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Experimental orthopedics

Diphosphonate (clodronate) could not retard the formation of osteoporosis induced by rigid plate fixation

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The influence of a diphosphonate, clodronate—Bonefos®, on the remodelling of trabecular bone in femur in conjunction with rigid plate osteosynthesis of the ipsilateral tibia was tested in 40 rabbits by histomorphometry at 9 and 18 weeks. A dosage of 50 mg/kg s.c., resulting in a mean bone concentration of 509 μg/g in two hours, was given once a week. A pronounced osteopenic response in the femur after plate fixation of the ipsilateral tibia was discovered, unrelated to direct stress shielding; the trabecular bone volume decreased by 25%. Clodronate was shown to retard this porotic transformation up to nine weeks after the operation, reflecting inhibition of the osteoclastic function. At 18 weeks, however, this inhibitory effect seemed to cease. No direct inhibitory effect on osteoclastic activity was found which supports the idea that clodronate treatment, if indicated, can be continued after osteosynthesis.

Early stages of fracture healing - an immunohistological study

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The local multicellular mediator mechanisms that contain precursor and supporting cells, capillaries, lymph and innervation, plus local autocrine and paracrine regulation play extremely important roles during the first stages of fracture healing. Errors in those functions can lead to several kinds of retarded or otherwise abnormal bone healing. That is why we tried to cast light over these early functions by means of modern immunohistological techniques and monoclonal antibodies. Immunohistological staining of normal paraffin and decalcified sections gave satisfactory results when using NCL-PCNA monoclonal antibody, which labels proliferating cells (in early S-phase), and QB-END/10 which is monoclonal antibody against endothelial cell membranes. At three days, the primary response was already evident, with cell proliferation of osteoblast-like cells in the periosteal and bone marrow regions. This was followed by an active front of the proliferating periosteal cells quite far from the fracture gap, and with high activity of the PCNA. On the contrary, the cartilaginous callus around and between the fracture ends had low activity of the proliferating and PCNA positive cells, speaking in favour of more differentiating than proliferating nature of the pluripotent cells originating from the periphery of the callus.

Bone and growth factors

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Cell activation, growth and differentiation are subjected to many control mechanisms including hormones and substances called cytokines. The cytokines are divided into leukokines and growth factors. Structurally growth factors are polypeptides and at cellular level they bind to specific receptors. Recent studies suggest that they locally may modulate bone formation and bone resorption. Many growth factors have been found in the bone extracellular mineralized matrix: platelet-derived growth factor (PDGF), acidic and basic fibroblast growth factor (FGF), transforming growth factor beta (TGF-beta) and insulin-like growth factors I and II (IGF). In bone there are also many osteoinductive agents. Bone morphogenic proteins (BMPs), osteogenin and osteoinductive factor (OIF) are perhaps the best known. Growth factors can regulate cellular events during bone remodelling in four different ways. This includes endocrine effect, paracrine and autocrine effect, and matricrine or delayed paracrine effect.

Recent research suggests that in fracture healing at least TGF-beta is activated. In our work we have also seen NGF activation and NGF-receptor induction during the healing process.

Preliminary results indicate that also during distraction, bone healing growth factors are activated due to tissue trauma and gradual lengthening.

Hydroxylapatite and bioglass in reconstruction of osteochondral defects

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A rabbit knee model with an aim to test various materials as bone substitutes on osteocartilaginous area was developed. In this model three conical holes were drilled (Friolit 4–0 drill) on patellar and both tibiofemoral joint surfaces. The model aims at testing composite materials. In this study incorporation of hydroxylapatite (HA) and bioglass (BG, 55.5% SiO_2, 29.0% Na_2O and 11.0% CaO as main chemical compositions) in the subchondral bone were evaluated. Conical HA and BG implants were manufactured and implanted in each hole with orthopedic sterility. The implants were harvested with surrounding bone after 3, 6, and 12 weeks. Tissue was fixed and embedded in light-hardening plastic (Technovit). 150–200 µm thick specimens for light microscopy and 20 microns for SEM and EDXA were processed with cut-and-grind technique. The surface of implants were examined with light-microscopy and SEM. The chemical fixation of implants was confirmed with EDXA. Our model worked well and the results are comparable to those of other research groups of this field. Models of this kind have not proved to work earlier.

Preparation and testing of bone morphogenetic protein (BMP) antibody

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Introduction: Bone formation is influenced by different growth factors, mitogens and cytokines. Bone morphogenetic protein (BMP) has been shown to induce de novo enchondral ossification in an extraskeletal site. BMP can be detected in blood in ng/ml quantities and according to previous studies BMP blood concentrations are altered in various pathological conditions, e.g. osteoporosis and Paget's disease (1). In our study a polyclonal antibody against bovine BMP was prepared and characterized.

Material and methods: A partially purified bovine-BMP preparate (0.5 mg) was injected with 200 µl of complete Freund's adjuvant (FA) into BALB/c mice intracutaneously. Immunization was continued with bBMP and incomplete FA, three times a week for four weeks, whereafter the serum was collected. The serum antibody was tested and characterized using enzyme linked immunosorbent assay (ELISA). The immunoglobulins were fractionated by high pressure liquid chromatography (HPLC).

Results and conclusions: The antibody concentration against bBMP was remarkably high in the immunized mouse serum. The antibody was still detectable when diluted to 1:8000. By HPLC and ELISA test the antibody was shown to be IgG. It has been shown that human BMP and bBMP cross react with mouse antibovine BMP antibody. Therefore the antibovine BMP antibody may be used for further studies to develop BMP radioimmunoassay for clinical practice.

Reference: 1) Urist M R, Nilsson O S, Hudak R, Huo Y-K, Rasmussen J, Hirota W and Lietze A. Immunologic evidence of a bone morphogenetic protein in the milieu intérieur. Ann Biol Clin 1985; 43: 755–66.

Fixation of a femoral shaft osteotomy by an intramedullary self-reinforced polyglycolide rod or metallic rod—an experimental comparative study on growing dogs

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Introduction: Rush-pins are manufactured of stainless steel. Polyglycolic acid (PGA) is a synthetic, biodegradable material. The self-reinforced polyglycolic acid (SR-PGA) implants are manufactured of biodegradable polymeric matrix reinforced with fibers of the same material.

The purpose of this study was to find out the effect of an intramedullary SR-PGA rod and a metallic rod on growing bone and applicability of these rods to the fixation of a femoral shaft osteotomy in a growing dog.

Materials and methods: In 5 twelve-week-old beagle dogs, osteotomy of the right femur was fixed with an intramedullary (4.5 mm in diameter, 60 mm in length) SR-PGA rod (PGA-group). In another 5 twelve-week-old beagle dogs, fixation of the osteotomy was achieved with an intramedullary Rush-pin of equal size (Rush-group). The follow-up intervals were 1, 3, 6, 12, 24, and 48 weeks.

Results: Solid union of the osteotomy without secondary displacement was seen six weeks after fixation in both groups. At the end of the growth, at 48 weeks' follow-up, the thickness of the femoral shaft was greater in the operated femur than in the control femur in the PGA-group, but in the Rush-group the reverse was true.

Narrowing of the femoral neck and a slight valgisation of the proximal femur without any functional disability was seen 48 weeks after the operation.

Conclusion: An intramedullary SR-PGA rod and a metallic provided equal and sufficient stability for rapid healing of a femoral shaft osteotomy in growing dogs. Neither the medullary SR-PGA rod nor the metallic rod caused any significant disturbance of the longitudinal growth of the operated on femur.

Fixation of tibial osteotomies with poly-L-lactide screws—a mechanical study in rabbits

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Introduction: Absorbable poly-L-lactide (PLLA) has been widely used in experimental studies as a material for internal fixation devices. Most of the reported studies have concerned cancellous bone fracture and osteotomy fixations (Bos et al. 1987, Rozema 1990). We have noted promising results of cortical bone osteotomy fixations with self-reinforced poly-L-lactide (SR-PLLA) rods (Majola et al, in press). This study was carried out to test SR-PLLA screws as lag-screws in the fixation of cortical bone osteotomies.

Materials and methods: 60 rabbits were operated on in a ketamine-medetomidine anesthesia. Their right knees were opened, 3.2 mm in diameter holes were drilled in the tibial medullary cavities, and they were tapped with a 4.5 mm in diameter tap. The proximal parts of the holes were widened to 4.5 mm. Tibial cortical bone osteotomies were made. The osteotomies were fixed with fully-threaded metallic cortical lag screws (4.5 mm in diameter) in 30 and with sintered self-reinforced poly-L-lactide (SR-PLLA) screws (4.5 mm in diameter) in 30 rabbits. Follow-up times were 6, 12 and 24 weeks. After killing of the rabbits, the healing of the osteotomies was evaluated, both tibias were radiographed, and they were tested mechanically in shear strength. The shear strength of the operated tibia was divided by that of the intact contralateral bones, thus giving the comparative shear strength value.

Results: Macroscopically 29/30 of the metallic and 12/30 of the SR-PLLA screw fixed osteotomies had healed well and radiographically the results in the metallic group were significantly better. The comparative shear strengths were 48% at 6, 58% at 12 and 72% at 24 weeks in the metallic and 28%, 48% and 61% in the SR-PLLA group, respectively.

Conclusion: This study showed that sintered SR-PLLA screws cannot be used as single lag-screws if hard rotational and bending forces act on the screws.

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Fixation of subcapital femoral osteotomies with absorbable self-reinforced poly-L-lactide (SR-PLLA) pins—an experimental study on sheep

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Introduction: On the way towards new and more demanding indications for absorbable osteosynthesis implants an experimental subcapital femoral osteotomy was chosen to mimic subcapital femoral fractures.

Materials and methods: Self-reinforced poly-L-lactic acid (SR-PLLA) pins, 3.2 mm in diameter and 120 mm long, were manufactured by using fibrillation technique. They showed bending strength of 250–300 MPa and shear strength of 200 MPa. Nine adult sheep were operated. Subcapital femoral osteotomies were made with oscillating saw and after open reduction three SR-PLLA pins were used for fixation. The excessive ends of the pins were cut off with a hot scalpel. No external support was used and after recovery from anesthesia the sheep were allowed to move freely in their stalls. Follow-ups were 3, 6, and 12 weeks. Macroscopic, radiographic, microradiographic and histologic studies were performed.

Results: Three weeks after operation one out of three osteotomies had consolidated while the other two showed a slight longitudinal instability in the direction of the femoral neck but no displacement. Six weeks postoperatively one out of three fixations had failed while the other two showed a solid bony union. At twelve weeks all three osteotomies had healed uneventfully. No adverse reactions to the implants were observed.

Conclusion: The results of the present study are encouraging and further studies with longer follow-ups and with more advanced implants have been started.

Hip

Loosening of threaded acetabular components

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Between 1987 and 1990 a total of 714 hips have been operated using smooth threaded Biomet-APTF acetabular components. At the same time 72 hips have been revised, 63 of which due to loose acetabular components. 14 such cases where the arthroplasty was done for primary arthrosis were selected for closer analysis, with a mean interval between the primary and secondary operation being 25 months. A control group for clinical evaluation of 14 patients without revision but with the same indication and age and sex distribution, having the follow-up at least one year more than the mean interval between primary THA and cup revision. Radiographic analysis focused on cup loosening, and the changes that normally appear around an uncemented stem in the femur.

The rate of acetabular component loosening in the whole material was considered unacceptably high. Radiographically all stages of loosening occurred in this series; in some patients the radiographic changes were new and scarcely observable at the time of the revision. In other patients the radiographic changes had prevailed for a long time and were marked.

The disappointing short-term results with these threaded cups in our hands have prompted us to abandon their use in favor of the porous surfaced hemispherical cups.

Analysis of synovial fluid with ferrography in revision arthroplasty

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Analysis of aspirated synovial fluid appears to be a useful method for the study of the rates, mechanisms and biological responses to wear in surgical joint replacements. Ferrography is a technique to magnetically harvest and separate metallic, as well as non-metallic particles (after coating them with magnetization solution) from aqueous and non-aqueous suspensions. Large amounts of metal and polyethylene debris were found in synovial fluid aspirated during revision arthroplasty when both titanium and cobalt-chromium prostheses had been used at primary operation. Large and bulky particles could be detected in seven specimens, both large and smaller particles in six, and only small and fine particles in two specimens. The sc coverage of the ferromagnetic plot area (max 5100) varied form 428 to 2774. The largest particles proved to be polyethylene and due to the abrasive wear mechanism of the polyethylene components. The findings speak in favour of the role of wear particles as a causative factor for the formation of aggressive granulomatous tissue and aseptic loosening of the prosthesis.

Fibronectin and collagen types I and III in aggressive granulomatous lesions in total hip arthroplasty

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Previously the most clear-cut difference in aggressive granulomatosis and common loosening has been found to be the relative lack of activated fibroblasts in case of aggressive granuloma. This may be related to an uncoupling of monocyte/macrophage mediated foreign material and tissue debris clearance which is normally followed by fibroblast mediated synthesis and remodelling of the extracellular matrix. The aim of this study was to characterize the appearance and localization of the connective tissue components fibronectin and collagen types I and III in the interstitial tissue between prosthesis stem and bone.

There were eleven patients undergoing revision arthroplasty for symptomatic prosthetic loosening and five cases were associated with aggressive granulomatosis. Six of the hips had been primarily operated on because of arthrosis, three because of rheumatoid or related arthritides and two patients had femoral neck fractures. All except one were cemented endoprostheses. The patients in aggressive granuloma group had an average age of 57 (53–68) years when first operated. The average age at the first operation in the group operated on for prosthetic loosening was 57 (51–60) years. The revision arthroplasty for aggressive granulomatosis was conducted an average of 11 (7–17) years and for simple loosening an average of 8 (4–15) years after the primary operation. In the revision operation all the granulomatous tissue between the prosthesis stem and the bone was

removed and samples were taken for histology, immunohistological staining and for bacterial culture. The tissue samples were fixed in 2% buffered (pH 7.4) glutaraldehyde and embedded in paraffin. The sections were stained for type I and III collagen and fibronectin with peroxidase-antiperoxidase (PAP) method. Antibodies to collagens were provoked in rabbit (I) and goat (III) and the activity and specificity were tested by the enzyme-linked immunosorbent assay (ELISA) technique.

Type I collagen and fibronectin were evenly distributed in the granulomatous tissue, but no type III collagen could be observed. Both type I and III collagen as well as fibronectin could be observed in the tissue samples form simple loosening although the intensity of type III collagen antibody staining was somewhat lower than that of type I collagen and fibronectin.

There may be a defensive mechanism of the host to the rapid osteolytic process to produce only larger collagen fibrils with higher tensile strength and integrity. On the other hand it is also possible that type III collagen is more susceptible than the fibrous type I collagen to the collagenolytic enzymes present in high amounts in aggressive granuloma lesions.

Table. Early fixation failures and reoperations within 3 months

	Mecron screw	Compression hip screw	Ullevaal screw
Number	120	75	100
Displaced	95	59	87
Female/male	82/13	47/12	69/18
Age, mean (SD)	80 (10)	83 (10)	83 (12)
Mortality	8	6	5
Reoperations, n (%)	12 (13)	16 (27)	7 (8)

The logistic regression an analysis showed significant associations of calcar comminution ($P = 0.001$), small head fragment ($P = 0.010$), varus angulation ($P = 0.013$), major displacement ($P = 0.05$), suboptimal fracture reduction ($P = 0.013$), and high age ($P = 0.045$) with failures of osteosynthesis during three months.

Conclusions: Osteosynthesis with three Ullevaal screws gives an adequate fixation in femoral neck fractures. Calcar comminution, small head fragment, extreme varus angulation and inadequate reduction impair the prognosis. Therefore, proper selection of patients to primary osteosynthesis vs endoprosthesis improves cost/benefit.

A new design of three-screw fixation of femoral neck fractures

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Primary hemiarthroplasty has not reduced the morbidity in femoral neck fractures compared with screw fixation (Skinner et al. Injury 1989; 20: 291), which is cost-effective (Söreide et al. Acta Orthop Scand 1980; 51: 827). The purpose of the present study was to develop a new osteosynthesis method phase by phase, and to define indications for osteosynthesis.

Material and methods: After phase I studies to develop a new hip screw system (Husby et al. Acta Orthop Scand (Suppl 237) 1990; 61: 83), a phase II clinical study was designed using the Ullevaal Hip Screw System® (Howmedica). The first 105 consecutive patients were operated on a 24-hour basis and followed for at least three months. However, five fractures where a satisfactory reduction could not be obtained underwent a primary hemiprosthesis replacement (Hastings®, Thackray). In a further study, 145 consecutive femoral neck fractures were subjected to a multivariate analysis to find out the value of primary radiographic findings in prediction of the outcome of treatment.

Results: The Ullevaal Hip Screw System had the lowest reoperation rate ($P < 0.005$, x2 test).

Knee and foot

Bone mineral density in the lower extremities and lumbar spine 10 years after an unilateral knee ligament injury

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Decreased bone mass is a well-recognized risk factor for stress fractures of lower extremities in young, active women, and especially for osteoporotic fractures of the knee, hip, spine, shoulder and distal radius in older women. The long-term effects of musculoskeletal injuries on bone density of the affected areas and their role as a risk factor for osteoporosis in later life have not been studied previously.

Materials and methods: The bone mineral density (BMD) and clinical status of 17 patients (8 women and 9 men with a mean age of 49±6 years) who 10 to 11 years previously had had a surgically treated acute knee ligament injury (with a 6- to 7-week postoperative immobilization) were examined. The BMD was measured in the spine (L2–4), and the femoral neck, distal femur, patella, proximal

tibia and calcaneus of both lower extremities. The relative BMD results of the injured knee were correlated with sex, age, knee stability and functional scores of the patient.

Results: The BMDs were significantly lower in the injured than in the uninjured knee: distal femur –4.7%, patella –8.7% and proximal tibia –3.9%. The femoral neck and the calcaneus showed no differences. There were no significant differences between men and women. The relative BMDs of the injured knee did no correlate with patient age or static knee stability, but they showed correlation (r=0.50–0.83) with the functional scores (Lysholm, Tegner, IKDC) of that knee: the better the knee function, the higher the relative BMD. The spinal BMDs of the patients were within the age-related Finnish reference values determined with our equipment.

Conclusion: A complete knee ligament sprain treated as described results in a permanently decreased BMD of the knee. Other parts of the same extremity or lumbar spine do not seem to be affected. The observed decrease in the BMD (4–9%) of the injured knee can be considered to be significant when compared with the general estimate of an age-related bone loss of 1% per year after the age of 35.

Instrumented measurement of tibiofemoral motion in patients with old anterior cruciate ligament tear

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Introduction: Accurate definition of knee instability is difficult using clinical examination. There is also poor correlation between the results of different examiners. Therefore instrumented devices for accurate measurement of knee motion have been designed.

Patients and methods: Instrumented measurements with a KSS arthrometer were performed on 26 patients (12 female and 14 male, mean age 28 years) with a documented old anterior cruciate ligament tear (mean 2.8 years from injury).

Results: Anterior translation of the affected and the uninjured, control knee was 14.2 (±4.2) mm and 8.0 (±2.2) mm, respectively. Correspondingly, the total anterioposterior translation was 19.2 (±4.9) mm and 12.2 (±2.5) mm, respectively. The shape of the deflection curves of unstable knees were typical for ACL tears and various parameters (maximal distance of active and passive deflection curves, the corresponding knee flexion angle and the area between the curves) can be calculated and were found to differ significantly from the control knee.

Conclusions: Values exceeding 10 mm in the anterior translation and 14 mm in anteroposterior translation at 200 N load were found to indicate an ACL insufficiency. A difference of over 3 mm between a control and an injured knee should be considered pathological.

Long-term results after operative treatment of acute, first time patellar dislocation in a prospective material

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Introduction: Treatment of primary patellar dislocation is still controversial. It was attempted in this prospective material to find guidelines for optimal selection of treatment in primary patellar dislocation.

Patients and methods: There were 64 cases of primary patellar dislocation which were treated operatively (repair of torn structures and lateral capsular division) of which 53 cases were available for a follow-up examination after a mean of seven years.

Results: There were nine recurrences, three of which had been reoperated and two patients were on a waiting list for distal realignment procedure. The remaining four patients did not wish to have another operation. All redislocations occurred in female patients. They also more often (p = 0.0013) had patellar dislocation in their other knee than the stable patients. Patients with redislocations were more often dissatisfied that the stable group, mainly because of anterior knee pain (p = 0.043). Preoperatively the redislocated patients had more pronounced patellofemoral pathologic congruity (Laurin's projections) in the operated knee (p < 0.05) as well as in their, at that time uninjured, control knee (p < 0.05).

Conclusions: To improve the results of soft tissue repair in acute patellar dislocation, surgery should be aimed at correcting the underlying pathology. In grossly and symmetrically pathological cases of patellofemoral articulation, a distal realignment procedure should be added. Otherwise conservative treatment might be justified.

Histopathological changes preceding spontaneous tendon rupture—a controlled study of 891 patients

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A spontaneous tendon rupture was a rarity until the 1950s, but its incidence has clearly increased in industrialized countries during the recent decades. Nevertheless, the histo-

pathological changes preceding a spontaneous rupture are not well established, and studies using age and sex matched controls and modern histological techniques have not been published.

Materials and methods: We evaluated biopsy specimens of spontaneously ruptured tendons from 891 patients treated at the National Institute of Traumatology, Budapest, Hungary between 1968 and 1989. The specimens, which were removed at the time of primary repair, included 397 Achilles, 302 biceps brachii, 40 extensor pollicis longus, 82 quadriceps and patella and 70 other tendon ruptures. The age and sex matched control material included 445 tendons taken at the time of death from cadavers of previously healthy individuals who had died accidentally. The histopathological analyses of the specimens included light and polarized light microscopy, and scanning and transmission electron microscopy.

Results: Healthy tendon structure was not seen in any spontaneously ruptured tendon, whereas two thirds of the control tendons were structurally healthy ($p < 0.001$). There were characteristic histopathologic patterns in the spontaneously ruptured tendons. Most (97%) of the pathological changes were degenerative: either hypoxic degenerative tendinopathy (HD), mucoid degeneration (MD), tendolipomatosis (TL), calcifying tendinopathy (CT), or a combination of these. In the controls, these changes were also found, but significantly less frequently (34%) ($p < 0.001$). In the other 26 ruptured tendons (3%), the pathological change was either an intra-tendinous foreign body; rheumatoid, tuberculous, granulomatous or non-specific tendinitis; gout; a xanthoma; a tumor; or a tumor-like lesion such as an intratendinous ganglion.

Conclusion: The findings clearly indicate that at least in an urban population degenerative changes are common in the tendons of people over 35 years of age, and that these changes predispose the tendons to spontaneous rupture.

Results of operative treatment of Achilles peritendinitis and retrocalcanear bursitis

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Achilles peritendinitis and retrocalcanear bursitis are common overuse injuries in athletes. When conservative measures are inefficient, operative intervention has been used to relieve symptoms. We have treated surgically during the years 1980 to 1988 49 patients with Achilles peritendinitis (APT, eleven bilateral cases) and 31 patients with retrocalcanear bursitis (RCB, five bilateral cases) in the Tampere University Hospital (in all 96 heels). There were 37 men and 12 women in the APT-group with a mean age of 38 years, and 26 men and five women in the RCB-group with a mean age of 32 years. 45 patients in the APT-group and 30 patients in the RCB-group were active in sports. Duration of the symptoms varied from six months to two years in 37 patients in the APT-group and 21 patients in the RCB-group, respectively, and in the rest of the cases from two to 15 years.

The operative method was bilateral division of fascia cruris and trimming of the adhesions to fascia and base of Kager's triangle in the APT-group and ablation of the posterior upper corner of os calcaneus in the RCB-group.

The subjective results were evaluated by a questionnaire in 42 patients (47 operations) in the APT-group and 25 patients (28 operations) in the RCB-group, two to eleven years postoperatively. The results were excellent in 27 cases, good in eleven, satisfactory in seven and poor in two cases in the APT-group, and excellent in 13 cases, good in ten, satisfactory in two and poor in three in the RCB-group, respectively.

Operative treatment of Achilles peritendinitis and retrocalcanear bursitis in patients with persisting symptoms after conservative measures seems to give favorable results in most cases.

Shoulder

Preoperative evaluation of the shoulder with ultrasonography and arthrography

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The purpose of this study was to analyse the value of ultrasonography (US) and arthrography in the diagnosis of lesions of the shoulder tendons. US of the shoulder joint was performed in 428 patients, 53 of whom were operated on later. During operation, impingement wear Stage I of the rotator cuff was noted in 13 patients, Stage II in eight patients and Stage III in 30 patients, and an anterior tear of the glenohumeral capsule in two patients. Associated lesions of the tendon of the long head of the biceps brachii were seen in 21% of the cases. In the detection of rotator cuff tears, US represented an overall sensitivity of 77%, a specificity of 96%, an accuracy of 85%, a positive predictive value of 96% and a negative predictive value of 75%. Correspondingly, arthrography represented a sensitivity of 93%, a specificity of 95%, an accuracy of 94%, a positive predictive value of 96% and a negative predictive value of 91%.

Evaluation of postoperative status of the rotator cuff with ultrasonography and NMR

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Ultrasonography of the shoulder was performed in 20 patients and in eight of them this was followed by an NMR examination of the joint at an average on one year after operative repair of a torn rotator cuff. In all shoulders US revealed local thinning of the cuff tendon tissue, as well as local effusion in the biceps sheath. In NMR three cases were interpreted as normal, in two cases there was residual impingement and in one a full-thickness rupture of the cuff. Despite this, all patients had complete relief of pain and abduction up to at least 150 degrees. It seems evident that a completely watertight closure of the cuff is not essential for a good functional result. In cases with functionally bad and painful results after the first operation, US or NMR evidence of residual impingement may indicate a second attempt.

The long-term results of rotator cuff ruptures after surgical repair

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The purpose of this study was to evaluate the long-term results after surgical repair of rotator cuff rupture.

Patients and methods: Rotator cuff ruptures were repaired in 98 cases (65 men and 33 women) during the years 1980–1985. The mean age of patients was 52 years. The mean follow-up time was 8 (6–11) years. The interval between the onset of symptoms and the operation was less than six months in 69 cases. The onset of symptoms was spontaneous in 17 cases. The cuff rupture was sutured and reinserted to the tuberculum majus in 75 cases. The defect was reconstructed with a free tendon graft in 16 cases. Decompression of the subacromial space was performed in these operations. In five cases cuff repair was performed without subacromial decompression. Decompression of the subacromial space without suturing or reconstructing the defect was performed in two cases. Tenodesis of the long head of the biceps tendon was carried out in 19 cases.

Results: Preoperatively 88 patients had severe shoulder pain. At follow-up 16 patients still had pain in their shoulder. 12 patients used analgesics at follow-up. Preoperatively active flexion in the shoulder joint was less than 90° in 50 cases and active abduction was less than 90 degrees in 66 cases. At follow-up active flexion was less than 90° in seven cases and active abduction was less than 90° in six cases. Postoperatively the average sick-leave was 89 days. Nine patients had retired due to their shoulder problems. If the shoulder movements became painless after the repair, the mobility remained unchanged during the follow-up period.

Conclusions: Early operative treatment resulted in good relief of pain and good function of the shoulder. If the primary results were good, the results were permanent. Good operative results suggest a favourable outcome in the early operative treatment of ruptured rotator cuff.

Spine

Premature disc degeneration—source of pain in isthmic spondylolisthesis in adolescents?

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The lower lumbar discs of 62 children and adolescents were evaluated by MRI to elucidate the role of disc pathology as possible source of pain in isthmic spondylolisthesis. The subjects were allocated into four groups: a) asymptomatic isthmic L5 slip (mean 18%, n=15), b) symptomatic L5 slip (mean 17%, n=10), c) idiopathic scoliosis (mean Cobb angle 30°, n=18), d) normal controls (n=19). The 5th lumbar disc was pathologic in all patients in groups a and b, in 5/18 in group c and in 7 of the 19 controls. Pathologic disc changes below the slipped vertebra seemed to be the rule in growing individuals with isthmic spondylolisthesis, regardless of whether they were symptomatic or not. The origin of pain remains unclear. The findings may support the assumption that disc pathology could be a primary factor in the pathogenesis of spondylolysis and olisthesis.

Complications of the external fixation test of the lumbar spine in 100 consecutive cases

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The external transpedicular fixation of spinal segments was originally introduced for the treatment of fractures of the thoracolumbar spine. Later it has also been used in attempts

to test and treat unstable conditions of the spine; degenerative disc disease and spondylolisthesis, and later combined with subsequent spinal fusions. Reported complications of the external stabilization tests are few.

Material: The rate and character of complications were analyzed in a series of 100 consecutive external fixation tests performed in 1985–1991. There were 61 female and 39 male patients. The mean age of patients was 43 (27–61) years. 69 patients had previous spinal surgery. The main indications for the test were multioperated back patients in 46 cases, isthmic spondylolisthesis in 15 and degenerative spondylolisthesis in six cases. The complications were gathered from the records. The postoperative radiographs were analyzed to register the position of the Schanz screws.

Results: 74 patients underwent subsequent anterior interbody fusion. 13 patients reported no relief of pain and the external device was removed. In another 13 cases the fixation was removed because of a complication. There were altogether 30 complications in 25 patients. The most common complication was pin tract infection, which was definite in 12 cases and probable in six. However, the infection was overcome with antibiotics in most cases and the subsequent fusion was carried out. In eight cases the frame had to be removed as a result of pin tract infection. Three neurological complications with L5 root lesion, one of which permanent, were registered. Postoperative radiographs showed eight cases with incorrect position of a Schanz screw. Three of these patients had neurological complications. The rate of complications with clinical significance resulting in removal or reapplication of the frame was 12%. No significant association of the frequency of complications to age, sex, previous operations or indications to the test was found.

The external stabilization test of lumbar spine seems to be a procedure associated with many complications. According to our results, the rate of complications is higher than reported in the literature. Therefore the indications for the test must be very carefully considered.

Direct repair of spondylolysis in first-grade spondylolisthesis

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A total of 28 patients (age range 8–28 years) with minimal symptomatic L3, L4 or L5 spondylolisthesis were operated. The operation comprised revision of the defect, local bone transplantation, and fixation of the defect with double 1.0 or 1.2 mm thick cerclage wires, the method described previously by Scott and Bradford. Two patients had an L3, three an L4 and the remaining 23 patients an L5 defect.

The overall results were good, i e the pain decreased or vanished postoperatively in 22 patients. However, six patients continued to have symptoms. Three patients were reoperated and showed non-union. Posterolateral fusion with good result was performed. Five patients had obvious secondary lumbar or thoracolumbar scoliosis: in one the curve pattern changed, in one the curve decreased and in three the curve remained the same postoperatively.

The natural history of minimal spondylolisthesis is benign and the question arises how much this is changed with this type of operation. Preoperative discography or MRI could improve the accuracy of diagnosis. Postoperatively it was very difficult to evaluate the fate of the fusion in ordinary radiographs.

Bone tumors

Large allografts in the treatment of bone tumors. Clinical results

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The skeletal defects after radical resection because of aggressive, often recurrent or malignant bone tumors of 30 patients were replaced by massive allografts during 1973–1990. The follow-up time was 5 (1–17) years. The grafts: osteoarticular (26 cases), segmental (two cases), a diaphyseal block for vertebral reconstruction and an iliac bone were harvested from healthy young persons after sudden, accidental death. The storage temperature of the bone bank was 70–80 °C. Cartilage preservatives were not used. In reconstruction, AO-plates or screws were used, ligament reinsertions and autologous bone grafting around the graft/host junction were performed. After immobilization in cast, flexion movements were started in a custom-made brace at the sixth week. Weight bearing was allowed gradually after five to six months. The postoperative follow-up included radiographs, bone scans by ^{99m}Te-diphophonate, CT, and single photon emission computed tomography (SPECT) and biopsies. The clinical results were evaluated according to Mankin's scale. The evaluation revealed excellent-good over all results in 20 cases, but osteoarticular grafts showed somewhat inferior results with late degenerative changes. Fatigue fractures and resorption changes were most common complications. Infections occurred in three patients. A high complication rate (13 patients) and reoperations characterized the material. Three amputations due to a local recurrence of sarcoma were performed. However, allograft surgery for the treatment of bone tumors is a useful method for limb salvage with acceptable functional results.

Surgical treatment of myeloma of bone

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The treatment of myeloma consists of chemotherapy and irradiation. In multifocal myeloma, surgery is usually needed because of a pathologic fracture and is aimed at reducing pain and allowing early mobilization. Intended curative surgical intervention in cases of solitary plasmocytoma of bone is combined with radiotherapy.

Patients and methods: Patients treated operatively during a ten-year period for solitary plasmacytoma or multiple myeloma were reviewed. The factors analyzed were age, sex, presenting symptom, the reason for operative treatment, site and spread of the disease, method of operative treatment and outcome.

Results: There were 33 patients, 21 men and 12 women. Their age was 54 (20–81) years at the time of diagnosis.

The main symptom was pain, but there were also four cases of paraparesis. The reason for operative treatment was an undefined bone tumor in 23 cases and a pathologic fracture in ten cases. The diagnosis was known before the operation only in six cases, in an additional four cases it was strongly suspected on the bases of radiographs. The tumor localizations were: vertebral column in 13, pelvis in six, femur in six, tibia in two, humerus in two, rib in one, fibula in one, scapula in one and olecranon in one case.

16 diagnostic biopsies were taken. In three cases this operation was followed by evacuation and stabilization, one in femur, one in tibia and one in Th X. Vertebral tumors were mainly evacuated or decompressed, combined with a stabilizing procedure in eight cases. A total of six endoprostheses, five femoral and one humeral were performed. No local tumor recurrence has been noted during follow-up.

Conclusion: We conclude that operative and oncologic treatment is successful in treating the disease locally and providing the patient with a stable, pain-free locomotion system.