient needed amputation. Some results were affected by sacrifice of nerves and/or muscles.

Conclusions: Massive autografts in bone tumor reconstruction give lasting, very good functional results with an acceptable complication rate.

Massive allograft reconstructions 1–4-year follow-up of 9 patients with primary bone tumors

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Since 4 years, we have used allografts for reconstruction of large skeletal defects after excision of primary bone tumors in young patients.

Patients and methods: Local en-bloc excision was performed in 4 men and 5 women, mean age 21 years, with giant cell tumor (2 cases), Stage IB osteosarcoma (3), and Stage IIB osteosarcoma (4). Reconstruction involved distal femur (6 cases), proximal tibia (1), and proximal humerus (2). Patients with Stage IIB osteosarcoma received pre- and postoperative adjuvant chemotherapy according to the Scandinavian Sarcoma Group. We received frozen allografts from the Bone bank at St. Luc hospital, Brussels. The allograft was thawed in warm solution of antibiotics and fixed into the skeletal defect using an intramedullary nail and/or plate. Ligaments and muscles were sutured to the corresponding soft tissue of the allograft.

Results: Surgical margin was assessed as wide in the 7 cases of osteosarcoma and marginal in the 2 cases of giant cell tumor. There have been no local recurrences and all patients are alive and free of disease. One case of infection of a distal femur allograft was treated with removal of the allograft and reconstruction with a custom-made knee prosthesis. All except two allografts healed within 8 months with callus formation at the osteotomy sites. 2 cases of delayed union were successfully treated with autogenous bone grafting. A fracture through a knee athrodesis (resection of Stage IIB osteosarcoma in proximal tibia) has recently been plated and bone grafted. This fracture has yet not healed. The 6 patients with distal femur reconstructions have a post-operative functional assessment score according to Enneking (POFA score) >90%. The 2 patients with proximal humerus allograft reconstructions have a remarkable good range of motion and stability (POFA score >90%).

Table 1. Complications and functional results after massive autograft reconstruction in bone tumor surgery

Resection	Reconstruction	Diagnosis	Complications	Functional score (max 30)	Follow-up years
Pelvis, 9 cm gap	Femuropelvic fusion, Pelvic reconstruction	Ewing's sarcoma	–	27	6
Pelvis, 11 cm gap	Femuroischial fusion, pelvic reconstruction	Chondrosarcoma	–	23	6
Prox tibia-fibula, 11 cm	Femurotibial fusion	Chondrosarcoma	Fatigue fracture	27	8
Prox humerus, 13 cm	Humeroscapular fusion	Chondrosarcoma	Traumatic fracture	27	12
Prox humerus, 8 cm	Humeroscapular fusion	Giant Cell Tumor	–	28	10
Prox humerus, 14 cm	Humeroscapular fusion	Aneurysmal Bone Cyst	–	27	7
Distal humerus, 15 cm	Humeroulnar fusion	Osteosarcoma	Infection, pseudoarthrosis	19	16
Distal radius, 6 cm	Radius reconstruction mobile joint	Giant Cell Tumor	–	21	18

Conclusions: Our results are encouraging both oncologically and functionally even though 4 reoperations have been done so far. Function after allograft reconstruction of the proximal humerus seems superior to that after endoprosthesis.

Bank bone for orthopedic reconstruction A 21-year experience

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In the 21-year period 1973–1992 we have used massive bone allografts to replace large bone defects mainly for tumor surgery. Femoral head allografts combined with autograft have been used, especially in hip revision and trauma surgery.

Donor selection and banking procedure: Massive allografts were harvested from young victims of sudden accidental death. They should not have premortal infection or previous history of transmittable disease or blood transfusion within the past six months. Femoral heads were retrieved with the same criteria after primary hip operations. Donors were screened for hepatitis, HIV, and syphilis, and bacterial cultures were taken from harvested bones. Massive allograft donors were also typed for Rh– and HLA-antigens. The bones were storaged at –70 °C to –80 °C after mechanical cleaning according to a modified method of Imamaliev. Cartilage cryopreservative agents were not used during the storage of osteoarticular allografts.

Results: Altogether 319 bone allografts have been harvested. Bacterial culture was positive in 14 (4%) allografts. None of the donors showed positive serum titer for HIV or other transmittable diseases. Altogether 249 bone allografts have been transplanted including 47 massive allografts, which are followed at regular intervals using radiographs, bone scan, CT, biopsies and immunological tests. The union between host bone and massive allograft occurred well at 14–16 months without non-union. However, in tumor surgery total graft related complication rate has been 30% with fatigue fracture in 23% as the most usual complication. The postoperative infection rate in massive allograft operations has been 9%. Nevertheless, the overall clinical results (Mankin's scale) after massive allograft operations were excellent or good in 72%. In benign cases the same figure was 77%. In hip operations with femoral head allografts there have been only minor complications as e g resorption of some degree.

Conclusions: Allograft bone is suitable and safe method for treatment of most large bone defects. Osteoarticular allograft also allows acceptable joint function.

Assessment of surgical margins in bone tumor surgery—value of frozen gross sections

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The type and grade of bone sarcomas should be known with certainty before ablative surgery. After the operation other questions are more important, as surgical margin and grade of response to preoperative chemotherapy. These informations guide postoperative management with possible local radiation and adjuvant chemotherapy.

In order to improve assessment of surgical margins, and response to chemotherapy, the resected tissue is frozen (–20 °C) fresh, without formaldehyde. 24 hours later it is ready to be sectioned with a bandsaw. The plane of section is laid according to the preoperative MRI tumograpahies. A diapositive photo is taken from the most informative section. Tumor size, it's margins and relation within the compartment is registered. The type of surgical margin is decided (intra-lesional, marginal, wide or compartmental), and, if needed completed with microscopic evaluation. In case of preoperative chemotherapy, material for microscopic examination of necrosis and fibrosis is taken according to the rules of the Scandinavian Sarcoma Group.

The gain to examine gross frozen sections compared to examinations after formaldehyde fixation is manifold, especially:

- appraisal of surgical margins is easier
- photographic documentation is of higher quality
- systematic and more accurate evaluation of response chemotherapy
- feedback to the radiologist as for tumor size and the propagation within compartments

The main drawback is the deteriorated histologic quality due to ice-crystals, although this is a minor problem, as the histologic diagnosis already is set before operation. Furthermore, at the operation theater, prior to the refrigeration, a piece of tumor tissue is taken and put in formaldehyde for microscopic evaluation.

The advantages of frozen gross sections outweigh the disadvantages. Evaluation of the sections helps to determine response to chemotherapy and evaluation of surgical margins, and thus to guide postoperative treatment. This is sufficient to justify the method in routine practice.

Social outcome of young adults after surviving malignancy in childhood or in adolescence

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Patients: Social outcome among 94 young adults who had survived malignancy in childhood (leukemia, Wilms' tumor) or in adolescence (osteosarcoma, testicular malignancy) is compared with 61 sibling or friend controls.

Results: Those surviving malignancy in childhood attended less often high school compared to their controls. They were also more often without partner and lived more often with their parents. Only 6% of them had offspring. In all aspects of social outcome males had more difficulties.

Those surviving malignancy in adolescence were eager to educate themselves after treatment. For example of the 10 osteosarcoma patients who had finished high school, as many as 7 continued at university level. Osteosarcoma led also to handicaps. Two had to change their profession because of invalidity. One female is on sickleave. Those adolescents who were without partner at diagnosis and those who had osteosarcoma located centrally or in the upper extremity had difficulties in finding a partner. The females were especially eager to study but were more often lacking a partner compared with the males. 23% of those surviving malignancy in adolescence had offspring compared to 33% among controls. Of the osteosarcoma survivors 16% had children.

Conclusion: Malignancy and its treatment leads to a long-term social trauma which differs depending on age at diagnosis, gender and the diagnosis itself.

Cytogenetic and molecular genetic studies on bone sarcomas

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Although sarcomas are cytogenetically less well characterized than hematologic malignancies, an understanding of the role of chromosomal changes in the genesis and progression of these neoplasms is emerging. Several tumor-specific aberrations have been identified and for some of them the consequences at the molecular level have been elucidated. From a clinical point of view, chromosome analysis may be an important tool in the establishment of a correct diagnosis, but little is known about the possible correlations between karyotypic picture and clinical outcome. In the following, the essential cytogenetic and molecular genetic findings in primary bone tumors are outlined.

More than 100 Ewing sarcomas (ES) with clonal chromosome aberrations have been reported and a distinct pattern of both primary and secondary aberrations has emerged. The reciprocal translocation t(11; 22)(q24; q12) is the characteristic primary rearrangement, found in almost 90% of the tumors. Most t (11; 22) cases have additional changes, the most common of which are trisomy 8 and an unbalanced t(1; 16) leading to gain of 1q and loss of 16q. An identical t(11; 22) is consistently found also in Askin tumor, peripheral neuroepithelioma, and esthesioneuroblastoma, all of which are histologically related to ES and thought to share a neuroectodermal origin. Molecular investigation have revealed that the translocation fuses the transcription factor gene FLI1 on chromosome 11 with EWS1 on chromosome 22. Only the chimeric gene on the derivative chromosome 22 is expressed; it contains a sequence encoding a DNA-binding domain from FLI1.

Less than 40 osteosarcomas (OS) with clonal chromosome changes have been reported. The vast majority have had complex karyotypes with a chromosome number in the triploid-tetraploid range and a large number of undefined marker chromosomes. Structural aberrations preferentially involve chromosome arms 1p, 1q, 3p, 3q, 7q, 11p, 17p, and 22q, whereas the most common numerical changes are -3, -10, -13, and -15. Loss of at least one copy of chromosome 13, found in half of the tumors with clonal changes, is of particular interest because of the association between the inactivation of the tumor suppressor gene RB1 in band 13q14 and the development of retinoblastoma and OS. Patients with constitutional mutation of one RB1 allele are at an increased risk of developing not only retinoblastomas, but also non-ocular tumors, most commonly OS. Molecular analyses of sporadic OS and OS in retinoblastoma patients have revealed a high frequency of tumors with homozygous loss of function of RB1. The only association between cytogenetic findings and histopathologic or clinical parameters so far detected is that parosteal OS have supernumerary ring chromosomes, often as the sole aberration.

Less than 40 chondrosarcomas (CS) with clonal aberrations have been published. Half of the tumors have had a hyperhaploid-hypodiploid chromosome count. Whereas extra-skeletal myxoid CS are characterized by a reciprocal t(9; 22), no consistent structural recombination has emerged among the skeletal CS. Recurrent numerical abnormalities include loss of chromosomes 6, 10, and 13, and gain of chromosomes 7 and 20. Frequent loss of chromosomes 10 and 13 is found not only in OS and CS, but also in the less thoroughly investigated chordomas, indicating that these three bone tumor types may share genetic mechanisms important in tumor development.

Treatment of high-grade osteosarcoma of the extremities—the Scandinavian Sarcoma Group (SSG) Experience

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Since 1982, SSG have employed two consecutive prospective treatment protocols, SSG-II (1982–1989) and SSG VIII (1190 onwards). 102 patients (pts) of median 16 years were treated according to the SSG-II protocol in eight Scandinavian institutions. The protocol was identical to the originial T-10 scheme, with 4 pre-operative courses of HDMTX 8 g/m^2 (12 g/m^2 for pts <8 years), followed postoperatively with HDMTX, BCD and doxorubicin. Poor histological responders to pre-operative treatment (Huvos grade I and II) were crossed over to "salvage" chemotherapy with cisplatin and doxorubicin, omitting further HDMTX treatment. The response to pre-operative HDMTX was disappointing, with only 18% achieving a good histologic response (grade III or IV). No histologic response (grade I) was associated with fast MTX excretion yielding significantly lower serum MTX concentrations than intermediate and good responders. The importance of serum MTX as an independant prognostic factor was maintained in a multivariate analysis. An association was found between hydration volume/diuresis, serum MTX concentrations and histologic response. Toxicity attributable to HDMTX was generally mild, and not related to serum MTX values within the "safe" range (below 50.0 mol/L at 24th and 5.0 mol/L at 48th). Median observation time for surviving pts in protocol SSG II is in excess of 6 years. Five-year metastasis free survival (MFS) is 56%, and overall survival 61%. MFS is better for pts with good histological response to pre-operative HDMTX (79% for grade III/IV vs 53% for grade I/II, $p = 0.03$). Postoperative "salvage" chemotherapy with cisplatin and doxorubicin could thus not rescue poor responders from a significantly inferior survival rate. Furthermore, pts with mean serum MTX concentrations <0.35 mol/L at 48 h had lower MFS than pts with higher values, irrespective of histologic response (74% vs. 43%, $p = 0.05$). The SSG II trial thus identified both histologic response in the primary tumor (reflecting the effect on micrometastatic disease) and serum MTX concentrations to be of significant importance for long term outcome.

On the basis of the SSG-II result, the following alterations were made in the subsequent SSG-VIII protocol (activated May 1990):

1. Pre-operative chemotherapy was strengthened with 2 courses of cisplatin in addition to 4 HDMTX in order to accomplish a higher frequency of good histologic response.
2. Ifosfamide and etoposide were introduced in the postoperative "salvage" chemotherapy for the remaining poor histologic responders.
3. The MTX dose was increased from 8 to 12 g/m^2 in all courses and all age groups (from Jan. 1993) and routine measurement of peak serum MTX concentrations (at the end of the MTX infusion) were introduced in addition of measurements at 24h and 48h.

So far, 65 eligible pts of median age 16 (2–39) years have been entered into the study. Data regarding pre-operative chemotherapy, surgery and histologic response have been reported in 56 pts. A good histologic response was achieved in 59%, and total tumor necrosis (grade IV) was seen in 21%, both figures highly significant improvements compared to the SSG-II results ($p < 0.001$). Following the MTX dose increase from 8 to 12 g/m^2 in January 1993, serum MTX concentrations have increased significantly at all measured time points. Peak MTX levels above 1000 mol/L have thus been achieved in 88% of the courses after the dose increase, vs. in 13% before ($p < 0.001$). 16/17 pts at 12 g/m^2 vs 0/20 pts at 8 g/m^2 obtained a mean serum MTX value >1000 mol/L, a value which may be of prognostic significance (3). Following the MTX dose increase, the fraction of pts achieving a mean 48h of ≥0.35 mol/L increased from 28% to 83% ($p = 0.004$), and this treshold value was found to be of importance for survival in the SSG-II study. Good histologic responders still have significantly higher serum MTX levels than poor responders, despite the addition of cisplatin/doxorubicin in the pre-operative treatment.

Median observation time for the SSG-VIII study is currently 16 (1–43) months, and projected 2-years metastis-free survival (MFS) is 79%. In accordance with the SSG-II study, there is a trend for better MFS for good histologic responders (91% vs 76%, $p = 0.11$) and for pts with mean MTX values at 48h above 350 mol/L (90% vs 81%, $p = 0.23$).

3-year results of the SSG IX protocol in Ewing's sarcoma

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In 1990 a new treatment protocol of Ewing's sarcoma, the SSG IX, was activated by the Scandinavian Sarcoma Group. The protocol features an intensive chemotherapy program of four cycles, each consisting of two courses VAI (vincristine, adriamycin, ifosfamide) alternating with one course PAI (cisplatin, adriamycin, ifosfamide) at three weeks interval. Total treatment time is 35 weeks. Local therapy is given at week 9. Inoperable or non-radically operattients receive hyperfractionated radiotherapy 1.5 Gy twice daily between chemotherapy courses to a total dose of 42 to 60 Gy, depending on surgical radicality and tumor localisation.

Of the 60 patients included only 58 (40 men, 18 women, mean age 20 years) had Ewings's sarcoma (52 M0 and 6 M1).

As local therapy irradiation was given to 21 patients; 29 patients were objected to surgery which was amputation in 7 and local excision in 22 patients. The type of operation was wide in 16 patients, marginal in 3 and intralesional in 2. Histologic response has been given in limited number of tumors: GI in 6, GII in 7, GIII in 3 and GIV in 13.

Only one local recurrence has been observed. The overall survial of M0 patients was at 2 and 3 years 93% and 74%, respectively, and correspondingly of M1 patients 66% and 33%. Response to chemotherapy in tumor had no effect on development of distant metastases.

Hematological (G3) and gastrointestinal (G1–2) side-effects (WHO) were equally common irrespective of the VAI or PAI courses. Missing data may change these interim results.

Surgical procedure and margin in osteo- and Ewing's sarcomas—the Scandinavian Sarcoma Group experience

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New pre- and postoperative chemotherapy protocols have been used since 1990 in osteosarcoma (SSG VIII) and Ewing's sarcoma (SSG IX). This study analysed retrospectively local recurrence in relation to surgical procedure and margin. A comparison was made with the results from previous SSG trials of osteosarcoma 1981–1989 (SSG II) and Ewingssarcoma 1984–1989 (SSG IV).

Type of surgery was recorded as local or ablative. Surgical margin was reevaluated by one of the authors (O.B.) and assessed as adequate, i e radical or wide or inadequate, i e marginal, contaminated wide or intralesional. Reevaluation of margin has yet not been completed with the SSG IV, VII, and IX material.

From 1990 to February 1994, 63 patients with osteosarcoma and 48 with Ewing's sarcoma have been treated. All lesions were Stage IIB according to the Surgical Staging System.

Findings and comments: The rate of local excisions in osteosarcoma is increasing, 46% in SSG VIII compared to 26% in SSG II, and yet no local recurrences have been detected since 1990. Compared to several other osteosarcoma trials reporting local excision rates of around 80%, there is still a remarkably high rate of ablative procedures. Efficacious preoperative chemotherapy may be more crucial than an adequate surgical margin to prevent local recurrence in osteosarcoma and Ewing's sarcoma.

Tumor response grading after preoperative chemotherapy in osteosarcoma according to SSG VIII protocol

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From the start in April 1990 to February 1994 a total of 70 patients with osteosarcoma in the extremities had been reported to the SSG VIII trial. For re-evaluation we have received the histological slides from 32 cases, both from pre-chemotherapy biopsies and postoperative (and post chemotherapy) specimens. Of the osteosarcoma 26 were osteoblastic, 5 chondroblastic and only one was fibrosarcomatous. The response of the tumor to the given chemotherapy was determined from the slides using the same criteria as for the former SSG II trial with a four-grade scale where Grade I denotes no or little effect and Grade IV no viable cells.

In the present material only three tumor showed Grade I response, there was 12 tumors with Grade II och Grade III response and five tumors with a Grade IV response.

Although the results are preliminary, it seems that the tumors respond much better to the chemotherapy in the SSG VIII regimen than in the SSG II regimen.

Tumor response grading after preoperative chemotherapy in Ewing's sarcoma treated according to SSG IX protocol

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From the start 1990 to March 1994, 60 patients had been reported to the SSG IX Ewing's sarcoma trial. 52 patients have been re-evaluated. It is of interest to note that fine needle aspiration (FNA) was performed in 23/52 patients in the primary diagnosis and the preoperative treatment was based on FNA, omitting histological biopsy, in 11 out of these 23 patients. Surgery after preoperative chemotherapy was performed in 32 patients (resection of the tumor in 29 and biopsy 3, respectively).

The response of the tumor to the given chemotherapy was determined from the slides using the same criteria as for the previous SSG IV trial, i.e., on a four-grade scale where Grade I denotes no or little effect and Grade IV no viable cells.

5 tumors showed Grade I response, 9 tumors showed Grade II response. There were 5 tumors with Grade III and 13 tumors with a Grade IV response.

In the Swedish material, comprising 17 patients vital tumor was present in the soft tissues in 9 patients, of which

7 had response Grades I–II and 2 response Grade III. In these cases the response within the bone was often comparable to a Grade IV response.

In the Swedish cases the number of slides examined from the surgical specimens varied between 5–21 although the majority of the resected tumor specimens were large.

Comments: The majority of the tumors responded well to the treatment although tumor infiltrates in the soft tissues seemed to respond less well.

Preoperative chemotherapy in osteosarcoma Implications for surgical margins

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To evaluate the effect of preoperative chemotherapy on the local aggressiveness of the tumor and to define the minimal surgical margin adequate to prevent local relapses, we have reviewed all cases of osteosarcoma, including surgically treated at the Istituto Ortopedico Rizzoli from 1983 to December 1988 (ref). The correlation between margins, necrosis and local recurrences was analyzed in the 237 resected patients. 3 prognostic factors for local control were identified: the chemotherapy response, the surgical margin, and the age of the patients (the older ones havng higher risk). After taking into account the age factor, a relative risk was assigned to 6 different combinations of necrosis and surgical margins. If the relative risk for patients with good necrosis and wide margin is 1, patients with either fair necrosis (and wide margin) or less than wide margin (and good necrosis) had a relative risk respectively of 4 and 5 fold the best group. However, if fair necrosis and less than wide margin occurred in the same patients the relative risk increased to 17 and if poor necrosis occurred in patients with less than wide margins, the relative risk was 46.

Reference: P Picci, G Bacci, S Ferrari, et al. Local recurrences after limb salvage procedures for osteosarcoma: correlation with margins and chemotherapy induced necrosis. Revue Chir Orthop 79: 29, 1993.

Preoperative chemotherapy in Ewing's sarcoma—implications for prognosis

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Chemotherapy-induced necrosis is the most reliable prognostic factor in osteosarcoma, while few data are reported regarding a correlation between necrosis and prognosis in Ewing's sarcoma. To investigate this field, the surgical specimens of 68 patients with non metastatic Ewing's sarcoma of the extremities, treated by preoperative chemotherapy and surgery between 1983 and 1989, were histopathologically evaluated correlating chemotherapy-induced necrosis with prognosis (ref).

Due to the different morphology of Ewing's sarcoma in comparison to osteosarcoma, a different method to evaluate necrosis was performed. Tumor necrosis was classified into three types not expressed as a percentage of remaining viable tumor but was quantitated as the absolute amount of remaining viable tumor (type I = no recognizable viable tumor; type II = presence of microscopic foci, consisting of less than one 10x microscopic field and type III = either macroscopic foci or microscopic foci greater than one 10x field per specimen).

Type I necrosis was observed in 23 patients with only 2 patients experiencing relapse while 21 were observed to have type II necrosis with 6 relapsing. Type III necrosis was identified in the remaining 24 patients with 9 relapsing. Only 2 of the relapses were local failures experienced after a type I and a type III necrosis.

Statistical evaluation utilizing both life table and multivariate analyses on age, sex, site, tumor volume and necrosis confirmed that type of necrosis was the only statistically significant prognostic factor. These findings may be relevant in the design of future protocols employing preoperative chemotherapy and surgery, where type of necrosis can be used as an indicator of the chemotherapy response for early identification of non-responding high risk patients.

Preferential sites of persisting viable tumor were also identified. The study revealed the periosteal reaction to be the site most frequently involved containing viable tumoral foci, followed by the surrounding soft tissues. The identification of these preferential sites provides valuable anatomic information as to the absolute minimal margins required when considering surgical therapy.

Reference: P Picci, B T Rougraff, G Bacci, et al. The prognostic significance of histopathological response to chemotherapy in non-metastatic Ewing's sarcoma of the extremities. J Clin Oncol 11: 1763–1769, 1993.

Treatment of osteosarcoma and Ewing's sarcoma in children—the Scandinavian Sarcoma Group experience

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Patients: 117 cases of osteosarcoma (n 79) and Ewing's sarcoma (n 38) were registered in children aged 2--15 years in the 4 Scandinavian Sarcoma Group studies (SSG II, IV, VIII, IX) in the period 1982–1993. This is less than half of all incident cases in that age group in the 4 Scandinavian countries in the same period. 61 of the children were from Sweden, 37 from Norway (lowest population in Scandinavia), 17 from Finland and only 2 from Denmark. All cases of osteosarcoma and half of Ewing's sarcoma were localized to the extremities.

Results: The crude survival for the first osteosarcoma protocol, SSg II (1982-1989), was 54% and p-EFS 48% (n 47). The crude survival for the first Ewing's sarcoma protocol, SSG IV (1984-1989), was 39% and the p-EFS 36% (n 19).

There was no difference in the results between larger and smaller treatment units. The observation time was too short for statistical evaluation of the last 2 treatment protocols studies.

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ELBOW/SHOULDER

Gschwend elbow arthroplasty

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We examined 15 Gschwend semiconstrained elbow arthroplasties (GSB III) inserted during the period May 1990 to January 1993.

Material and method: 15 GSB III elbow arthroplasties including 2 revisions were examined in 13 patients, 8 women and 5 men. 3 patients died prior to the time of follow-up. Mean age was 63 (33–81) years. 11 patients had rheumatoid arthritis, 1 patient had psoriatic arthritis and 1 patient had sequelae after a traumatic elbow dislocation. All of the prostheses were cemented with gentamicin cement and all patients received a single dose of 1 g of dicloxacillin and 240 mg of gentamicin.

10 patients were available at the time of follow-up. Pain, function, complications and patient satisfaction were registered. Standardised radiographs were obtained.

Results: All of the examined patients were relieved of their pain. Average range of flexion/extension was improved from 82° (28°–110°) preoperatively to 107° (27°–134°) postoperatively. Average range of pronation/ supination was 153°. Using the rating system of Hospital for Special Surgery, the average elbow score was 88 (73–100). 2 patients had intraoperative fractures, 1 of the trochlea and 1 of the radial humerusepicondyle, and 1 patient had postoperative rupture of the triceps tendon suture. 2 patients had a reoperation, 1 due to dislocation and 1 due to operative failure. Radiolucencies were seen in 3 patients, and 1 prosthesis was clinically loose. 8 of 10 patients graded the final result as excellent.

Conclusion: The Gschwend semiconstrained elbow arthroplasty was used with satisfactory result in patients who had painful arthritis of the elbow joint.

Introduction of a new operating procedure Arthroscopic subacromial decompression

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Introduction: The aim is to describe the introduction of a new operating procedure, arthroscopic subacromial decompression, and the need of a quality insurance by means of a standardised preoperative examination, a surgical protocol and a follow-up procedure.

Material: 20 consecutive patients were included and operated over a period of 20 months in 1992–1993. 8 women and 12 men, with an average age of 52 years. The patients were examined by an unbiased observer, at follow-up 2-19 months postoperatively. 18 operations were completed transarthroscopically, 2 had to be operated openly during the same anesthesia. 6 patients had total rupture of the supraspinatus tendon. 4 of the patients were dissatisfied with the arthroscopic subacromial decompression and were operated openly later. 11 patients were satisfied. In 14 patients the pain was reduced. 14 patients had improved abduction. The operations were performed by 6 surgeons with an operation rate of 1 to 10. The surgeons' experience of the new method was the principal determinant of a successful operation.

Conclusion: 11 patients were satisfied, 14 had reduced pain, 14 gained higher mobility and 11 had to be reoperated. Consequently we find the results acceptable. However, to increase the success rate it is crucial to achieve experience of the method. Thus it is a necessity to limit the new operation method to a few surgeons. Furthermore it is recommended to use a standardised preoperative examination, surgical protocol and a follow-up procedure.

KNEE

Interobserver variation at Tegner and Lysholm scoring

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Aim: To test the ability to reproduce data at Tegner and Lysholm scoring.

Method: With 1 year difference, 90 patients were interviewed twice, as part of a 10-year follow-up investigation on arthroscopy. All patients described their symptoms as unchanged during the interobserver period.

Statistics: In this investigation, we used analysis of correlation coefficient rho. By statistic regression, we calculated a squared correlation coefficient. For prediction of new values, we also calculated the adjusted squared multiple R (ASMR).

Results: Regression analysis showed the following figures.

Comparison	ASMR	R^2
Tegner, MD 1 and MD 2	0.329	0.336
Tegner, transformed, MD 1 and MD 2	0.323	0.331
Lysholm, MD 1 and MD 2	0.555	0.560
Lysholm, transformed, MD 1 and MD 2	0.423	0.429

Discussion: ASMR expresses the expected amount of equal observation at future examinations. Data is also logit transformed. Only 33% of Tegner scores can be predicted. Figures look somewhat better at Lysholm scores, though that might be explained by so many figures close to 100.

Conclusion: We find insufficient reproducibility in the chosen model. Repeated examinations should be performed by the same doctor.

ACL reconstruction with the Stryker-Dacron knee augmentation graft Median follow-up 6 (3.5–8) years

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Material and methods: 17 patients (18 knees) with knee instability after ACL rupture were operated by the same surgeon in the years 1986–1989. A technique with isometrically placed drill channels was used. The ligament was fixated in both ends with Stryker-staples.

Results: The median follow-up was 6 (3.5–8) years. 3 patients were excluded because of major combined lesions. In the material there were 8 verified ruptures. The remaining 7 patients had a preoperative Lysholm-score of 42 (21–72) and 67 (44–88) at the examination. The pretraumatic Tegner Activity Score fell from 4.1 (0–7) to 2.6 (0–5). 5 patients had a drawer laxity < 3 mm with the Stryker Laxity tester. One of these had a positive Pivot-shift (1+). According to the IKDC-evaluation criteria 2 patients had a poor result and 4 patients a good result. All had full extension, while 2 lacked 15° in full flexion. No postoperative infections were seen. None had persisting synovitis. 4 patients changed occupation or were unemployed because of knee trouble.

Conclusion: ACL-reconstruction with the Stryker-Dacron ligament has given an unacceptable high rate of ruptures. The clinical result for the remaining patients has not been satisfactory, which in part may be explained by the poor preoperative status as seen by the low Lysholm-score. Recent international literature supports the findings.

ACL reconstruction using the iliotibial-band and a Kennedy-LAD ligament Median follow-up 2.8 (2–4.5) years

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Material and methods: Patients with persisting knee instability after a period of rehabilitation where operated using a 3–4 cm wide and 20 cm long iliotibial-band, reinforced with a Kennedy-LAD ligament introduced through isometrically placed drill channels. 32 patients were operated in 1989-92 by the same surgeon, except one. 7 patients did not show up for the interview. 2 had been reoperated using another technique, thus 23 patients remained for follow-up.

Results: The Lysholm-score increased from a median preoperative 63 (31–86) to 85 (45–100) at the examination. The pretraumatic Tegner Activity Score decreased from 5.2 (0–9) to 4.6 (0–8). 16 knees had a drawer laxity < 3 mm measured with the Stryker laxity tester. Drawer laxity was reduced in half of the rest. No pivot-shift was found in 16 patients, while 7 patients had 1+ in pivot-shift. 22 patients obtained an excellent/good result according to the IKDC-evaluation criteria. None had extension problems. 4 patients had 10° flexion deficit. No postoperative infections were seen. One patient needed Brisement Forcé and Lysis Adhesiones. She had normal ROM at follow-up. None had persisting symptoms of synovitis. One patient was operated with a Dacron-mesh graft because of a lateral muscle hernia.

Conclusion: The material suggests that this method is a good alternative for patients with chronic instability.

Reconstruction of anterior cruciate ligament with the central third of the patellar tendon with and without Kennedy-LAD

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Introduction: We report the early clinical result after reconstruction of the anterior cruciate ligament using the central third of the patellar tendon in a traditional open arthrotomy.

Patient and methods: All patients had a traumatic rupture of ACL or had chronic symptomatic instability of the knee. 26 patients were reconstructed from 1992 through 1993. Mean follow-up time was one year. 22 patients were available for a complete follow-up. Isometric reconstruction was performed using autogenous medial one-third patellar tendon grafts (bone-tendon-bone) augmented with a Kennedy-LAD in 12 patients.

Results: Median Lysholm Knee Score increased from 62.3 (39–100) pre-reconstruction to 84.8 (61–100) at follow-up.

The mean Tegner score was 4.9 pre-reconstruction and 3.0 at follow-up. A stable knee joint at follow-up was noted in 17 of the patients (< 3 mm paired laxity difference and no pivot shift). 6 patients had reduced range of motion: 5 patients lacked 5° of extension and one 10° of flexion. Using the IKDC (International Knee Documentation Committee) evaluation criteria 20 patients had an excellent or good result and 2 a fair result. 18 patients had no patellofemoral pain at follow-up. 11 patients had patellofemoral crepitations.

Compared with the traditional open methods, there are several advantages: The stability can be tested in anesthesia and the indication for conservative or surgical treatment evaluated. Other intraarticular lesions and evacuation of a hematoma may be managed concomitantly. The method is atraumatic. The rehabilitation phase is short. A reduced risk of secondary arthrosis is expected.

The disadvantages are: The method is technically difficult and due to the requirement of relatively large amounts of bone material during the bone transplantation, it is recommended to build a local "bone bank".

Arthroscopic management of tibial plateau fractures

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Introduction. To present a method of arthroscopical management of tibial plateau fractures, combined with bone transplantation.

Material: 6 patients were operated in the period 1992–1993. All patients were examined clinically pre- and postoperatively, and 3 months postoperatively. 4 patients had lateral and 2 patients medial tibial fractures, with joint depression between 10 and 15 mm. 5 patients received bone transplantation. Postoperatively all patients received an ROM-bandage and no weight-bearing was permitted for 6-8 weeks. Average length of hospitalization was 6.5 days.

Results: Assessed by radiographic and clinical criteria the results were excellent.

Conclusion: Arthroscopically guided management of tibial plateau fractures is a highly recommended method.

Arthroscopic synovectomy of the knee for rheumatoid arthritis

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Introduction: The purpose of this investigation is to describe the long-term results after arthroscopic synovectomy of the knee for arthritis.

Methods: The investigation was retrospective, consecutive and descriptive with clinical scores, radiographs and a patient questionnaire.

Results: The material included 40 knees/36 persons. 21 knees had rheumatoid arthritis (RA-group), 19 had other types of arthritis (non-RA-group). After 3 years, 33 of the patients had a satisfactory outcome of the operation with less pain, no/slight synovitis, better function and at least as good a ROM as prior to the operation. A statistically significant difference was found between the patients with no or little cartilage damage on radiography compared to those with moderate. The mean operation time was 97 minutes. The patients required a hospital stay of 4.6 days. There were no infection, bleeding or surgical problems. 34 patients (87.5%) were satisfied with the operation and rehabilitation. 7 (5 RA/2 non-RA) patients developed moderate or severe synovitis. They were classified as failures.

Discussion: Corrected for level of cartilage damage we found no significant difference between the outcome for RA and non-RA. Our study describes a better outcome in patients with slight cartilage damage. The outcome with moderate is unpredictable, this group included all recurrences. We found 33 knees still good with low or no pain and synovitis after 3 years. 35 patients were satisfied with the operation and rehabilitation.

Conclusion: We recommend arthroscopic synovectomy, in patients with little cartilage damage. The rehabilitation is fast. The hospital stay is short.

Arthroscopy under local anesthesia in ambulatory patients

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The "Danish Arthroscopic enquete 1992" concluded that only 10 of 46 departments of orthopedic or general surgery performed outpatient arthroscopy of the knee under local anesthesia. This conservative attitude may be due to limited knowledge about the operative possibilities for patients in local anesthesia.

403 arthroscopies in local anesthesia were performed on 401 outpatients (aged 15–85 years) between December 1992 and December 1993. The referring physician's findings indicated arthroscopy without further examination was found in 194 knees. The remaining 209 knees were examined clinically before arthroscopy. Without premedication, local anesthetic, 40 mL of 1% lidocain with adrenaline was injected into the joint cavity and 20 ml was distributed subcutaneously and in the capsular tissue at the sites of the joint lines. After 15 minutes, the arthroscope was introduced into the knee through the anterolateral approach.

Only 21 arthroscopies were not completed. Among these, the diagnosis was achieved in 15 patients, but transarthroscopic surgery was not carried through. Transarthroscopic surgery was performed in 194 patients. The operations were: 144 partial meniscectomies, 21 synovial plicae resections, 17 partial chondrectomies, 5 removal of loose bodies and 1 resection of a ruptured ACL.

Conclusion: Outpatient arthroscopy of the knee with transarthroscopic surgery under local anesthesia is a valuable tool and ought to be used on a larger scale. 50% of the patients were selected for arthroscopy directly from referral information.

HIP

10-year follow-up evaluation of Müller curved-stem and Müller long-stem total hip replacement arthroplasty

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376 total hip arthroplasties—100 using the Müller curved-stem (MCS) and 276 using the Müller long-stem (MLS)—were performed in our department from 1978 to 1983. From the patients' clinical records, all demographic data and follow-up information were recorded and saved in a PC-database. All patients alive who had not had a revision performed were sent a questionnaire to determine the status of the patient/hip. Patients representing 79% (MCS) and 83% (MLS) of the hips answered the questionnaire.

Preoperative diagnoses and postoperative complications (i.e., infections, dislocations) did not differ between the 2 groups, but there were differences regarding observation time, age and sex.

At follow-up 36 MCS and 111 MLS had died, and of those 6 MCS and 5 MLS had previously been revised. 22 out of 64 MCS and 9 out of 165 MLS in patients still alive had been revised. The long-term survival of the femoral component of the arthroplasty was significantly better using the Müller long-stem. The questionnaires did not reveal any differences in the clinical result between the 2 groups.

To eliminate differences in age, sex and observation time, 77 patients from each group were paired regarding all important demographic parameters. Neither between the paired groups were there any difference in the clinical results (questionnaires), and the long-term survival of the Müller long-stem was still significantly better. Kaplan-Meier survivorship-analysis has been performed.

Does thromboprophylaxis reduce mortality in patients undergoing total hip replacement?

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Introduction: To determine the long-term survival and cause of death in relation to thromboprophylaxis in patients undergoing total hip arthroplasty (THA).

Patients and methods: 542 patients who participated in one of 3 different prospective, randomized, prophylaxis studies with low molecular weight heparin vs placebo were included in this follow-up study on an intention-to-treat basis. In the original studies the primary end-point was reduction of thromboembolic complications (TEC), DVT or PE, verified by phlebography or lungscan. In case of TEC the patients were treated with oral anticoagulation for 3–6 months. The 3 prophylactic treatments were sandoparin-DHE (n 112) vs placebo (n 116), dalteparin (n 59) vs placebo (n 60) and tinzaparin (n 100) vs placebo (n 102).

The treatment was started preoperatively and continued for 7–10 days. The median follow-up time was 5.3 (0.02–8.8) years.

Survival analysis was made between the subgroups in all studies and an additional stratified log rank test was performed. A log linear analysis was made on the causes of

death.

Results: There was no significant difference in survival between LMWH and placebo, but there was a trend towards a better survival in the placebo groups and a stratified log rank test showed a significantly better survival in the placebo groups ($p = 0.027$). The analysis of the causes of death showed a significant excess of cardiovascular deaths in the LMWH groups ($p = 0.013$).

Conclusion: These findings suggest that active screening for TEC by objective methods and treatment of verified cases after THA may be the most effective from a survival point of view. On the contrary, the risk of late death is increased in patients having short-term preventive methods in spite of screening. Further studies are needed with mortality as the main end-point. More extensive prophylactic regimens (prolonged administration and/or increased dosages) should be considered if screening is not to be employed routinely.

2 years' experience with Boneloc cement and the Exeter total hip replacement

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We reviewed at a minimum elapsed time of two years a consecutive series of 44 primary Exeter hip replacements in which Boneloc cement had been used. Clinical and radiographic examination was performed with special interest in subsidence and early aseptic loosening.

24 women and 16 men with a diagnosis of primary osteoarthrosis in 38 and rheumatoid arthritis in 2 patients were examined at a mean of 28 (20–33) months postoperatively. Clinical results were evaluated by Harris hip-score. Subsidence ≥ 2 mm was found in 27 of 44 hips (62%) without relation to clinical results. Osteolysis in cement-bone interphase in more than one zone was found in 5 hips without clinical symptoms and in 2 hips with definite loosening.

2 years' results after primary Exeter hip replacement and Boneloc cement does not imply greater tendency of early aseptic loosening in comparison with materials where Simplex cement has been used. However, there seems to be increased subsidence between the femur stem and Boneloc cement. Whether this creep will continue linearly over the years will require further observation time.

TUMOR

Adjuvant radiation therapy and local excision of high-grade soft tissue sarcomas - Preliminary results

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Introduction: The combined treatment is often used in order to make limb-salvage possible.

Materials: 22 consecutive patients with high-grade soft tissue sarcomas were treated with the combined treatment. 9 tumours were located to the trunk and 13 tumours to the extremities. In 19 patients the radiation therapy (50 GY/25) was given preoperatively and in 3 patients postoperatively. A wide excision was obtained in 21 and a marginal excision in 1 patient.

Results: No surgical complications occurred in the 3 patients irradiated postoperatively and in 5 patients who were treated with soft tissue reconstruction initially (split skin transplantation in 2 and a musculocutaneous flap in 3). Of 14 patients preoperatively irradiated, 8 were reoperated because of: rupture of the wound (5 patients), hygroma (1 patient), hematoma (1 patient) and fibrosis (1 patient). At follow-up after median 10 (3–21) months all wounds were healed. 2 patients developed lung metastases before 6 months after surgery, but no patients had local recurrence.

Conclusion: The combined treatment seems to give local tumor control. The surgical healing after preoperative radiation therapy is difficult.

TRAUMA

ICD-10: Trauma codes—the value of a code matrix, evaluation of observer variations

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Introduction: The use of the 10th revised version of the International Classification of Diseases (ICD-10) has since January 1, 1994—as the first place in the world—been mandatory in Denmark. The trauma chapters, S and T, have been

revised extensively and a new structure based upon a matrix system with 2 axes: Type of lesion and Body region, has been introduced. The purpose of this new structure was to facilitate coding and to improve the quality (validity) of the coding. As generally in the ICD-10, 4-digit codes are now used instead of 5-digit codes and the first digit is a letter instead of a figure.

To evaluate the intended benefits of the new structure, we performed a test of the code-system, comparing the listed official version to a code-scheme reflecting the systematic matrix structure.

Method and material: 202 consecutive case records from the emergency department (2 days' admissions), were divided in 2 sets (each consisting of 101 case records) which was coded by 6 doctors. 3 of the doctors coded set 1 at first using the official manual and thereafter the second set using the "code-scheme". The other 3 doctors coded set 2 first with the manual and thereafter set 1 using the "code-scheme".

The time spent was registered. Following the agreement of choice of codes was evaluated.

Results: By use of the manual it took a mean of 91 minutes (80, 84, 110) to code set 1, and 92 minutes (67, 64, 145) to code set 2. By use of the "code-scheme" it took 62 minutes (46, 67, 73) to code set 1 and 64 minutes (54, 59, 80) to code set 2. In the 167 cases where only one code was needed to describe the lesion, full agreement in choice of code was achieved in 40% of the cases at 4-digit level and 80% of the cases at 3-digit level. Disagreement was most often caused by systematic differences in the interpretation of the exact diagnosis (open wound vs superficial lesion, contusions vs distortions) or region (hand vs forearm).

Conclusions: The use of a code-scheme respecting the systematic matrix structure of the trauma chapters in the ICD-10 reduces the code time with 1/3, compared to the use of the official manual. Disagreements in the choice of relevant codes might be avoided or reduced after careful instruction and if the definitions are further specified.

Good inter-observer agreement in an emergency unit

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Purpose: To assess the inter-observer agreement in evaluating radiographs from an emergency unit.

Material and methods: Radiographs: 100 consecutive radiographs from patients suffering a trauma within the last 24 hours were included.

Observers: 5 observers (1 specialist in orthopedic surgery and 4 registrars) assessed the radiographs. The observers assessed the radiographs independently. Statistics: Kappa (k)-statistics.

Results: The inter-observer variation was low. When it was assessed whether or not there was an acute change on the radiographs, k was between 0.63–0.88, correspondingly the observed agreement was 82–94%.

When it was assessed whether or not a fracture was present, k was 0.71–0.89 and the correspondingly observed agreement was 87–95%. In all, the observers stated an acute change to be present in 36–52 cases and fracture in 29–39 cases.

Conclusion: According to Landis & Koch (1), the results show substantial strength of agreement to almost perfect agreement.

Reference: 1. Landis J R, Koch G G. Biometrics 1977; 33: 159–174

MRI findings after acute primary anterior shoulder dislocations in young patients

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Purpose: The evaluation of conventional MRI to identify the intraarticular lesions after acute primary anterior shoulder dislocations.

Material and method: 25 patients who had suffered an acute primary and traumatic anterior shoulder dislocation were examined with MRI and arthroscopy. Criteria for inclusion were no prior history of shoulder dislocations, age between 15 and 39 years, radiographic confirmation of the dislocated shoulder and examination with MRI and arthroscopy within 10 days. Average age was 27 (16–39) years with 18 males and 7 females. MRI was performed with a 1.5-T MR Imager using spin-echo technique and a gradient-echo-sequence with a thin-slice (1.0–1.5) mm contiguous 3-D imaging.

Results:

	A-scopy	MRI	Sens.	Spec.	Acc.
Extralabral lesion	17	12	0.75	1.0	0.79
Intralabral lesion	5	3	0.60	0.75	0.66
Hill Sachs lesion	15	12	0.80	1.0	0.88
Osseous Bankart	1	0			
Partial cuff rupture	1	1			
Total cuff rupture	1	1			
Partial biceps rupture	1	1			

Conclusion: Anterior capsulolabral tears and Hill Sachs lesions appear with a high incidence after an acute anterior primary shoulder dislocation. Conventional MRI is a reliable preoperative method in the evaluation of undifferentiated labral tears and Hill Sachs lesions, but fails to give an accurate differentiated preoperative capsulolabral diagnosis.

Unreamed intramedullary nailing of humeral, femoral and tibial fractures

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The purpose of this study was to evaluate the results after unreamed i m nailing procedure in the treatment of humeral, femoral and tibial fractures; and in the femoral fractures to investigate data concerning operation time, blood loss, mobilisation, healing time and complications during the first years (November 1992 to November 1993).

Material and method: 16 humeral fractures were operated on with the Russell-Taylor Humeral I M Nail made of steel; in 13 closed femoral fractures the ACE Titanium i m nail was used and in 11 tibial fractures, 6 of which were open, the ACE Titanium i m nail was used.

Results: 11 of the traumatic humeral fractures healed uneventfully and 1 fracture healed after a secondary bone transplantation. 2 non-unions did not heal, and 1 of the patients is now waiting for a secondary revision and replacement of the nail. 1 humerus was infected, but healed after removal of the nail and revision. All of the traumatic femoral fractures healed uneventfully. The quality of the earlier mentioned data were all improved compared to the same data in the literature using reaming technique. 1 tibia was deeply infected, but healed after nail removal and secondary plastic surgery. 8 tibial fractures healed uneventfully and the remaining 2 healed after dynamisation.

In conclusion the unreamed technique was found to be satisfactory and it is now introduced in the department as an important technique in fracture treatment.

Surgical treatment of clavicular nonunion

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Introduction: Non-union of the clavicle is very uncommon - when it occurs plate fixation combined with bone-grafting is regarded as the treatment of choice. The aim of this study was to evaluate surgical treatment as performed at our department.

Material and methods: 12 patients—10 treated with plate fixation and bone-grafting, and 2 treated with screws—were reviewed. There were 5 men and 7 women, median age 34 (19–60) years. 11 non-unions were in the middle third and one in the lateral third of the clavicle—9 were atrophic and 3 were hypertrophic. At follow-up all patients were scored after Constant Functional Shoulderscore (CFS).

Results: 9 out of 12 patients achieved a normal CFS, but before this almost half of the patients had been reoperated. The reason for this was probably the use of short (4 holes) semitubular plates and insufficient postoperative immobilisation. Including reoperations only 3 out of 8 operations with short semitubular plates were successful versus 6 out of 7 operations with 6 hole dynamic compression plates well immobilized postoperatively.

Conclusions: Short semitubular plates cannot be recommended for the management of clavicular non-union, because of a high risk of failure. 6 hole dynamic compression plates with sufficient postoperative immobilization should be preferred.

Regeneration of Achilles tendon after necrosis

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The regeneration potentials of Achilles tendon are well-known, and casuistical reports of healing without immobilization after ruptures are published (1). However, the healing is based on clinical examination without attempt to radiological evidence. In contrast, Häggmark et al. (2) describe a case with insufficient plantar flexion strength after non-operatively treated Achilles tendon rupture. Peroperatively they found a gap between the tendon ends, but the peritendineum had healed by thickening, and had taken over the function of the Achilles tendon.

To study the regeneration potential more definitely, we have examined 2 cases with tendon necrosis after infection. Both had been treated operatively after Achilles tendon ruptures, but after infection and revision the Achilles tendon had large defects. In the first case the wound was closed over a 3 cm gap in the tendon, and the leg immobilized 7 weeks in a below-knee plaster. 6 years after the treatment the patient had normal ROM in the ankle joint, no atrophy of the calf muscle, and was tiptoeing without problems. In the second case a 73-year old man had massive necrosis after operative tenorrhaphia. After several revisions the whole Achilles tendon was excised, and a large skin defect was allowed to granulate before skin transplantation. After the skin had healed, the patient was allowed weight bearing as tolerated. The only kind of immobilization was an ankle stirrup with the ankle joint in neutral position. This brace was used for 8 weeks. After 2.5 years the patient had normal ROM in the ankle joint, 2 cm atrophy of the calf muscle, but was tiptoeing without problems. Both patients were examined with MRI (T1, T2, STIR), and we found the tendons regenerated without defects.

The cases confirm the regeneration potential of the Achilles tendon.

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Sports injuries in children of school-age

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Since 1988 the a&e department at Esbjerg Centralsygehus has been involved in the EHLASS project (European Home- and Leisure-Accident Surveillance System). The purpose of this project is to establish a surveillance system concerning home and leisure accidents of which no official statistics are available. We are able to present data concerning sports injuries from the period 1988-1992. Data describing type of sport, demographics, accident circumstances and the injuries sustained are recorded in the register. In the age group 6–17-year old children a total of 6069 contacted the a&e department with a sports injury. Incidence rates were calculated based on contacts from the municipality of Esbjerg (n = 4619).

Results: 54.5% boys and 45.5% girls were injured. Boys were most often injured in soccer, skateboard, handball, gymnastics and basketball, girls in handball, horse riding, gymnastics, basketball and roller skating. The overall incidence rate was 73.6/1000/year. The highest rate was seen in soccer, 18.3/1000/year (boys 29.2/1000/year). There was no significant change in the overall incidence rate in this 5-year period. There were no sex-related differences in the number of accidents in the age group 6–13. For both sexes a peak was seen for children aged 14. The types of injuries were contusions 37.1%, fractures 22%, sprains 24.8%, abrations/lacerations 9.5%, strains 5.0% and luxations 1.6%. The hospitalization rate was 3.8%, with an average of 3.4 days.

Conclusion: The register—and the project—has fulfilled its purpose. Valuable data concerning sports injuries are now available and have served as a tool in planning local preventive campaigns.

EXPERIMENTAL ORTHOPEDICS

Hemodynamic interactions between neuropeptide Y and noradrenaline in bone

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Introduction: Neuropeptide Y (NPY) is a sympathetic neurotransmitter co-localised with noradrenaline (NA) in bone in adrenergic nerve fibres in bone vessels exclusively in epiphyseal areas. Electrical stimulation of sympathetic nerves releases both NPY and NA. Both NA and NPY are known to be potent vasoconstrictors in bone in vivo. The purpose of this investigation was to study the interactive effects of NPY and NA in the bone vascular domain.

Material and methods: 7 Danish landrace pigs (50-55 kg) were used. In anesthesia the tibial nutrient artery was exposed and catheterised and perfused with autologous blood through a pulsatile pump set to deliver a constant volume and generate a bone perfusion pressure (BPP) equal the mean arterial pressure (MAP). The study included 3 protocols with intervals of steady state (baseline) in between. In protocol 1 the dose-response curve for NA (10^{-8} – 10^{-5} M) was made. In protocol 2 a new dose-response curve for NA (10^{-8} – 10^{-5} M) in combination with NPY (10^{-7} M) was made. Protocol 3 was identical with protocol 1.

Results: In all 3 protocols the BPP increased significantly during NA infusion ($p < 0.05$, ANOVA repeated measurements). Infusion of NA together with NPY (protocol 2) resulted in a significant higher BPP compared to infusion of NA alone (protocol 1 & 3) ($p < 0.05$; paired t-test). Both infusion of NA alone and in combination with NPY (10^{-7} M) caused significant higher increase in BPP at lowest concentrations of NA ($p < 0.01$; paired t-test). No difference in dose-response curves for NA in protocol 1 and 3 was observed. Infusion of the substances had no side-effects on baseline values of BPP, MAP and CVP.

Conclusion: Neuropeptide Y and noradrenaline had an additive effect on bone perfusion pressure. The study confirms the vasoconstrictive effect of noradrenaline in the bone vascular bed.

AMPUTATION

Patients with arteriosclerosis extremitas inferioris and ulcus cruris admitted to an orthopedic department

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Introduction: To follow and evaluate patients with the diagnosis arteriosclerosis extremitas inferioris (symptoms: claudicatio intermittens and/or ulcer) and thereby estimating their demands in ambulatory and as inpatients, and evaluate our handling of these patients seen in the light of the increasing angiosurgery on lower limps in Denmark during the last 10 years with more than 2,000 reconstructions/year (1).

Materials and methods: 102 patients followed in ambulatory and/or as inpatients (81 patients with claudicatio intermittens and 21 patients with ulcer/gangrene) during 1 year in 1992/93.

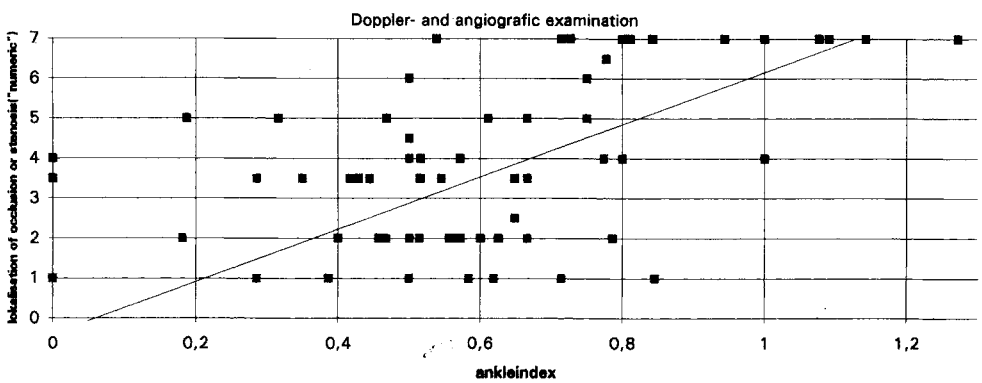
Results: 102 patients, 63 men (66 years) and 39 women (63 years). 21 patients with ulcer/gangrene and 81 patients with claudicatio intermittens. 89 patients were seen in all 147 times as outpatients (1.65 times/patient). 87% were ended during the year (20 patients after one single control). 66 patients were inpatients (1.25 times/patient) and 21 patients continued ambulatory control (7 patients with claudicatio). 4 patients died during the year (4%), 1 amputation patient, all men, and all smokers. 59 (58%) of all the patients were smokers, and 16 patients had diabetes (16%).

77 (75%) of the patients were examined with a minidoppler (83% of the patients with claudicatio). 55 patients were angiographed and again 55 patients were admitted to department of angiosurgery. Of these 35 patients (66%) were operated on during the year. 11 patients were amputated and 3 reamputated (27%). Amputations/patient: 1.3. 3 of the patients amputated had previous angiosurgery. The amputations were 1 femur amputation, 3 knee-exarticulations, 6 lower leg amputations and 1 toe amputation. The reamputations were 2 knee-exarticulations after earlier lower leg amputations, and 1 reamputation on the lower leg.

Among the patients with ulcer/gangrene, healing of ulcers was seen in 13 patients, 3 of whom with previous angiosurgery. Their average stay in hospital was 22 (7–49) days and their demand on beds accounted for 4% of the total. We were able to examine with minidoppler 75% of all the patients and 83% of the patients with claudicatio. In 34 patients (68 ankle index measurements) ankle index could be compared to final angiographic examination, and we found correlation and linearity ($p < 0.001$) and a sensitivity on 95% and specificity on 62% for the examination with the minidoppler (Figure 1).

Conclusion: The small number of patients with arteriosclerosis extremitas inferioris makes a great demand on ambulatory and as inpatients, but less than the average for the whole country (2). We succeeded to examine with minidoppler 75% of all, and found the minidoppler valid for evaluation of the patients. We find our diagnostic ability and treatment of these patients sufficient, and we find our cooperation with the Department of Angiosurgery to be good enough.

34 patients(68 ankleindexmeasurements) - linearity(p<0,001)



Angiografic examination: Numeric value referes to:
0 = occlusion at bifurcature
1 = occlusion at iliacal artery
2 = occlusion at femoral artery
3 = occlusion at popliteal artery
4 = stenosis at iliacal artery
5 = stenosis at femoral artery
6 = stenosis at popliteal artery
7 = normal angiografy

Sensitivity = 95%,and specificity = 62% if ankleindex > 0,8 i calculated as negativ test,and ankleindex < = 0,8 is positive. "numeric" angiografic value > 6 is normal status of the arteries,and "numeric" value < = 6 is abnormal.

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Stump necrosis
Is thrombus formation involved?

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Introduction: Amputation of an extremity results in necrosis of the stump in at least 10% of the cases. Inadequate vascular supply to the remaining tissue is one of the main causes. Thrombosis may be another mechanism involved. Our aim therefore is to elucidate whether thrombosis and edema are present in distally failing flaps.

Materials and methods: Danish landrace pigs, n=7. Blood components (RBC, platelets and fibrinogen) were radioactively labelled. Tracers were injected i v. Latissimus dorsi myocutaneous flaps (10x20 cm) and Buttock skin flaps (10x18 cm) were raised and resutured bilaterally. 3 hours and 40 minutes after raising the last flap, the perfused areas were measured using i v fluorescein. Biopsies were taken for histology and for measuring edema formation. The flaps were cut into approximately 1 cm slices and the 3 different radioactive tracers were counted separately in a gamma counter.

Results:

Ischemic/ vital tissue	Fibrinogen ± SEM	Platelets ± SEM	Red blood cells ± SEM
Buttock	1.80 ± 0.22 *	2.63 ± 0.25 *	3.97 ± 0.30 *
Lat dorsi skin	1.87 ± 0.17 *	3.15 ± 0.24 *	4.41 ± 0.29 *
Lat dorsi muscle	1.22 ± 0.08	2.23 ± 0.14 *	3.39 ± 0.25 *

*Significant difference between ischemic and vital parts ($p < 0.01$)

Edema: No edema was found in the ischemic tissue when compared with the vital tissue.

Histology: No organised thrombi was seen.

Conclusion: The accumulation of platelets and fibrinogen distally suggests, that thrombosis could be a problem in distally failing flaps. However, the lack of histologic evidence of thrombus formation, the lack of edema, and the accumulation of red blood cells distally, imply that a selective accumulation of formed elements—and not organised thrombus formation—is the primary pathophysiological mechanism in distal flap failure.

INFECTION

Acute hematogenous osteomyelitis and septic arthritis—an 11-year review

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Purpose: To describe the epidemiology behind the admittance of all children between 1 month and 15 years to our departments with acute hematogenous osteomyelitis (AHO) and septic arthritis (PA) and to have an assessment of our treatment regimen and the long-term prognosis.

Material and method: We reviewed all medical records of all children admitted to our departments during the 11-year period from 1978 through 1988 with the diagnosis of AHO and PA. At follow-up in 1994 after a mean follow-up time of 10 years, a comprehensive questionnaire was sent out with a returning percentage of 96%. All patients with a questionnaire divergent from the totally normal were offered clinical and radiographic follow-up. For inclusion at least 2 of the following diagnostic criteria were met: 1) Localised tenderness, redness, swelling or reduced mobility; 2) Pus aspirated from bones or joints; 3) Positive bacteriology from blood, joint fluid or bone specimen, and in case of AHO 4) Radiological or scintigraphic signs of osteomyelitis. 65 patients met these criteria - 37 with AHO and 28 with PA.

Results: Patients with AHO were significantly older than those with PA with mean ages 4.9 vs 1.3. Male/female ratio was 1.7 (AHO) and 1.3 (PA). Bacteriological diagnosis was found in 71% (AHO) and 56% (PA), respectively. The most frequent bacteriological agent was Staph aureus (AHO) and H influenza (PA). 65% of the AHO-patients had positive bone scans whereas 27% had radiographic manifestations of osteomyelitis at the time of diagnosis. A further 16% developed these characteristics within 1 month. 8% never showed any of these evidences. ESR-values were significantly higher in PA compared to AHO: 49 vs 37. Most frequent localisation in AHO was femur, tibia and humerus, and in PA the knee-joint.

Treatment: Uniform initial regimen with 1 week of i v penicillin combination started after a mean time of 0.7 days possibly with complementary surgical intervention, in 82% of the cases performed within the first 24 hours; followed by p o antibiotics for a minimum of 5 weeks, if necessary changed according to antimicrobial susceptibility pattern.

Follow-up: 9 patients showed a questionnaire not totally normal; 8 of these were examined radiographically and clinically and only 1 patient demonstrated minor sequelae after a PA in the ankle-joint. All radiographs were interpreted by a radiologist as normal.

Conclusion: On a well defined uniform antibiotic initial regimen 0.7 days after hospitalisation and, when possible, fast complementary surgical intervention, we observed a very low frequency of sequelae. Compared to a similar

study in 1965–1976, we found an increasing incidence of both disorders. The frequency of positive bacteriology, radiographic findings and isotopic bone scans resembled those in other scientific studies.

Gentacoll® for local prophylaxis against postoperative *Staph. aureus* osteomyelitis in rabbits

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Resorbable collagen sponge containing gentamicin (Gentacoll®) may provide a high local concentration without need for secondary removal of the drug carrier. We compared the effect of gentamicin incorporated in collagen with the effect of collagen alone and systematically administered gentamicin in acute osteomyelitis. A total of 34 rabbits (Ssc:CPH) including 6 for local pharmacokinetics were used for the experiment. Under anesthesia K-wires were placed in 4 holes drilled in both tibiae. Local application of NaOH and an inoculum of 2×10^8 *S. aureus* resulted in acute osteomyelitis. Collagen sponge (12 legs) or Gentacoll® (10 mg/kg) (18 legs) placed in the wound, or gentamicin 10 mg/kg intravenously (12 legs) were used for treatment. 14 legs got no prophylaxis. Infection was quantitated by macroscopic evaluation of inflammation in tissue, bone and bone marrow, and by growth biopsies from the same areas giving a score of 0–8.

Both collagen+gentamicin (Gentacoll®) and systemic gentamicin reduced infection-rate compared to no treatment ($p < 0.01$), but the difference between the 2 regimens was not significant. Peak concentration in serum was 5–10 µg/mL and 30–40 µg/mL respectively after local and systemic prophylaxis. The concentration of gentamicin locally showed a peak after 2 hours in the range of 112–3000 µg/mL for bone and 225–890 µg/mL for tissue.

Gentamicin incorporated in collagen may thus be a valuable adjunct for prophylaxis against postoperative infections in rabbits and is comparable to systemic gentamicin given peroperatively.

Registration of postoperative infections

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Introduction: Registration of postoperative infections as part of a quality-assurance process under Statens Serum institute.

Methods: Constant registration of postoperative infections according to the procedures laid out by Statens Seruminstitute. The data are registered in the DANOP DATA system. For all operations 2 simple registration forms are used. 1 is given to the patient and the other is registered by the hospital pharmacy. In case of an infection the registration form is filled out by the patient's own doctor or one of the doctors in our department.

Results: During the past 4 years all "clean" operations have had an infection rate of 0.8 to 1.9% and the "deep" infections from 0.3 to 0.9%. Infection rates for all types of operations, including contaminated wounds and revisions, were between 0.3 and 0.84 for the "deep" infections and between 1.5 and 2.2 for all types of infections. Approximately 5000 operations were registered during these 4 years. Almost 80% of the "clean" operations were performed under laminary airflow.

Conclusion: With an infection rate of 1.3% for superficial infections and 0.4% for the "deep" infections we have an acceptable hygienic standard. We do not yet know if the use of laminary airflow for standard procedures has had a positive influence on the infection rates.

Pseudarthrosis with or without infection treated after Ilizarov principles

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Patients and methods: Between January and May 1993, the principles of Ilizarov were used in the treatment of pseudarthrosis in 18 cases, 17 tibial fractures and 1 humeral. The mean age was 35 (13–88) years.

The mean time from fracture to operation for pseudarthrosis was 15 (3–39) months. 11 patients had reoperations from 1 to 3 times before the final operation for pseudarthrosis. 7 patients had infection, 15 atrophic, 2 hypertrophic and 1 defect pseudarthrosis. 5 patients were treated with bone transportations, 4 only with compression and 9 with intermittent compression/distraction.

Result: The fixation period varied from 2–11.5 (mean 5) months. Mean time from operation to weightbearing was 9.3 (2–19) months. 3 patients are still using orthoplastorthoses. 14 patients were hospitalised during the fixation period.

Conclusion: With Ilizarov's principles, pseudarthroses can be treated radically and all our 18 patients healed well with good results.

MISCELLANEOUS

Results of fusion in lower lumbar degenerative disease

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The role of surgery in lower lumbar degenerative disease is controversial. The study comprised 36 consecutive patients (median age 51 years), treated from 1987–1992. All had degenerative disease of their lower back. In 26 cases a degenerative spondylolisthesis was found, 4 of these on 2 levels. All except 1 of the patients had degenerative disc disease and all had facet joint degeneration. 18 had spinal stenosis, 26 had lateral stenosis. 13 had been operated on before (failed back symptom), 4 of these more than once. All were operated on with an extensive root release, if any root compromise was found, followed by a posterolateral fusion with pedicle screw technique.

All fusions healed except 2, and 1 case was reoperated with removal of the implant and further root release. All patients were seen after 1 year with radiographs. Follow-up was performed by an independent observer after median 30 months with a questionnaire and all patients with continuous symptomatology were examined clinically and with new radiographs.

16 patients were classified as excellent, 8 good, 9 fair and 3 poor. 16 were at work and 11 could participate in some kind of sports. Except for 2 pseudarthroses no serious complications were found. This result shows that operation with nerve release and fusion is a worthwhile and relatively safe alternative in a selected group of patients with severe degenerative disease. It further shows that patients classified as failed backs could benefit from further surgery.

Bone lengthening using the Ilizarov method

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Introduction: The purpose is to describe the indications and results in 18 bone lengthenings carried out on 14 patients in our department during the period January 1991 through September 1993.

Material: The indications for surgery were: Sequelae after epiphysiolysis or fracture (5 patients), inborn dysplasia or aplasia (5 patients), Turner syndrome (1 patient, with 4 operations), traumatic amputation of all fingers on one hand (lengthening of 2 metacarpelia), sequelae after congenital hip dislocation (1 patient) and shortening after neonatal osteomyelitis in a humerus (1 patient).

Results: The average hospitalisation was 27 days. The average elongation and index of healing for the different bones was: femur 4.87 cm and 43 days/cm; tibia 5.56 cm and 35 days/cm; fibula 1.5 cm and 45 days/cm; humerus 7.5 cm and 15 days/cm; ulna 3.5 cm and 37 days/cm; radius 1.9 cm and 34 days/cm; metacarpelia 1.53 cm and 89 days/cm.

In the 18 bone elongations there were 14 cases of pin-problems which needed surgery. In 10 cases there was tension of the skin around the pins, in 4 cases the pins had loosened and needed replacement. 9 cases of infection around the pin-holes were treated with antibiotics only. 5 patients suffered from severe pain. 3 needed prolonged hospitalisation after the operation and 2 needed rehospitalisation. In all the cases the pain was due to distraction. There was 1 case of contracture with 25 degrees loss of extension in the knee, after treatment for fibular aplasia. We had 2 cases of fracture after removal of the external fixation. 1 fracture was treated by nailing and the other was treated by external fixation. Both fractures healed without further problems. We had no vascular complications. 3 patients suffered from transient paraesthesia, without permanent nerve damage.

Conclusion: The Ilizarov method for bone elongation is a demanding procedure. Because of the many—often minor—problems and complications the patients must be seen frequently because one must be prepared for aggressive treatment of the problems.

Dissertation abstracts

Clinical and experimental studies on the thoracospinal deformity in scoliosis

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ISBN 91-628-1224-6

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The purpose of the investigation was to determine the effects of the Boston brace, Harrington rod instrumentation (HRI) and Cotrel-Dubousset instrumentation (CDI) on the thoracospinal deformity in idiopathic scoliosis (IS), and to analyse the three-dimensional (3-D) effects of the thoracospinal muscles on the spine and the thoracic cage.

The effects of Boston brace treatment were investigated in 33 consecutive adolescent patients. The mean pre-treatment Cobb angle, vertebral rotation, rib hump and translation of the apical vertebra were not changed by bracing at mean follow-up of 8.5 years in the 25 brace compliant patients.

The effects of HRI were investigated in 33 consecutive patients with a follow-up rate of 33/33 (100%). Mean Cobb angle was improved by 40%, rotation of the apical vertebra was increased by 15%, and the rib hump, the coronal translation of the apical vertebra, and the sagittal diameter of the thoracic cage were unchanged at mean 10.8 years follow-up. The sagittal contour was flattened. Similar results were found in patients below 18 years of age, except that the rib hump was increased by 30%.

The effects of CDI were investigated in 24 patients with a follow-up rate of 24/28 (86%). Mean Cobb angle was decreased by 73% and translation of the apical vertebra by 33%, and thoracic kyphosis and lumbar lordosis were significantly improved at mean 3.2 years follow-up. Vertebral rotation and rib hump improved postoperatively, but at follow-up no significant correction remained.

In a multisegmental pre- and postoperative study of 38 patients operated on by CDI, the mean rotation of all vertebrae within the instrumented part of the spine were improved. The vertebral derotation was higher in the apical than in the upper and lower instrumented area. There was no worsening of the mean vertebral rotation or rib hump at any level within or outside the instrumentation.

The effects of the latissimus dorsi, erector spinae and intercostal muscles on the spinal configuration were investigated by electrostimulation of the respective muscles in 16 rabbits. In all rabbits, electrostimulation on the right side of the spine resulted in a left convex, hypokyphotic curve with vertebral body rotation towards the convexity of the curve, i.e. a 3-D spinal deformity similar to IS. The finding suggests that muscle imbalance may play a role in the evolution of IS.

Leg lengthening
A clinical and radiological study

Dissertation University of Uppsala 1994
ISBN 91–554–3285–9

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One hundred leg lengthenings were performed in 85 consecutive patients, between 1980 and 1991, with 3 different surgical lengthening techniques.

75 patients were reviewed as regards the type and degree of preoperative subjective complaints and how these were affected by the lengthening. Young patients had few complaints both before and after lengthening. More than half of the older patients stated preoperative low back pain. Lengthening diminished these complaints significantly. Most patients were satisfied with the result and stated that their ability to perform every-day activities had improved.

20 patients were lengthened an average of 3 cm with a direct lengthening technique. Two patients suffered vascular complications resulting in permanent dysfunction of the lengthened limb. The healing time was prolonged and one third of the patients required repeated bonegraftings.

24 patients underwent 27 Wagner lengthenings with a gain in length of on average 5 cm. An average of 5 operations were required to complete the lengthening. Five deep infections and nine fractures were registered.

45 patients underwent 53 lengthenings with callus distraction with a gain in length of on average 6 cm. Complications were common but most were benign and did not affect the end result. One fourth of the patients had, at follow-up, a slightly restricted joint motion in the lengthened extremity. Of the 3 reviewed techniques callus distraction is the safest and the one recommended.

In a clinical material (16 patients) the radiographs during lengthening displayed a magnification rate of 16 (0–36)%. By placing a radio-opaque ruler parallel to and at the same level as the bone, reliable measurements of the distraction gap could be obtained.

The regenerated bone, assessed in 10 patients, displayed

an irregular form and no medullary canal was present, at the time of fixator removal, on CT and MR scans. The new bone remodelled continuously and closely resembled the surrounding normal bone one year after lengthening.

The effects of micromotion and particulate materials on tissue differentiation
Bone chamber studies in rabbits

Dissertation University of Lund 1994
ISSN 0300–8827

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Motion and particulate materials may interfere with osseointegration and prosthesis stabilization. In this study we investigate the effects of micromotion and particulate orthopedic materials on tissue differentiation within bone.

Titanium bone harvest chambers were implanted in the proximal tibiae of mature rabbits. The chambers provided a lxlx5 mm pore for tissue ingrowth. Particulate orthopedic materials were mixed with a carrier solution (sodium hyaluronate) at a concentration of 108 particles/mL. Small, phagocytoseable, similar-sized particles os Simplex bone cement, high density polyethylene and cobalt chrome alloy, but not titanium 6-aluminium 4-vanadium alloy were associated with a foreign body and chronic inflammatory reaction, and inhibition of bone ingrowth.

The chamber was modified to allow the application of discrete, manually imposed periods of micromotion at the interface between the outer cylinder and inner core (the micromotion chamber). Using a round-hole chamber, a micromotion stimulus of only 20 cycles per day delivered over a period of less than 1 minute inhibited bone ingrowth. This same stimulus increased bone ingrowth into a square-hole chamber. Increasing the amplitude of micromotion from 0.50 to 0.75 mm, or increasing the number of motion periods from 1 to 2 per day favored fibrous tissue formation, rather than bone using the square-hole chamber. Cessation of a given set of motion parameters was accompanied by tissue differentiation that reflected the new functional biomechanical environment.

Despite evoking different histological reactions, micromotion and particulate materials could affect tissue differentiation in the rabbit chamber model. Excessive amounts of motion and wear debris may have an adverse effect on the osseointegration of prosthetic implants.

Magnetic resonance imaging in low back pain and sciatica with special emphasis on the postdiscectomy period
A study using 0.2 and 0.3 T vertical magnetic fields

Dissertation University of Lund 1994

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The diagonostic capability of magnetic resonance (MR) imaging at 0.3 T was evaluated and compared with other modalities in patients with previous disc surgery and remaining or recurrent sciatica, and in patients with spondylolisthesis and sciatica.

In the early postoperative period after successful lumbar discectomy. MR showed a large amount of abnormal soft tissue in the anterior epidural space, without correlation with clinical symptoms.

In the late postoperative period contrast-enhanced MR provided the best correlation with surgical findings, compared with CT and myelography, in discriminatinc recurrent/remaining disc herniation from epidural fibrosis in patients with the lumbar postdiscectomy syndrome. Contrast-enhanced MR could not demonstrate any differences regarding presence and extent of epidural fibrosis between symptomatic and asymptomatic patients.

In spondylolithesis, MR gave excellent information about the root canals and the degree of nerve root streching and compression, which was not possible to evaluate with myelography.

MR at 0.3 T provided information comparable to that reported from examinations performed with superconducting MR scanners, and is well suited as the imaging modality in the evaluation of lumbar spine disorders.

After introducing MR at 0.2 and 0.3 T with vertical magnetic fields as the first neuroradiological modality, instead of myelography or CT, in the evaluation of the soft tissues of the lumbar spine in patients with low back pain and sciatica a significant increase in the number ot patients examined, a moderate increase in the total cost of investigations, and a significant decrease in the cost per investigated and per operated patient was noted.

Langerhans cell histiocytosis

Dissertation University of Amsterdam 1994

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In 191 patients with histologically confirmed Langerhans cell histiocytosis (former: Histiocytosis X, eosinophilic granuloma, Hand-Schuller-Christian disease and Abt-Letterer-Siwe disease) the therapy response and the late sequelae

were studied.

The patients were classified by the 3 step scoring system of Raney and D'Angio: Group Ia: localized disease, Group Ib: multifocal disease and Group II: systemic disease with organ dysfunction. Of special orthopedic interest were the late sequelae in the spine, the pelvis, the long bones and the problems related to epiphyseal lesions and pathological fractures.

The percentage of second tumors found in this study, 2.6%, is high for a primary benign disease.

The incidence of the disease in the Netherlands in the years 1984–1990 was found to be 1.1/million for all age groups. As 75% of the patients are under 15 years of age in this and most other studies, the incidence was corrected for this age group: the incidence is 4.6/million children per year under the age of 15 years.

Therapy in this disease in the years studied, 1950 to 1988, ranged from biopsy, intralesional steroid injections, low- to high dose radiotherapy, prednisone- and or chemotherapy to major surgical procedures.

In Group Ia 82% of the lesions came to complete healing, no matter what treatment was given. In the mulitifocal Group Ib in only 65% a complete recovery was found, with more serious late sequelae. In the systemic Group II 5 of the 5 of the 14 patients died and serious late sequelae were frequent in the patients who survived.

The vertebral lesions with partial or total collapse (vertebra plana) in the pediatric age group show tendency toward restoration of the original height. The final outcome of the vertebral height was found not to be influenced by the therapy chosen. In the adults no vertebral restoration was noted. Epiphyseal lesions, especially in the proximal femur, gives rise to deformity in nearly all cases. Pathological fractures in the long bones due to this disease consoldate in the normal period and no special treatment methods, apart from treatment of the Langerhans cell histiocytosis, are necessary.

Conclusion: Treatment in patients with Langerhans cell histiocytosis must be individualized and is strongly related to the extent of the disease and age of the patient. The isolated bone lesions, Group Ia, should only be treated if the lesion is painful or poses a risk of pathological fracture, as there is a high tendency towards spontaneous regression of these lesions. The best treatment mode seems to be an intralesional injection with Methylprednisolone acetete (Depo-Medrol). The multifocal group Ib should be treated locally until this fails to control the disease. Systemic prednisone therapy should then be considered. Systemic disease with organ failure, Group II, should be treated with chemotherapy and supportive treatment of the involved organ system. Late complications, in particular the development of a second malignancy should always be kept in mind.

Soft tissue sarcoma
Epidemiology and prognosis in 508 patients

Dissertation University of Lund 1994
ISSN 0300-8827

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We have evaluated epidemiology, prognosis, and the association between metastasis and local recurrence in a series of 508 adult patients with soft tissue sarcoma of extremity and trunk wall. The series was population-based, i.e. all patients within a defined area and time-period were included irrespective of where treated, thereby avoiding selection bias in referral and follow-up.

Epidemiology: The annual incidence was 18/million. The median age was 64 years. Almost one third of the tumors were subcutaneous, and these were smaller than the deep-seated tumors. Malignant fibrous histiocytoma was the most common histotype, and grade IV the most common malignancy grade. The 5-year metastasis-free survival rate (MFSR) was 0.6. The majority of both metastasis and local recurrences occurred within 3 years after diagnosis of the primary tumor. There was noted differences in clinicopathologic data among histotypes.

Prognostic factors: Prognostic factors varied among different histotypes. However, since there is no consensus on histopathologic classification, an ideal prognostication system should be independent of histotype. Three strong parameters, tumor size, tumor necrosis, and vascular invasion were selected. Fortning subsets of patients with different combinations of these factors, a prognostication system was designed; patients with none or one factor constituted two thirds of all patients, and had a 5-year MFSR of 0.8. Patients with two or three factors constituted one third of all patients, and had a 5-year MFSR of 0.3.

Metastasis and local recurrence: The causal association proposed for local recurrence and metastasis should be questioned. We suggest that highly malignant tumors combine local and distant aggressiveness, and that local recurrence, just as other prognostic factors, is a marker of risk for, and not necessarily a cause of, metastasis.

Microinvasive lumbar disc surgery
A study on patients treated with microdiscectomy or percutaneous nucleotomy for disc herniation

Dissertation University of Turku

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During the last 2 decades, new microinvasive techniques have been introduced into the treatment of lumbar disc herniation. The polential benefits of microinvasive disc surgery are the reduced surgical.trauma to the tissue, increased safety due to good visualization of the operation field under the microscope and, consequently, reduced postoperative morbidity and shorter hospitalization in comparison to conventioal surgery. In this study, we evaluated the use of microdiscectomy and percutaneous nucleotomy in the treatment of patients with lumbar disc herniation.

Of the 237 patients who underwent microdiscectomy for virgin single-level lumbar disc herniation, 92% informed that their scialic pain had complelely recovered or markedly diminished during a median postoperative follow-up of 2 years and 79% of these patients had returned to work. The outcome of the patients operated on for a disc protrusion was to some extent less satisfactory than the outcome of the patients operated on for a prolapse or a scquestrum. Further, of the 45 patients who underwent percutaneous nucleotomy, the sciatic pain had completely recovered or markedly diminished in 38 (84%) patients during a mean postoperative follow-up of 2 years and 78% of them had returned to work. Also in these patients, a protrusion-type of disc herniation was associated with an inferior outcome.

After a mean postoperative follow-up of 3 years, the patients treated with microdiscectomy underwent repeated clinical examination. Segmental instabiliy of the lumbar spine was observed in 22% of 190 patients studied. Lumbar instability correlated significantly ($p < 0.0001$) with an unsatisfactory long-term outcome in these patients. Clinical instability was preoperatively detected in 24% of the 45 patients treated with percutaneous nucleotomy. Also in these patients, instability predicted significantly ($p < 0.05$) an inferior outcome.

On the first postoperative day, there was an extradural hematoma in 86% of the 44 patients studied with MRI. The incidence of hematomas was associated with the surgical method used: all 28 patients treated with microdiscectomy but only 10 (63%) of the 16 patients treated with percutaneous nucleotomy had a hematoma ($p = 0.001$). In addition, 25 (61%) of the 41 patients studied had an edematous epidural mass effect mimicking preoperative disc herniation. During follow-up for 6 months, the mass effect resolved completely in 10 of these patients but in 15 patients, MRI subsequently revealed either a disc prolapse or a protrusion. In addition, a protrusion was detected in 7 patients with no postoperative mass effect. There was, however, no association between these MRI findings and the clinical outcome of the patients. Moreover, none of the 39 patients developed muscle atrophy in the operation area during the follow-up period of 6 months when they were studied by the cross-sectional MRI slices of the lumbar muscles.

Collectively, the results of the present study indicate that microdiscectomy and percutaneous nucleotomy are both effective and safe. These findings encourage the use of these microinvasive surgical methods in the treatment of patients with lumbar disc herniation. Further studies are needed to define the optimal therapy for patients with a protrusion-type of disc herniation and for those with a disc herniation and clinical spinal instabilily.

Chronic lateral instability of the ankle joint
Natural course, pathophysiology and stereoradiographic evaluation of conservative and surgical treatment

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Chronic lateral instability of the ankle (CLI), defined as frequent sprains and recurrent giving way, difficulty in walking and running on uneven surface, is often connected with pain and swollen ankles. It occurs in 10 to 20% after acute ankle injuries. Mechanical instability of the talocrural and subtalar joint, peroneal weakness and impaired proprioception has been suggested as etiological factors.

Aim: To investigate the natural course in conservatively treated patients with CLI.

To assess the mechanical stability in patients with CLI by measuring the three dimensional motions in the talus, the fibula and the calcaneus in relation to the tibia during different testing procedures pre- and postoperatively.

To determine if CLI is associated with proprioceptive deficiency.

Patients and methods: This Thesis includes 127 ankles in 78 patients (30 women, 48 men) with CLI.

37 patients were followed up 20 years after their first contact with the orthopedic department because of CLI. 46 ankles were evaluated radiographically and the result was compared with a genderand age- matched control-material.

The neuromuscular response to a sudden angular displacement of the ankles was studied in 15 ankles in 13 patients using EMG.

36 patients entered a prospective study using radiostereometric analysis (RSA) in which the ankles were tested at manual adduction, adduction with predetermined torque, with and without external support and at drawer tests (40N and 160N). 27 patients were followed 5 years postoperatively.

Result: After 20 years 22 patients, conservatively treated still suffered from instability of the ankle and 10 had recurrent giving way symptoms even on plane surface. Six ankles in the patient group and 4 in the control group displayed osteoarthritic changes

Prolonged ipsilateral reaction time (m. per. long. and m. tib. ant.) was found in patients with CLI indicating proprioceptive insufficiency.

Increased talar adduction and a tendency toward increased total translation of the talar center was found in ankles with CLI. Concomitant fibular rotations and translations were found but with no conclusive deviation in the ankles with symptoms. The talo-calcaneal adduction reached the same level in the patient and control groups regardless of symptoms. External support (ankle brace) increased the talar stability. The use of predetermined torque and constrained testing procedure did not add information compared with the manual test.

25 patients graded the result as excellent or good 5 years after lateral ligament reconstruction. Talar stability (decreased adduction and translation) was increased 2 years postoperatively and was improved or remained the same at 5 years without comprising the range of motion.

Conclusion: In more than half the cases symptoms of CLI did not resolve spontaneously. Minor degenerative changes was found after 20 years, but not to a greater extent than in a control group. CLI was associated with proprioceptive insufficiency and talocrural but not subtalar instability. Increased ankle stability can be obtained by the use of an ankle brace and by an anatomical ligament reconstruction.

Exercise, knee injury and osteoarthrosis

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The short- and long-term effects of exercise and knee injuries on athlete physical activity and joint cartilage were investigated.

All organized Swedish soccer players are insured in the same company. One fourth of reported injuries were located to the knee, and of these anterior cruciate ligament (ACL) injuries represented over one third. Female players, elite players and forward players sustained relatively more ACL injuries. Females injured their ACL at a younger age. Only one fifth of the ACL injured players still participaled in soccer after 7 years. About half of the ACL-injured players were treated by surgery, but this did not increase the proportion of players still playing soccer after 7 years. None of the elite players played on the same level at follow-up. The annual drop-out from soccer in a normal population of players was 12%, injuries represented the cause in about one fifth of the cases.

Radiographic signs of osteoarthrosis (OA) of the knee were found on an average about 15 years after an ACL injury. Time after injury and age independently influenced the rate of OA progression after major knee injuries. The rate of progression of joint cartilage changes was much increased when the meniscus injury was diagnosed after 30 years of age.

The prevalence of hip OA was increased in former soccer players, mainly in those who had played at elite level. Knee OA was also more common among former elite soccer players compared to a control group, even after excluding subjects with diagnosed knee injuries.

The joint fluid concentrations of aggrecan fragments, stromelysin-1 and tissue inhibitor of metalloproteinases-1 (TIMP-1) all increased in the acute phase after ACL and meniscus injury. The increase was most pronounced for stromelysin. The marker concentrations decreased within the first month after the trauma, but were all still increased compared to reference values after 20 years. Between 1 and 6 months after the trauma the increase in marker concentrations was higher after ACL injuries compared to meniscus injuries.

One event of physical activity induced a rising trend for the products of cartilage matrix degradation in joint fluid, though only significant for aggrecan. The serum levels of keratan sulfate increased after long-distance running.

Conclusion: Injuries to the ligaments of the knee are common and have serious shon- and long-term consequences. Only few soccer players are able to continue their career after an ACL injury. Soccer at the elite level increases the risk of OA of both hip and knee. Surgery as performed 1986–1991 did not improve the rate of return to soccer and little proof exists that it decreases the risk of OA. Results of assays of cartilage markers in joint fluid after injury suggest both short- and long-term changes in the metabolism of jount canilage matrix which may be associated with the development of OA.

Hydroxyapatite ceramic coating for bone-implant fixation

Mechanical and histological studies in dogs

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The present series of studies were performed in order to investigate the effect of hydroxyapatite coating (HA) on bone ingrowth into porous coated titanium-alloy implants (TI) when subjected to pathological and mechanical conditions mimicking the clinical situation. The studies particularly focused on the effect of osteoporosis, bone deficiencies, bone grafting, and micromotion on implant fixation.

HA- and TI-coated implants were inserted into the femoral condyles of mature dogs. The observation period ranged from 4 to 16 weeks, and the results were evaluated by mechanical push-out testing, histomorphometric analysis,

polarized light microscopy, UV fluorescence microscopy, collagen analysis and transmission electron microscopy (microanalysis). There were no complications related to the operative procedures and all dogs were terminated according to the original time schedule.

Host bone related factors were studied in the initial experiments. First, the effect of the gap between bone and implant was studied and compared with press-fit insertion. The HA-coating yielded superior effect on bone ingrowth compared to Ti in situations where the implant was surrounded by a gap and also where the implants were inserted in press-fit. Gaps of 1 mm and 2 mm around the implant were bridged by bone around HA implants whereas significantly less amounts of bone filled the gap around Ti implants. The gap-healing capacity of bone was increased even at a relatively great distance (400 µm) from the HA surface. This finding indicates that the osteoconductive effect of HA is not limited to the bone forming capacity on the surface of the implants. A positive gradient of newly formed bone was found towards the HA-coating, this gradient not being found towards the Ti-coating.

In order to investigate the significance of arthritic bone changes (osteopenia) on fixation of porous coated implants we adopted the Carragheening-induced gonarthritis model resulting in substantial bone loss as determined by CT-scanning. In osteopenic bone, the anchorage of Ti-coated implants was weakened compared with control bone whereas HA-coated implants were not affected by the osteopenic condition in the bone bed. However, the fixation of Ti-coated implants was superior to that of HA-coated implants in normal bone. HA-coating was shown to accelerate the rate of bone ingrowth in the presence of an initial gap between bone and implant even in the presence of osteopenic host bone bed.

A model was developed to investigate incorporation of bone graft material into Ti- and HA-coated implants. Allogenic bone graft packed around the implant enhanced the anchorage of Ti implants by 900%, but HA-coating alone without bone graft offered almost the same improvement in anchorage in 2 mm defects. Only minor additional improvement was obtained when bone graft was used together with HA. Arthritic bone changes did not influence incorporation of allogenic bone graft.

The last three experiments focused on the significance of mechanical stabilization and loading conditions of the implant immediately after surgery. Micromovements between bone and implant prevented bony ingrowth and resulted in development of fibrous membrane. HA-coating was shown to modify this fibrous membrane as evidence by the presence of fibrocartilage, higher collagen concentration, radiating orientation of collagen fibers, and a thinner membrane as compared with T-coated implants. In a longer-term study (16 weeks), the membrane around HA-implants became replaced by bone even when subjected to continuous load, whereas the membrane around Ti implants persisted after 16 weeks.

A great amount of bone ingrowth into loaded but stable HA-coated implants was demonstrated even in the presence of an initial gap around the implant. Moreover, dynamic load was even shown to increase the amount of bone ingrowth into HA-coated implants, this being three-fold greater compared with completely unloaded implants. This positive effect of dynamic load was not evident for Ti implants. The best anchorage and greatest amount of bone ingrowth was obtained in the loaded stable situation when the implants was coated with HA.

An increased fibrous fixation was obtained with decreased range of motion (from 500 µm to 150 µm) by both HA and Ti implants, and a further increase in fixation was obtained when the observation period was extended from 4 weeks to 16 weeks. From these studies it could also be demonstrated that the fixation of fibrous anchored HA implants was obtained in 1/4 of the time required for the equal fixation of implants without HA-coating.

The consequence of immobilization of a motion-induced fibrous anchored implant was a complete replacement of the membrane by bone, irrespective of type of coating. A greater amount of bone ingrowth was obtained with immobilized HA-coated implants compared with immobilized Ti implants.

From the results presented here it can be concluded that HA-coating has a positive effect on bone-implant fixation in various situations, i.e. under stable unloaded conditions, under stable loaded conditions, and under unstable mechanical conditions. The most striking effect of HA was the capability to enhance bone to grow across a gap around the implant both during stable and unstable mechanical conditions, and even be capable of converting a motion-induced fibrous membrane to bony anchorage.