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Hip prosthesis

1. Hydroxyapatite coated total hip prostheses, clinical and radiographic results after 4 and 5 years in a European multicentre study (1)

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A hydroxyapatite coated hip prosthesis designed to stimulate proximal instead of distal femoral stress transfer was studied in 637 cases. All patients had primary total hip arthroplasty and complied with the inclusion criteria of the study protocol. Although the study is ongoing, 510 patients have a minimum of 3 years follow-up, 350 have 4 years follow-up and currently there are 150 patients with 5 years follow-up.

The femoral component is a roughened titanium alloy with a 50 μ surface coating of hydroxyapatite applied to the proximal one third. A proximal press-fit technique was used with distal femoral overreaming as standard procedure. The hydroxyapatite coated acetabular cup is of hemispherical design. Analysis of the clinical results showed a mean Merle D'Aubigné score of 16.7 at 6 months, 17.2 at 1 year and this score has been maintained through to the 5 years follow-up. Residual mild thigh pain necessitating analgesics was reported in less than 2% of patients after 4 years.

The rate of loosening of both the acetabular cup and the femoral stem was less than 0.4%. Radiographic evaluation showed acetabular cup osseointegration in 635 of 637 patients and proximal femoral stem integration was also excellent (634/637).

There were 13 revisions of which 9 occurred during the first year of follow-up; after the second year of follow-up no further revisions have been reported. The indications for the revisions were recurrent dislocation (6 cases), stem loosening (3 cases), acetabular cup loosening (2 cases), severe thigh pain (1 case) and peri-articular ossification (1 case). Nearly all revisions were due to technical failures. Except for the cases of loosening no radiolucent or reactive line formation was observed around the hydroxyapatite parts of the prosthesis. Instead, femoral cancellous and cortical bone densification were seen exclusively at the transition zone of hydroxyapatite coated to uncoated parts of the stem (53% at 4 years), 4–6% showed cortical hypertrophy only at the non-hydroxyapatite coated part of the stem, whereas reactive line formation around the distal part of the prosthesis was seen in 44% after 3 years and 46% after 4 years. All these radiographic changes were particularly progressive during the first 2 years.

In general, the clinical outcome was excellent and the radiographic data pointed mainly to proximal stress transfer.

Reference: 1. Tonino A J et al. Hydroxyapatite coated hip prostheses. Early results from an international study. Clin Orthop 1995; 312: 211-225.

2. HA coated cups and PE wear danger?—retrospective study of a personal series of 118 Tropic cups with more than 6 years follow-up

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Screwed smooth ring acetabular components often fail during the first post-operative years; poor functional results, and the high revision rate are consequences of a bad fixation. With the Tropic cup, initial primary fixation is provided by the threads placed in the tropical area of this hemispherical shell. A biological bond is subsequently achieved by the HA coating.

We have already published a comparative study between two series of first and second generations cups; the results confirmed the advantages of bio-active coatings in acetabular components stability. But, nowadays, some authors focus on the danger of HA debris setting up third-body wear. The purpose of this work is to assess whether the stability improvement provided by the coating, is counterbalanced by premature wear and by severe osteolysis as the origin of a mid-term arthroplasty failure.

Patients and methods: This retrospective study concerns 118 threaded Tropic cups implanted by the same surgeon in 1988 and 1989. 22 patients were deceased or were lost from the follow-up. So, the longitudinal analysis concerns 96 hips followed over the 6th year. The femoral implant has always been a cementless HA coated Corail stem. Alumina was the material of the prosthetic heads and the diameter was 28 mm in every cases. The distribution of the cup sizes is a typical Gauss' curve. Insert PE wear was evaluated on a plain radiograph, using a transparent drawing.

Results: 1) Casuistry: Demographic data are fully representative of a standard population who underwent THA. Men 53%, women 47%; mean age: 62 years. Primary arthro-

sis (72%) is the main etiology.

2) Global clinical results confirm the score improvement due to the bioactive coating. PMA pre-op score:11.2 (n 118);17.1 by the end of the 1st year (n 109);17.2 at the 6th year (n 96).

3) No perioperative complications occured. Concerning the late complications, only 1 case of recurrent dislocation and 1 case of severe groin pain (without any clinical or radiological explanation) needed to be operated on again; the metallic shells were perfectly fixed and integrated and were not removed, and only the PE liners were changed. A microanalysis of the internal surface of these 2 sockets did not reveal any apatite cristals. If the removal of the cup is considered to be the end of the life of the prosthesis, the survival rate is evaluated at 1.00%, over the 6th year.

4) Radiological analysis confirm:

– that PE wear rate is always lower than 0.08 mm per year (less than the rate of a reference series of Titan cemented prostheses). We were not able to establish a correlation between the wear rate and different parameters taking part in the PE thickness reduction: cup diameter, weight and patients activity,

– the interface bone-metallic shell actually confirms the osseointegration of the implant: no radiolucent lines in any zone, plus a really physiological pattern of bone ingrowth. Some dense trabeculae can be observed from the top of the threads in few cases of acetabular components that are too vertical,

– the trophicity of the cortical and cancellous bone is slightly modified in the proximal femur. In 5 cases of significant PE wear, we can note calcar modifications corresponding to a progressive foreign-body granuloma. In 1 case, with slight osteopenia observed in zones 1 and 7 without any lucencies around the prosthesis, it seems to be related to a stress-shielding phenomenon.

Conclusions: This short series confirm the reliability of the secondary, biological fixation of uncemented HA coated screw cups. At the 6th year no abnormal thickness reduction can be evaluated on the PE liner correlating with third-body wear. It is a potential and theorical risk which does not seem to be specific to coated implants; calcium phospate particles are usually found on the internal surface of PE insert even if the components have not been coated with bioactive materials.

3. Femoral revision with an entirely HA coated stem. 3-7 year results

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Disappointing results have been substantiated both with cemented and uncemented femoral revision. HA coatings are known to improve bonding, which may be particularly adventageous in case of revision.

Patients and methods: 60 hips (58 patients) underwent femoral revision with the entirely HA coated Landos Corail stem. 36 women and 22 men ranged in age from 45 to 83 years (mean, 68). 44 of the removed prostheses were cemented and 11 were cementless. 5 patients had Girdlestone hips.

Results: 5 intraoperative femoral fissures healed uneventfully. One patient with persistent thigh pain was reoperated at one year. The stem was firmly anchored near the tip, while the proximal part was encapsulated with fibrous tissue. A screw in the medullary canal had probably prevented the complete insertion of the stem. A previously infected Girdlestone hip developed a chronic fistula, reaching the stem through a cortical defect. No loosening has taken place, and the hip is still painless. All the other patients had dramatically improved their hip function. Thigh pain was no problem. Some radiolucencies were seen proximally in zones 1 and 7, but no diaphyseal lines.

Conclusion: Except for one case of failed ingrowth, this entirely HA-coated femoral stem exhibits very good clinical results. Radiographic evaluation indicates extensive diaphyseal bonding, even in a case with persistent fistula.

4. Complications with an entirely HA coated total hip replacement

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Due to the well-substantiated osteotropic effect, HA coatings provide an attractive method of anchoring implants. However, there is concern about the stability of the coating.

Patients and methods: We have performed a 5–7 year prospective follow-up study of 100 consecutive total hip replacements. The straight tapered stem and the hemispherical threaded cup were entirely coated with 155 ± 35 µm HA. Ceramic or stainless steel heads were employed, mostly 32 mm. 49 cups had a minimum polyethylene thickness of 3 mm.

Results: We have found excellent clinical results, and radiographic signs of bony anchoring in all cases. Accelerating polyethylene wear was seen. Mean wear at six years was 1.1 ±1.3 mm. 6 hips were reoperated. In 3 cases without polyethylene wear-through, metallosis and matting of the steel heads were surprisingly found. Osteolytic lesions in the acetabular bone and in the greater trochanter were found in 4 cases. 5 cups loosened. At revision, there was almost complete lack of HA coating on the metal backings. We regularly noticed the disappearence of almost all HA coating on uncovered proximal parts of the stems.

Discussion/conclusion: The excessive polyethylene wear may be related to free intraarticular HA particles, and the osteolytic lesions may be due to reaction against polyethylene and HA particles. The very thin polyethylene layers have probably accelerated the wear. The loosenings may be

caused by delamination or resorption of the HA coating, possibly enhanced by reaction against particles.

5. Uncemented revision for mechanical stem failure using a HA-coated hip prosthesis

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Between 1990 and 1995, 52 failed total hip stems were exchanged to an uncemented HA-coated Omnifit prosthesis. The overwhelming majority of the explanted stems were cemented with surrounding bone defects of grade II and III according to Gustilo and Pasternak.

Results: In hips not complicated by an intraoperative fracture and followed at least one year, subsidence of 4–8 mm was observed in 6/45 cases and in excess of 10 mm in another 6 cases. Serial RSA-examinations were performed in 13 of the cases and in only one of these migration was found to progress beyond 6 months. Re-revision has been undertaken in 3 cases and one is scheduled for such a procedure. The median HHS-score increased from 80 after 1 year to 92 after 2 years.

Conclusion: Exchange of failed cemented or uncemented stem can with reasonable safety be performed using a HA-coated prosthesis, provided primary stability is satisfactory and the bone defects not too advanced. Intraoperative cortical perforations and fractures seem to heal rapidly.

6. High frequency of loosening of HA coated cups in revision hip arthroplasty

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The results of uncemented hydroxyl apatite (HA) coated hip arthroplasties in general and the use of uncemented prostheses in complicated and revision cases are far from elucidated. The aim of this study was to evaluate the survival of HA coated acetabular components in complicated hip arthroplasty.

Patients and methods: In 1990, the Atoll hemispheric acetabular component was introduced at our hospital. The metal backing consists of a titanium alloy with a rough surface covered with a layer of HA. During 1990–1993, we operated 243 cases, mainly revisions. Of these, 193 have been followed for mean 3 (3–5) years. At follow up we focused on mechanical loosening of the acetabular cup.

Results: Mechanical loosening of 10 cups was found in this material. All these cases were revisions after previously failed arthroplasties. In 5 cases bone grafting was performed, allografting in 2, autografting in 2 and combined allo- and autografting in 1. However, an unexpected observation of excessive polyethylene wear was seen in many cases.

Discussion: It is well known that the frequency of mechanical failure in revision arthroplasties is higher than in primary. In our material the frequency of failure was about 5% with a rather short observation time. Furthermore, during the year 1993 we operated 93 cases of which 71 have been followed. Of these 71 cases, 6 acetabular components have shown evidence of mechanical failure. In our opinion, this is an unacceptably high rate of loosening.

7. Localized femoral osteolysis in HA coated titanium prosthesis with steel head

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Short time results for hydroxylapatite (HA) coated prosthesis are promising [3]. However, an osteolysis rate of 32% has been reported in the proximal femur of HA coated prosthesis after 7 years follow up [2]. We have revised 6 patients for femoral osteolysis, and report the laboratory findings in these cases.

Patients and methods: 4 men and 2 women, age 40–63 years, were revised for osteolysis 2–6 years after the primary operation. The stem was fixed in 5 and loose in 1 patient. The patients with fixed stems were revised for localized osteolysis with pain. One patient had, 1 year pre-revision, clinical signs of infection with fever, elevated ESR and CRP and positive scintigraphy. The diagnosis of infection was not confirmed at revision. At revision, tissues from the osteolysis were taken for histology, and in 4 cases the head and liner, and in 2 cases also the stem were retrieved for analysis. Prosthetic components were examined under a dissecting microscope, and the liners and tissues were evaluated for particle contents by EDAX.

Results: Histology showed a dense fibrous membrane with CD-68 positive macrophages and many giant cells. In the macrophages dark particles were numerous, and in von Kossa (calcium) staining particles were found in the cases that had not been decalcified. EDAX showed steel particles and conglomerate particles (produced by corrosion). HA particles were found only in the liners. Three of the 4 heads were severely scratched, and did also show sign of surface etching. The tapers were moderately corroded, while severe corrosion was found inside the head. Measurements on digitized radiographs showed linear wear of the liner ranging from 0.2 to 0.55 mm/year

Discussion: We first thought the mechanism of osteolysis in this cases wase macrophage stimulation by HA particles [1, 4]. However, HA particles have only been found in the liners. The von Kossa positive particles were by EDAX found to be conglomerate particles from corrosion, and the

retrieved steel heads were severely corroded. Three-body wear by trapped HA particles with extensive UHMWPE production, and the combination of steel with Ti6Al4V alloy seems to be the main reason for particle production and macrophage stimulated osteolysis in these case.

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2. Geesink R G T. In: Hydroxyapatite coated hip and knee arthroplasty (Eds. Epinette J A, Geesink R G T). Expansion Scientifique Française, Paris 1995: 204–214.
3. Havelin L I, et al. J Bone Joint Surg [Br] 1995; 77B: 11-17.
4. Nordsletten L, et al. Biomaterials 1996. In print.

8. Prognosis of dislocated hip arthroplasties and the results of operative treatment

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The dislocation rate after primary total hip arthroplasty (THA) in Scandinavia has been reported to be 3–5% and somewhat higher in revisions. The treatment is delicate and not always obvious, since a dislocation often is a result of more than one suboptimal condition acting together. The purpose of this study was to determine the outcome of THA:s that have started to dislocate and to analyze the results of operative treatment in recurrent dislocations.

Patients and methods: We studied 194 hips operated on at our department between 1979 and 1994 with at least one dislocation after a primary or revision THA. More than 80% were performed with Charnley prostheses, using the lateral incision and operated on with either a transtrochanteric osteotomy or a transgluteal approach. All primary dislocations were verified by radiographs. Recurrent dislocations were treated with reoperations in 21 cases and revision with exchange of prosthetic components in 61 cases. The reasons for the dislocations were judged in detail by the surgeon and noted in the operation records.

Results: A survival analysis of all THA:s that had suffered from one dislocation, indicated that only 42% had no further dislocation or revision due to instability within 1 year. Survival rate at 3 years had decreased to 37%. The occurrence of a second dislocation resulted in a 1-year survival of 27% and a 3-year survival of 22%. Corresponding survival after dislocation number three was 20% and 15%, respectively. The survival was not influenced by age, diagnosis and primary operation.

Only 8 of 21 of the reoperations had no further dislocation within 1 year, while 46 of 75 revisions stopped dislocating. Treatment was successful in 48 of 64 cases when there was an assumed technical error to correct, compared to only 6 of 18 cases when no mechanical reason was found to cause dislocation (p=0.003).

Conclusions: Our results show that the prognosis for a dislocating hip to stabilize by conservative treatment is poor and especially if several dislocations have occurred. If a new operation is performed, the best results are found after exchange of one or both prosthetic components due to a technical error.

9. Uncemented femoral stems combined with impacted cancellous allografts for revision hip arthroplasty

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We report the results of using impacted cancellous allografts and uncemented fully HA-coated femoral stems (Landos Corail/KAR) when revision hip surgery is required in the face of lost bone stock.

40 hips (26 women, 14 men) were reviewed after mean 21 (12–36) months. The mean age of the patients at time of surgery was 67 (31–91) years.13 long stem (Landos KAR) and 27 short stem (Landos Corail) femoral components were inserted. The femoral defects were classified according to Paprosky: 1: 2, 2A: 27, 2B: 4, and 3: 7.

An average of 2 (1–4) morcellized femoral heads were spent. Initial stability of the femoral phantom was achieved before impaction started. Additional procedures as mesh, cerclage and cortical grafts were used in 10 patients.

Results:

	pre	post
Hip score[a] (max 18)	9.0 (5–13)	14.8 (10–18)
Pain score (max 6)	3.0 (2–4)	6.0 (3–6)

[a]Charnley modific. of Merle' d'Aubigne'-Postel classification

Subsidence of the stem in the femur was observed in one patient (8mm). No lysis in either of the Gruen zones was observed.

Complications: Femoral fissures appeared in 3 cases, subcutaneous infection in one and peroneus injury in one.

Conclusion: Despite our short-time experience, we conclude that uncemented fully HA-coated stems combined with impacted cancellous allografts show considerable promise when there is severe loss of bone stock.

10. Fractures of the femur in association with hip arthroplasty

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The stem of a hip endoprosthesis inserted into the proximal femur changes the mechanical conditions of the bone in several ways making it susceptible for periprosthetic fractures. Our aim was to create guidelines for their treatment.

Patients and methods: We collected a retrospective series of 140 fractures treated in 2 hospitals during 10 years. The diagnoses were: coxarthrosis in 76, RA in 12, femoral neck fracture in 24, DDH in 20 and other in 8. The prosthesis was stable in 59, loose in 49 and indefinite in 32 hips. For the present analysis we selected patients, who were treated for comparable fractures with plate or revision arthroplasty.

Results: Bone grafts were used similarly in both groups, in 21 of 46 plate fixations and in 23 of 43 revision arthroplasties. They did not affect the healing of the fracture significantly. An exact fracture position was obtained more often in the plate group ($p=0.05$, chi^2 test). 2 non-unions occurred in both groups. 21 patients with plate fixation needed 32 reoperations, while 9 in the revision arthroplasty group needed 14 reoperations ($p=0.01$). Including revisions because of loosening of the stem, 28 patients with plate were reoperated 47 times and 15 patients with revision arthroplasty 20 times ($p=0.001$).

Conclusion: Excluding cases where removal of a stable stem would result in major problems, revision arthroplasty requires a reoperation more seldom than plate fixation of a fracture associated with hip arthroplasty.

11. Cementless revision of the acetabular component—clinical and radiographic evaluation of four different types of implants

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During the period 1988–1991 we performed 91 cementless revisions of the acetabular component. Three types of screwed sockets were used: Mecron (n=15), Alloclassic (n=23), Hofer-Imhof (n=26) and one hemispherical pressfit cup Knahr-Salzer (n=27) (Figure 1).

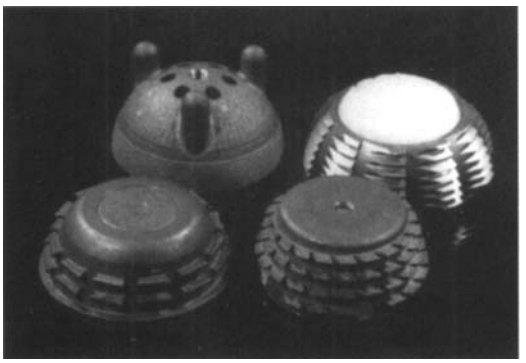

Figure 1. Cementless cups used for revisions: the Hofer-Imhof cup (parabolic; in front left), the Alloclassic cup (conical; in front right), the Knahr-Salzer pressfit cup (hemispherical; behind left), and the Mecron cup (hemispherical; behind right).

83 patients (91%) could be clinically and radiographically evaluated after an average period of 60 months; 6 patients had died and 2 were lost for follow up.

63% of the 52 revised cementless cups had loosened with some bone defects and 90% of the 39 reoperated cemented cups had caused a defect of the acetabulum (AAOS classification). Thus, for revisions of cementless components only in 30% bone grafting had to be performed, while for revisions of cemented loose cups in 51% a bone graft was necessary for stabilization (classification of Borden).

The clinical result (Harris Hip Score) was improved with the Mecron types from 44 to 68, with the Alloclassic cup from 56 to 70, with the Hofer-Imhof cup from 48 to 80 and with the hemispherical pressfit cup from 45 to 71.

The radiographic evaluation presented with the pressfit cup 48% stable, 40% probably loose and 12% loose or revised implants. The Hofer-Imhof cup had 48% stable, 9% stable after migration, 30% probably loose and 13% loose or revised. The worst results were presented by the Mecron cup with only 9% stable, 55% probably loose and 36% loose or revised. With the Alloclassic cup we could achieve the best results with 81% stable, 19% probably loose and no loose or revised cup.

Large bone defects and the resulting need for bone grafts had a negative influence on longterm stability of any type of implant used.

12. The use of an acetabulum reinforcement ring in cup revision arthroplasty—results at 9-year follow-up

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Late aseptic loosening of cemented acetabular cups present a major problem when there is also a considerable loss of bone. From biomechanic studies it is learned that in this situation it is important to restore the normal centre of rotation. Using only cement or bulk allografts to reach this aim, has proven to give insufficient results. Therefore we use morselized allografts with an acetabular reinforcement ring.

Patients and methods: From 1980 to 1988, 44 cup revision arthroplasties in 42 patients were performed because of aseptic loosening of the acetabular cup. The cup had been in situ for a mean of 8.1 years. The mean age at the moment of revision was 67.3 years. Deficiencies of the acetabular bone were classified according to the AAOS[1] classification system.

A Müller reinforcement ring was used in 28, a Burch-Schneider ring in 15, and an Eichler ring in one revision. To fill up the bone deficiency morselized bone was used from our own bone bank. Patients were followed-up and clinically assessed by the Merle d'Aubigné score and radiographically by the Harris classification[2] of loosening.

Results: Two patients with a Müller reinforcement ring were lost to follow-up. There were no early complications. 4

patients needed a re-revision after a mean of 3.5 years; 3 for deep infection and 1 for aseptic loosening. Of the other 38 hips not needing or wanting a re-revision, the mean follow-up was 9.0 (3.4–14.2) years. Using Harris classification of loosening, 3 cases showed definite loosening of the acetabular cup, but the mean Merle d'Aubigné score of this group went up from 9.2 to 14.6 at the latest follow-up. Except for the infection cases the radiographic failure rate of this method was 10% after 9 years (4/39), with a revision rate of only 3%.

Conclusion: Using morselized bone allografts and a reinforcement ring in acetabular cup revision with major bone deficiency gives good reliable long-term results.

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2. Harris W H. Femoral component loosening using contemporary techniques of femoral cement fixation J Bone Joint Surg 1982; 64-A: 1063–7.

13. Reinforcement rings in the revision surgery of acetabulum—clinical results with the uncemented modular HA Cup OCTOPUS in 2 series of 50 cases with 5 years maximum follow-up

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Recurrent failures of the acetabular component lead to a triple challenge: mechanical, biological and anatomical. In such an atrophic and destroyed bony bed, new cementation is impossible and new impaction of standard uncemended cup in grafted acetabulum is unreliable.

As Müller and Kerboul have shown, a reinforcement ring is necessary to consolidate the underground. For the uncemented option, we designed an original implant called Octopus which we presented at the NOF meeting in Reykjavik 2 years ago.

This modular anatomical component is indicated for severe acetabular destructions: stage II B and III of Paporsky or minor stages associated with dysplasia.

A multicentric study allowed us to collect 100 clinical cases: 50 from the Artro Group and 50 from other surgical teams with a follow-up ranging from 1 to 6 years (a group of 26 cases with more than 3 years will be reported)

Clinical results are based on pain notion and function. Radiological grafting behaviour is observed with some mechanical failures: we analysed the nature of grafting material, the quantity used and the procedure done.

The technique of rebuilding acetabuloplasty with an uncemented re-inforcement ring allows major revisions when megacups—with or without compacted grafting—are insufficient.

14. Joint arthroplasty in Lithuania

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Hip and knee joint arthroplasty has been practised in Lithuania since 1972. During the first stage, up to 1987, the Sivash prostheses were used, in the second 1987–1990 period, prostheses from various systems (Gerchev, Müller, Mecron, Richard's, DePuy and Intermedics), and in the third 1990–1995 period, arthroplasty with the Biomet, Mitab and Metrimed mainly cemented implants from one or two systems was used in Lithuania clinics.

The population of Lithuania is 3,751,400. We dispose no statistical data on the patients suffering from arthrosis. We suppose their number equals some 10,000–12,000. Hip arthroplasty has been performed only since 1972 and knee arthroplasty since 1991. By 1996 as many as 1,426 primary hip and 106 knee arthroplasties had been performed. 52 hip and 3 knee prostheses have been revised. The most frequent reason for revisions was loosening of a threaded cup.

In the first period, 1972–1987, 80 noncemented Sivash prostheses were implanted in one clinic.

In the second period, 1987–1990, 282 hip arthroplasties with the Gerchev prostheses in 199, DePuy in 27, Richard's in 21, Mecron in 12, Intermedics in 14, Müller in 9 were performed in three clinics. Among them 184 were noncemented Gerchev, 15 mixed and 14 noncemented Intermedics prostheses. The Mecron, Müller, DePuy and Richards prostheses are cemented.

In the third period, 1990–1995, 1064 hip prostheses were implanted, among them 1041 cemented and 23 noncemented, and 106 knee prostheses (cemented). 52 Gerchev and Sivash hips were revised. Among them 34 were due to cup loosening and 18 due to the stem loosening. In 34 cases the reason for revision was aseptic loosening and in 19 cases infection.

Among 106 knee arthroplasties, 3 were revised, 2 due to infection and 1 due to the loosening of a unicondylar tibial component.

Conclusion: Under our conditions cemented fixation of prostheses is more acceptable. Besides, taking into consideration our operating conditions, the cement with Gentamicin is more suitable for the implantation of prostheses.

15. Economical appraisals of inferior total hip arthroplasties in Norway

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In the Norwegian Arthroplasty Register several types of un-

cemented prostheses and several types of cements, have been demonstrated to have higher revision-rates than others. In this paper we have estimated the costs of some "inferior" implants compared to a reference-THA.

Patients and methods: As reference-operation was chosen the primary THA most commonly used in Norway, the Charnley prosthesis with antibiotic-containing high viscosity cement and with systemic antibiotic-prophylaxis (n 4,970). This reference-group was compared to: 1) all other primary THA (n 24,027) and to the following subgroups: 2) uncemented Ti-Fit/Bio-Fit (cup/stem) (n 173), 3) uncemented Coxa/Femora (cup/stem) (n 153), 4) THA with low-viscosity-cement (n 1,807), and 5) THA with Boneloc-cement (n 1,250). In addition, based on numbers in the literature, comparisons were also made for two earlier commonly used prostheses in Norway: 6) the Christiansen prosthesis (n 6,500) and 7) the Wagner double-cup prosthesis (n 2,200).

Results: Compared to the reference-operation, the annual extra cost the first 3–5 years postoperatively for the different groups was: 1) all other primary THA 1.71 mill. USD, 2) Ti-Fit/Bio-Fit 0.12 mill. USD, 3) Coxa/Femora 0.08 mill. USD, 4) low-viscosity cement 0.27 mill. USD, 5) Boneloc cement 0.44 mill. USD, 6) Christiansen 2.65 mill. USD, and 7) Wagner 2.38 mill. USD.

Conclusion: The extra cost each year of using implants other than a referance-THA, is equivalent to 3% of the cost of all primary THA in Norway (60 mill.USD).

16. Boneloc cemented total hip prostheses

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We have previously reported the inferior survival results (0–3 years) of Charnley prostheses implanted with Boneloc cement (1). Questions have been raised as to whether these results are specific to the Charnley prosthesis or whether other prostheses show equally inferior results.

Patients and methods: During the years 1991–1993, the Norwegian Arthroplasty Register recorded 1,196 primary arthroplasties implanted with Boneloc cement. In 955 hips the prosthesis used was Charnley and in 172 hips (from two hospitals) the prosthesis used was Exeter. No other prosthesis was used in more than 40 hips and the last group consisting of 9 different types of prostheses in 69 hips was not included in the analyses. Analyses of time to revision were done by the Kaplan-Meier method, and the level of significance was investigated by the log-rank test. The observation period was 0–5 years. The duration of survival was defined as the time to revision due to aseptic loosening.

Results: In the Charnley group the estimated probability of survival of a femoral component was 74.1% (95% confidence interval (CI) 69.2–78.9) at 4.5 years. The estimated probability of survival of a Charnley acetabular component was 92.1% (CI 89.8–94.4). In the Exeter group the estimated probability of survival of a femoral component was 97.0% (CI 94.1–100.0). The estimated probability of survival of an Exeter acetabular component was 96.8% (CI 94.1–99.6). The difference between the Charnley and Exeter femoral components was statistically significant ($p<0.0001$). The difference between the Charnley and the Exeter acetabular components was not significant ($p=0.10$). For Exeter prostheses implanted with high viscosity cement the estimated probability of survival of a femoral component was 99.4% (CI 99.1-99.7) at 4.5 year, and the results of Exeter prostheses implanted with Boneloc cement was significantly poorer (97%) ($p=0.002$). The Cox proportional hazards model with adjustment for age, sex, cement type and systemic antibiotic confirmed the results.

Conclusion: The results confirmed the previously reported inferior survival results of Charnley hip prostheses implanted with Boneloc cement. With Boneloc cement, the Exeter prostheses showed better results than the Charnley prostheses (in this limited material from two hospitals). However, Exeter prostheses also showed poorer results with Boneloc cement than with high viscosity cement.

Reference: 1. Havelin LI, Espehaug B, Vollset SE, Engesæter LB. The effect of the type of cement on early revision of Charnley total hip prostheses. J Bone Joint Surg (Am) 1995; 77 (10): 1543-50.

17. Antibiotic prophylaxis in total hip arthroplasty—a review of 8,830 primary cemented total hip replacements reported to the Norwegian Arthroplast Register, 1987–1994

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The purpose of our study was to compare the effect of different antibiotic prophylaxis regimens on the survival of total hip replacements (THRs), with a particular reference to the possible benefit of adding antibiotics to the bone cement.

Patients and methods: The study was based on 8,830 cemented THRs performed because of primary osteoarthritis of the hip registered in the Norwegian Arthroplasty Register, 1987–1994. We included only operations performed with cement- and prosthesis-brands reported previously with good results and operations where the most commonly used systemic antibiotic prophylaxis types had been applied. Cox estimated failure rate ratios adjusted for gender, age, cement- and prosthesis brand, type of operating theatre and operating time are presented.

Results: The lowest revision rate was found among THRs receiving antibiotic-containing cement plus a high total dose

(>4.0g) of systemic antibiotics (n 2,071). When comparing this regimen with the other antibiotic prophylaxis regimens, the Cox estimated failure rates ranged from a 2.7 (p=0.02) times higher failure rate for THRs performed with a high total systemic dose only (n 607) to 4.5 (p=0.0002) times higher for THRs with antibiotics in the cement only (n 232). THRs with no antibiotic prophylaxis (n 254) had the poorest result with a failure rate ratio of 7.2 (p=0.0001). The same results, only more pronounced, were found with revisions performed because of infection as endpoint. With aseptic loosening as endpoint, we found a similar although weaker pattern.

Conclusion: Our study indicates that a high total dose of systemic antibiotics combined with antibiotic-containing bone cement give fewer revisions than the other alternatives.

18. Treatment of early post operative deep orthopedic infections

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Early post operative infection after hip arthroplasty or internal fixation of a fracture jeopardizes the final result. Our experience with aggressive surgical revision and active irrigation-suction drainage in patients with deep infections is reported.

Patients and methods: Totally 13 patients, 7 female and 6 male, with a median age of 67 years were treated. All patients had clinical signs of deep infection. In 10 patients positive bacteriology was obtained. Positive cultures for *Staphylococcus epidermis* (6 patients and 1 with meticillin resistant *S. epidermis*) and *S. aureus* (2 patients) were obtained. 1 patient had a mixed flora. 8 patients had total hip replacement and 5 patients were treated for fractures with open reduction and internal fixation. The primary revision was done 12 (3-45) days after the first operation. 5 patients had one or more unsuccessful revisions with implantation of gentamycin beads before the irrigation-suction drainage was performed.

The irrigation-suction drainage was standardised: two irrigation drains were placed deep, next to the implant. Three suction drains were used, one next to the implant, one subfacially and one subcutaneously. All suction drains were put on active suction.

1 g of Fucidin added to 3 L of 0.9% saline was used for irrigation. The patients were treated for 1 week with 3 L irrigation solution per 24 hours. Parenteral antibiotics were given according to resistogram (when available) in all patients. At the follow up, the patients were evaluated clinically, radiographically and by determining the sedimentation rate and C-reactive protein (CRP).

Results: Median observation time was 13 months. 1 patient with a fracture, who was revised 3 times, died unrelated to the infection. This patient had a fistulating chronic osteomyelitis. In 12 patients there were no clinical signs of infection. Five patients are still on antibiotics. In no patients the implant had to be removed. All the fractures were clinically and radiographically healed at the last follow-up. The preoperative CRP was 71 (56–89) and the CRP at the control was 6 (3–11).

Conclusion: In 12 of 13 patients with early deep postoperative infection after internal fixation of fractures or infection after arthroplasty were healed by aggressive surgical revision and irrigation suction-drainage combined with antibiotics. The infections did not delay the fracture healing. None of the implants had to be removed. The results are encouraging. This is the choice of method at our hospitals when treating early post operative orthopedics deep infections.

19. Histological diagnosis of infection in revision of hip prosthesis

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The diagnosis of infection in total hip replacement (THR) may be difficult. Histology have been suggested as a method with high sensitivity and specificity [1].

In a prospective study we evaluated the use of histology for the diagnosis of infection. As we do not have facilities for evaluation of frozen sections in our hospital, we evaluated the use of ordinary sections fixed in formaldehyde.

Patients and methods: 31 women and 10 men (age 32–84 years) were revised with preoperative diagnosis aseptic loosening (n 29), osteolysis (4), infection (6), pain (1) and Girdlestone (1). During revision, pseudocapsule or interface tissue were fixed in formaldehyde, and 1 to 5 samples were taken for aerobIC and anaerobIC culture. Infection was diagnosed when polymorphonuclear granulocytes (PMN) were found in a loose connective tissue.

Results: PMNs were found in 11 cases. In 1 case the PMN was found in necrotic tissue and was not diagnosed as infection. In 4 of the 10 cases diagnosed as having infection by histology, culture was positive, while in one case culture was positive with negative histology. One patient had clinical infection and positive scintigraphy 1 year prior to revision, and was treated by antibiotics, but cultures were negative and histology showed no signs of infection. ESR and CRP was higher in the patients diagnosed as having infection ($p<0.02$), but there was no cut off point which clearly indicated infection. However, only 1 patient with infection had both ESR lower than 20 and CRP lower than 10.

Discussion: 12 patients in this material had a probable infection as evaluated clinically, by culture and by histology. Histology was positive in 10 of these patients, while culture was positive in 5. In 1 patient both histology and culture was negative. This study shows that diagnosing infection at revision by culture has a low sensitivity when relatively few samples are taken. Histology had a better sensitivity, and was of value for the postrevision antibiotic treatment al-

though the diagnosis came several days later.

Reference: 1. Athanasou NA, Pandey R, Desteiger R, Crook D, Smith PM. Diagnosis of infection by frozen section during revision arthroplasty. J Bone Joint Surg [Br] 1995; 77B: 28-33.

20. Total hip replacement in patients with hemophilia

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During the period 1973–1988, 13 total hip replacements were performed in 11 hemophilia patients, with mean age 46 (25–65) years. The perioperative blood loss averaged 920 mL, the mean factor VIII/IX used was 120,000 units, and the mean duration of follow-up was 83 (12-188) months. Five hips became loose within 6 years, and another after 13 years. Four hips were revised within 99-142 months postoperatively, 2 of which due to infection in patients also seropositive for human immunodeficiency virus. At the latest follow-up, 6 of 10 surviving patients were painfree and 7 of 10 patients could walk at least 1,000 meters. Although the results are inferior to those obtained in osteoarthrosis patients, total hip replacement in hemophilia patients is nonetheless beneficial, and in some cases crucial to preserve walking ability and independent living.

21. Reliability of a titanium cemented femoral stem—retrospective study of a personal series of 120 Titan prostheses with more than 10 years follow-up

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In 1995, cemented stems are still the most widely used in THR, due to the modern cementing technic and the high reliability (material, design, etc) of the present implants. This fact is supported by unequalled clinical results either in their quality or their long follow-up.

In 1982,several innovating options permitTed the birth of a new generation of implants, the Titan system: femoral stems in a polish forged titanium alloy, modularity of the prosthetic heads (stainless steel or alumina ceramic) fixed on the stem taper, allowing a choice of neck length, three-dimensional widening of the metaphyseal area—it is the stereostability concept which is more efficient than the traditionnal medio-lateral locking—and large range of implants in order to get a good fit and a constant mantle thickness.

Nowadays, some of these options are criticized (cemented versus cementless, titanium versus chrome-cobalt, modularity versus monoblock, etc). So, we thought that it could be interesting to analyse a homogeneous series of Titan prostheses with more than 10 years follow-up.

Patients and methods: This retrospective study concerns 120 Titan stems implanted by the same surgeon in 1983 and 1984. 21 patients deceased, 37 were definitively lost to follow-up. The longitudinal analysis over the 10th year only concerns 62 arthroplasties (51 patients). The femoral implant has always been a cemented Titan stem. The heads of 32mm diameter were either in stainless steel (34) or in ceramic (86). The acetabular components were either cemented PE cups (78), or metal-backed cemented cups (42). The pressurized cementing (CMW) were performed using a cement gun after inserting a plug in the medullary canal.

Results: 1) Casuistry: the high mean age (68 years) explains the rate of patients lost of the follow-up (58/120). On an etiologic plane, osteoarthritis (68%) and neck fractures (14%) constitute the most important groups. 2) Early complications were not specific and did not significantly modify the mid-term and long-term results. 3) Functional results were remarkable by their rapidity, their quality and their stability. PMA hip score: 11.3 preop. (n 120); 17.3 at 3 months (n 112); 17.45 at 1 year (n 101); 17.4 at 5 years (n 78); 17.2 at 10 years (n 62). All the revisions cases (7) concern aseptic bipolar loosening in relation with a major PE wear of the acetabular component. Slight bone damages were usual (grade II of Paproski in 5 cases, grade III in 2), and the prosthetic reconstructions were easy. Histological analysis of the different granulomas have shown a lot of wear debris of PE, and few metallic particles (titanium). The retrieved prosthetic components were analysed too: no fretting corrosion signs were observed either on the femoral stem or on the taper. 4) After 10 years of implantation, we can note, however, several radiological signs on the prostheses still in activity: significant wear of the PE of the acetabular insert, with no close correlation with the length of use, high rate of calcar remodeling and resorption (72%) with scallopping, cortical atrophy, cysts and asymptomatic granulomas slightly evolutive all along the stem, no cortical or cancellous modification of the femoral cortex in relation to potential stress-shielding.

Conclusion: Global functional results illustrate the clinical stability and the patient's satisfaction after the operation. The explant examinations do not reveal any interface problem (titanium-cement). The mechanical reliability of the taper-head junction seems to prevent any corrosion problem. The weak-point is the PE socket; apart from the design and the type of cup, some manufactured series seem to be better than others. Technical difficulties in revision surgery are in proportion with the bone damages. This fact justifies a periodic supervision of all patients operated on.

22. Landos total replacement of the hip—a 10-year follow-up study

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The Landos total hip prosthesis was introduced in Norway during 1983. The first Landos prosthesis was implanted in our hospital in May 1983 and has since then been used extensively. In a retrospective study, the patients have been clinically studied and the final outcome evaluated.

Methods: The patient records have been studied and the patients invited to a follow-up visit for radiographic examination and clinical asssessment.

The surgical technique has been standarized with the patient in the supine position with lateral approach. In the first years no antibiotic prophylaxis was given routinly but since 1987, all patients have received Keflin 2 g x 2 preoperatively. With cemented prostheses Palacos cement with Gentamicin has been used. All patients have had Macrodex as thromboprofylaxis.

Material: 405 patients (486 hips), 307 women and 98 men with an average age 71 (19–94) years had a total hip replacement. 386 patients (462 hips) had a primary hip replacement while 19 patients (25 hips) had a revision operation where the previous prosthesis was replaced with Landos total hip prosthesis.115 patients had a previous operation in the hip (fracture, dysplasia, prosthesis) and 106 patients had bilateral replacement. 410 prosthesis (84%) were cemented, 64 uncemented (13%) and in 12 prosthesis (3%) a combination of cemented/uncemented components was used.

Results: 311 hips have been assessed, 261 cemented and 50 uncemented with observation time 51 (±25) months and 39 (±14) months, respectively. There was no 30-days mortality. Six patients had a shaft fracture or fissure during the introduction of the femoral stem and one patient an injury of the femoral artery. Three patients had postoperative femoral nerve paralysis. One patient had postoperatively multiorgan insufficiency, 2 patients pulmonary embolism and 8 patients venographically verified deep venous thrombosis. Three patients had a postoperative superficial infection and one patient a deep infection necessitating open revision and drainage.

8 early luxations (1.6%) have been recorded. 2 patients (0.4%) with cemented prosthesis have been revised due to loosening of the components during the follow-up period.

Conclusion: The follow-up results of the Landos total hip prosthesis are encouraging with low incidence of complications and favorable, early survival of the prosthesis.

23. The Scientific Hip Prosthesis—design rationale and early clinical results

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The SHP hip replacement system is a new cemented system based on the hypothesis that optimal mechanical endurance of the cement mantle and its bone and implant bonds would minimize clinical failure rates. By Nummerical Shape Optimisation the shape of the prosthesis and cement mantle was computed, so that the stresses in the cement and interfaces were as low as possible and evenly spread.

Patients and methods: The author will report on his personal series of 250 SHP's, with a maximal follow-up of 4 years. The patients reached a Harris Hip Score up to ± 90 points. Complications specifically related to the prosthesis were not seen and no infections. One loosening of the cup appeared, because of improper initial placement in a case of protrusion of the acetabulum. Radiolucent lines at the cup side were noted to increase in amount with time. At the stem side, hardly any radiolucent lines were seen at the cement-bone interface. At the cement-prosthesis interface, one patient showed a radiolucency in progress.

Conclusion: The results are promising, but the follow-up is relatively short.

24. 11-year results with the Exeter and Landos Titan cemented hip arthroplasty

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We report the long term results of the first 39 stainless steel Exeter and 39 titanium Landos Titan prostheses implanted in 1983–1985.

Patients and methods: The same surgical team operated with both types of prostheses using the direct lateral approach and the pressurizing cementing technique, and the patients had the same postoperative training program and follow-up.

Results: Radiolucent lines were the same for the two types of acetabular components. 2 Titan cups and 1 Exeter cup were exchanged due to mechanical loosening. The stems had not loosened, but 1 of the Titan stems and the Exeter stem were simultaneously exhanged. Radiolucent lines were more often seen around the Exeter stems and some of them developed localized granulomas which were not seen around the Titan stems. 4 Exeter stems loosened and 1 of them fractured. 2 other Exeter stems fractured. No Titan stem loosened or fractured, but 2 were exchanged due to infection and femoral fracture.

Conclusion: The acetabular components of the Exeter and Titan prostheses seem to perform similarly after 11 years of implantation, whereas the Exeter stems perform inferior compared to the Titan stems. Cemented titanium stems have been questioned. Our results indicate that they can be recommended.

25. Total hip replacement in City Hospital, Klaipeda, Lithuania

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In the late eighties operations with Russian and Bulgarian Total Hip Replacements (THR) were partly a disaster. The rates of infections and of aseptic loosenings were unacceptably high. We had no experience with modern prostheses and had to introduce a modern type of operation and a new aseptic thinking into the existing health care system. It was done with the assistance of colleges from Karlskrona, Sweden. Education of surgeons, operation- and rehabilitation nurses were done in Sweden.

Patients and methods: No special equipment in the operating theater, like "green-house", was used. All patients received pre- and postoperative antibiotics as well as cement with Gentamicin. Heparin was given as prophylaxis. Since November 1991 till January 1996, 478 THR were operated. As main types we used Scan Hip Classical and Optima prostheses, made by MITAB, Sweden, in 403 patients. Howmedica Universal Hip System was used in 75 patients. The mean age was 61.1 years, and the diagnosis was arthrosis in 88%, rheumatoid arthritis in 2.7%, and trauma or late result of trauma in 7.4%. 14 operations were revisions.

Results: All patients were followed-up, pre- and postoperatively evaluated according to Postel d'Aubigné. We have one infection in 0.2%, dislocations 1.7%, postoperative hematoma 1.5%, thrombosis 4%, and pneumonia 3.1%. 14 operations were revisions (one aseptic loosening, one for malposition of the cup and one for exchange of stem, the rest were loosenings of earlier implanted uncemented hips from other hospitals).

Conclusion: We found that THR can be performed in a hospital like ours with results equivalent to those in western hospitals. A strict sterility disciplin, prophylactic antibiotics, antibiotica loaded cement, a modern design of prosthesis and thorough education are important.

26. PCA vs Harris-Galante (HG I) in uncemented total hip arthroplasty—a prospective and randomized study

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This study evaluated the clinical and radiographic performance of 2 cementless THA.

Patients and methods: 171 patients with a mean age of 50 (21-64) years were randomized to either a PCA (n 84) or a Harris-Galante I (n 87) prosthesis between august 1985 and mars 1989. Clinical and radiographic examinations were done every second year and up to 10 years. Four patients deceased and 1 patient was lost to follow-up. The mean follow-up was 7 (PCA: 5–10; HG: 1–10) years in both groups.

Results: 17 patients (16 mechanical loosening, 1 infection) were revised after median 67 (10–101) months after the operation. The cup was exchanged in 3 hips, the stem in 7 and in 3 hips both components were revised. In 4 hips only the polyethylene liner was exchanged. 5 of 6 acetabular components revised were of the PCA design (ns) and 7 of 10 stem revisions were of the HG type (ns). The mean Harris score was 90/94 (PCA vs. HG; $p<0.05$) and Harris pain 41/43 ($p<0.01$). Increased frequency of cups with wear ($p=0.00005$) and radiolucent lines on the AP-view was noted in the HG group ($p<0.05$), whereas the frequency of osteolysis did not differ.

Summary: The PCA prosthesis was associated with an inferior clinical result. Difficulties to measure wear of the PCA cup with a more radio-opaque metal-backing might partly explain the differences in wear between the 2 groups.

27. Excellent 5–7-year results with a threaded conical titanium cup

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Smooth hemispherical threaded cups are practically abandoned due to high rates of loosening.

Patients and methods: The Endler metal backed screw cup is conical and supplied with wide threads. The backing is made from c.p. titanium, and has a rough, blasted surface. The cup is inserted after precise reaming and thread-cutting. The first 50 consecutive hips (48 patients) operated on between 1988 and 1991 were followed prospectively. There were 27 women and 21 men, with a mean age of 63 (25–81) years.

Results: No complication related to the cup was encountered, and the clinical results were excellent. No acetabular component loosened or migrated. At the latest control, 2 reactive lines were seen in zone A and 2 in zone C, while the remaining parts of the interface showed intimate bone-implant contact. Gaps adjacent to the cup filled in regularly.

Discussion/conclusion: The excellent results with this screw cup may be related to the good stability provided by the conical shape of the cup. The insertion into wide pre-cut threads gives additional fixation and results in a press fitting of the cup against the acetabular bone. The rough surfaced c.p. titanium is also known to be adventageous as to achieving bone bonding.

28. Custom femoral stems—design principles and preliminary operative experience

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For noncemented femoral prostheses optimum contact between the stem and the inner cortex of the proximal part of the femur is considered crucial to secure good mechanical stability. An optimum contact in the most proximal areas is also generally aimed at to avoid stress-shielding of the femur leading to late loosening of the stem. Due to a great variety of the anatomical shape of the femur, an optimum contact can not be obtained in a great number of femurs by using standard femoral stems. Since 1992 we have performed a series of experimental studies to develope a CT-based custom CAD/CAM cementless femoral component. The purpose of this paper is to summarize the results of these studies and to present the preliminary operative experience.

Patients and methods: Optimal bone density level for CT-based design was studied on cadaver femurs. The femurs were scanned through various areas using Philips TX CT and a standard CT algorithm. Scanning was performed before the femurs were rasped and curretaged until no more bone tissue could be removed from the inner cortex. True contours of the rasped surface were compared to the corresponding CT scans at multiple levels to find the optimum density level for design. The optimum bone density level was adjusted after studies on cadavers of the beam hardening effect due to soft tissues. Custom femoral stems for insertion into cadaveric specimens were produced by CAD/CAM technology, using the adjusted optimum bone density level for design. Optimum endosteal contact was aimed at only proximal to a level 1.5 cm below the lesser trochanter. Proximal to the same level the stem was coated by HA. The geometry of the CAD/CAM model was modified to save some cancellous bone in the area of the greater trochanter, and to secure a safe insertion.

The micro-motion of custom femoral stems was studied in cadaveric femurs and compared to that of standard femoral stems. The changes in proximal femoral strain following insertion of the two types of components were also studied.

Results: We found that 600-700 Hounsfield units represent the optimum CT-level for CAD/CAM custom femoral stems. The biomechanical studies showed a more reliable stability of custom femoral stems compared to standard anatomic stems. Furthermore, the changes in proximal femoral strain were far less after insertion of custom stems. The clinical study confirmed that femoral stems manufactured according the described design criteria, can be safely implanted. Use of custom broaches is necessary. Use of custom stems has proved favorable in cases of abnormal shape of the upper-femur, such as deformities after osteotomies, CDH, and abnormal femoral neck anteversion.

Conclusions: The studies have shown that custom femoral stems offer biomechanical advantages compared to a standard anatomic noncemented femoral component. Such stems seem favorable in femurs with highly abnormal shape.

29. Changes in proximal femoral strain following insertion of uncemented standard and custom femoral stems

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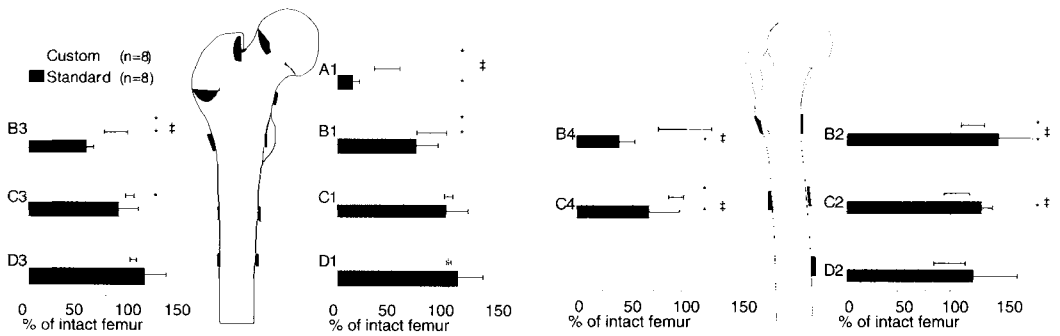
The proximal fit-and-fill of uncemented stems is considered as an important factor for the stress transfer to the bone. The objective of this experimental study was to compare the acute stress-shielding of the femur following insertion of a standard, uncemented stem and a CT-based, custom stem.

Materials and methods: Eight pairs of fresh femurs were obtained from human cadavers. Each femur was instrumented with twelve 45° strain gauge rosettes at 4 levels (Figure 1). The specimens were tested in a materials testing machine simulating a stair climbing situation, applying a joint resultant force of 1450 N and a torsional moment of 10 Nm. First the intact femurs were tested followed by repeated testing after insertion of the femoral components. In one femur of each pair of specimens we inserted an off-the-shelf, uncemented stem (Profile®, DePuy). In the other femurs we inserted a CT-based custom femoral stem made of titanium alloy and coated with hydroxy-apatite in the proximal half. During static loading strain values were recorded from each rosette element and the principal shear strain was computed according to the formula:

Shear strain = max. principal strain (E_1) – min. principal strain (E_2).

Results: The figure shows the relative changes in shear strain on twelve locations on the femur after insertion of the two different stems. At the two proximal gauge levels the shear strain was significantly reduced after insertion of both types of prostheses. At the calcar the shear strain was on average reduced by 86% and 56% after insertion of the standard and custom stems, respectively. At level B the difference in stress-shielding was less pronounced, however, the strain reduction was significantly larger for the standard stem with exception for the medial cortex.

Discussion: We have investigated the strain pattern in intact femurs and after insertion of two uncemented prostheses with different design. Compared to the standard femoral stems, the custom stems produced a strain distribution more comparable to the strain pattern in intact femurs. This phenomenon was more pronounced proximally where stress transfer to cortical bone is considered important in order to prevent bone loss. Although the pattern of strain distribution may be influenced by bone ongrowth to the femoral stem after in-vivo implantation, it seems reasonable to assume that the more favorable immediate stress distribution after



insertion of a customised femoral stem may contribute to favorable long-term results after such prostheses.

30. CAD-based preoperative planning of total hip replacements

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Preoperative planning (p.p.) of a primary total hip replacement (THR) by drawing is helpful; it allows us to foresee problems in finding the correct pivot point, as to its height and lateralisation, it helps us to choose an implant with the right CCD-angle and neck length to establish the correct offset, thus helping us to avoid unwanted leg length discrepancies and poor gait. P.p. of a complex THR is mandatory, because, due to abnormalities of the anatomy, some of the clinical intraoperative tests, i.e., tension of the capsule and soft tissue, cannot be used in order to reconstruct a proper biomechanic situation. Measuring the correct size of implants is in all cases essential so as not to overream weak bone stock in the acetabulum or in the femur.

Materials and methods: A geometric analysis of pre- and postoperative anteroposterior radiographs was done on 150 consecutive cases which have been operated on by the author after p.p. We selected cases with a normal geometry of the nonoperated side and compared it with the operated side:

Results: 1) The average (SD) postoperative leg length discrepancy was +3.4 (6.5) mm. 2) Reconstruction of pivot point geometry was in average in the x-axis +0.3 (5.6) mm and in the y-axis +0.3 (5.6). 3) Reconstruction of the offset was in average –4.3 (6.5) mm. 4) Prediction of the correct implants was possible for more than 95% of the cemented implants and more than 85% of the uncemented ones. 5) clinical relevant ectopic bone formation was below 3%. 6) the rate of postoperative dislocations was below 2%.

Conclusion: CAD-based p.p. is a helpful device to obtain a good accuracy of the postoperative geometric parameters in primary THR. This better accuracy seems to coincide with a better early functional result and maybe a better long-term result.

31. Migration of the femoral component in total hip arthroplasty—randomised evaluation between 3 modes of fixation using RSA

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We measured migration of a femoral stem (Tifit) made of titanium alloy fixated with cement (C), proximal hydroxyapatite (HA) or porous (P) coating up to 5 years after the operation.

Patients and methods: 64 THR were randomly allocated to the three types of fixation. Repeated measurements of the migration of the femoral component were done using radiostereometry. At the 2-year follow-up, analysis of Titanium (Ti) in joint fluid was done in 19 hips (10 C, 6 HA, 3 P) using atomic absorption spectrometry. Non-parametric tests were used.

Results: At the 5-year follow-up, 1 hip (P) had been revised because of loosening and fracture of the prosthetic collar and 1 patient (1 hip - C) had deceased. The mean proximal (+) - distal (–) migration and range in the three groups (C, HA, P) had reached –0.2 (–1.6 to 0.2), 0.1 (–0.9 to 0.3) and –0.6 (–3.2 to 0.3) mm (C vs HA and P: p=0.01 and 0.72, HA vs. P: p=0.08). Evaluation of conventional radiographs revealed focal (n 3) or linear osteolysis (n 2) in the cemented group. Four of these, where recordings of Ti in joint fluid were available, had displayed the highest levels (>30 ng/g) of Ti 3 years previously. The cemented hips with osteolyses also displayed increased subsidence (–0.67 vs. –0.07 mm, p=0.03) at the 5-year follow-up.

Conclusions: The most stable fixation was obtained when proximal HA coating was used. The unacceptably high failure rate in cemented group was most probably caused by increased release of titanium. The gritblasted Tifit stem turned out to be a poor cemented control.

32. Stem and socket migration following hip revision with impacted morselized allograft—a radiostereometric study

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The purpose was to evaluate prosthetic fixation by radiostereometric analysis (RSA) in cemented hip revisions with contained and impacted morselized allograft.

Patients and methods: 17 consecutive operations, 15 for mechanical loosening and 2 for deep infection, were performed in 8 men and 9 women with mean aged 76 (67-85) years. The Exeter revision system combined with contained and impacted morselized allograft from frozen femoral heads was used to revise 15 femoral components and 17 acetabular. RSA was performed in the postoperative period before mobilization and at 1.5, 3, 6 and 12 months.

Results: In 7 patients followed for 1 year there was one reinfection reoperated on three months postoperatively. In the other 6 cases, RSA revealed continuous distal migration of the femoral component (1.27–4.46 mm at 1 year) including 1 case of pronounced migration combined with femoral shaft fracture 5 months postoperatively. Continuous cranial migration of the acetabular component was found in 4 cases (0.69–2.50 mm at 1 year), but 2 were fixed in a stable position. Similar migration patterns were seen in the remaining 10 cases until now followed for less than one year.

Conclusion: In cemented hip revisions with contained and impacted morselized allograft the prosthetic components continue to subside into the allograft up to 1 year postoperatively. Prolonged RSA follow-up can determine whether subsidence continues for more than 1 year

33. Migration of cemented versus uncemented hydroxyapatite-coated implants in bilateral simultaneous THA—a radiostereometric analysis of 21 patients

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Patients and methods: 21 patients with bilateral, primary arthrosis of the hip were included; 9 men and 12 women; median age 58 (47-71) years. A hydroxyapatite (HA)-coated or cemented prosthesis (Omnifit, Osteonics) was randomly allocated to either side. Tantalum beads (0.8 mm) were implanted into the pelvic and femoral bone as well as into the polyethylene of the sockets. The stems had 1.0 mm tantalum beads inserted by the manufacturer. Radiostereometric analysis (RSA) was performed postoperatively, and again at 3 months (n 20), 12 months (n 21), 24 months (n 15) and 36 months (n 12). RSA-results are presented as proximal migration of the socket and longitudinal migration of the femoral stem.

Results: There was no difference in proximal migration between the two socket models (p=0.4; MANOVA test). There was no overall difference in longitudinal migration of the stem (p=0.15; MANOVA test). In a test of parallelism, however, the cemented stems proved to proceed in migration more than the HA-coated stems (p=0.00003).

Discussion: HA-coated stems displayed initially a longitudinal migration, which then leveled off, as opposed to the cemented stems. No difference was observed for the sockets.

34. Migration of hip prostheses fixed with Cemex or Palacos cement

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Heat and release of toxic monomers from the cement is supposed to be an important reason for loosening of hip prostheses. This study aimed to compare Palacos and a low temperature curing cement, Cemex, regarding implant fixation and biologic response of bone.

Patients and methods: 50 THR with arthrosis were randomised to cementation with either Palacos R or Cemex Rx bone cements. All patients received a Lubinus SP 2 prostheses with a Ti-Al-V femoral component. The fixation of the components was recorded up to 1 year using radiostereometry and blood samples measuring bone turnover (P1CP, 1CTP) were obtained.

Results: At 1 year the mean horizontal, longitudinal and transverse *cup* migration reached 0.13/0.28, 0.21/0.23 and 0.15/0.13 mm (Cemex/Palacos, not significant). The mean rotations around the three axes varied between 0.31° and 0.58° without difference between the groups. The *stem* subsided a mean of 0.14 and 0.12 mm (0–0.44) in the two groups (C/P) with a significant subsidence inside the cement mantle (>0.2mm) in 0/4 cases. The stems rotated 0.21°, 0.70° and 0.17° around the x, y and z axes, with no differences between the groups.

The clinical results (Harris hip score) and the levels of bone collagen markers in serum did not differ either.

Discussion: Mjöberg 1986 found less early migration with a cold curing cement, and Thanner found a poor performance of Boneloc cement, where the methyl methacrylate was partially substituted. The fixation of our THR and the biologic response of the bone in terms of bone collagen markers was not influenced by the type of cement used, suggesting that the damage to bone was equal in the two groups.

35. Migration of uncemented HA coated press fit cups in hip revision surgery

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In hip revision surgery, uncemented porous coated press-fit cups have displayed superior mid-term results compared with cemented ones. The purpose of this radiostereometric study was to evaluate the early fixation of HA coated cups in revision surgery.

Patients and methods: Because of aseptic loosening, 29 revisions were done with a grit blasted titanium cup coated with 75 µ HA (ABG, Howmedica) with additional screw fixation. Acetabular defects were filled with a mixture of morsellized allo- and autograft bone.

Results: After 2 years the medial-lateral migration reached 0.36 mm, proximal-distal 0.21mm, anterior-posterior migration 0.49 mm and the rotations about 0.6° around the three axes. Mean wear rate was 0.1 mm/year. The preoperative osteolyses or the extent of used bone graft had no influence on the migration, but a low body weight implied increased medial-lateral migration and rotation around the x-axis (p=0.004 and 0.03, resp.; stepwise linear regression). The length of radiolucent lines decreased the first 2 years but when found, a proximal zone on the AP view implied increased migration (p=0.0004).

Discussion: The HA coated press-fit cup displayed small micromotions even when used in revisions with cavitary defects and bone transplant. Maintenance of stability up to 2 years, reduction of postoperative gaps and a comparatively low wear rate indicate that a HA coated cup fixed with screws is a favorable alternative in acetabular revision surgery. However, the efficacy of the ABG cup has to be further evaluated since the effect of continuous graft remodelling and the biologic response to wear particles can only be established in long-term studies.

Posters

36. Femoral cortical resorption and fracture induced by Dall-Miles cable wires in hip revisions

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In prosthetic hip revisions according to the Exeter exchange method, Dall-Miles cable wires were used yielding complications.

Patients and methods: Cable wires were used in 6 patients aged 72–81 years; in 2 cases to treat proximal femoral fracture and in 4 to prevent fracture during stem insertion.

Results: 3–8 months postoperatively, the 4 patients with 3 or more wires each complained of increasing pain in the thigh. Radiography disclosed cortical resorption along at least 1 wire in all 4 cases and femoral fracture with angulation in 3. All wires were extracted and the 3 femoral fractures were aligned and stabilized with a cemented long stem prosthesis in one case and a long AO compression plate in 2. All 4 cases healed uneventfully within 6 months. 2 patients with one wire each had no pain or radiographic cortical resorption and were not reoperated.

Conclusion: Dall-Miles cable wires can cause cortical resorption leading to femoral fracture.

37. The Anspach system for removal of fractured stem in total hip replacements

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Fracture of a femoral component in total hip replacement (THR) is a well known complication with a reported incidence from 0.23% to 19%. A fractured stem will in most cases necessitate a revison. The distal part of the stem is often solidly fixed in the femoral canal and impossible to remove without making a fenester below the tip. This procedure increases morbidity with weakening of the bone and requires a long-stem prosthesis. We present our early experience with a new extraction device.

In the period 1993–1995, we have used the Anspach 65K Extractor 111 Biomet, Denmark, for retrieval of 8 broken Charnley stems. With a high speed carbide cutter a hole is made in the fracture surface of the stem and secondarily undercut with a conical drill. An extractor rod is then fixed by means of a small malleable sleeve impacted over the rod head. The broken stem is then extracted antegrade with help of a slide hammer attached to the rod.

We have extracted 6/8 stems without any problems. In 1 case the hole in the fracture surface was made too wide and in 1 case the hole was partly outside the stemside, due to free hand drilling, which in both cases resulted in insufficient grip of the extractor. These stems were removed retrogradely with instrumentation through a distal fenester followed by a long stem re-THR.

The above problems may be avoided by use of either an oversized head of the extractor rod, which is now delivered together with the instruments or a longer drill, which can protrude further through the drill guide, which in case of very oblique fractures may collide with the upper fracture corner. Both of these proposals are now delivered together with the instruments. The method is easy to use, shortens the revision surgery time, reduces morbidity and can thus be recommended in case of a broken femoral stem.

38. Proximal femoral strain—in-vitro and in-vivo measurements

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In the biomechanical literature it is disputed whether the proximal femur is subjected to bending during physiological loading. The aim of this study was to measure the strain on the proximal/lateral femur in an experimental hip model including the simulation of the abductor muscles and the iliotibial tract. In addition, in-vivo strain on the femur was measured in two patients during single leg stance and walking.

Material and methods: In-vitro experiment: One strain gauge rosette was glued to the proximal/lateral aspect of 9 human cadaver femurs. The specimens were loaded in a mechanical hip simulator with a resultant force of 1450 N on the femoral head. The axial and principal strains were measured during simulation of three different configurations of lateral muscular constraint: 1) abductor strap (ABD) alone, 2) ilio-tibial band (ITB) alone and 3) ABD and ITB combined with equal force in the two straps.

In-vivo experiment: Two women were operated on for a "snapping hip syndrome" in local anesthesia. A strain gauge rosette was glued to the proximal/lateral femur 35 mm distal to the greater trochanter. The wound was temporarily closed and outputs from the strain gauges were measured during single leg stance, stair climbing and level walking on a force platform.

Results: See Table.

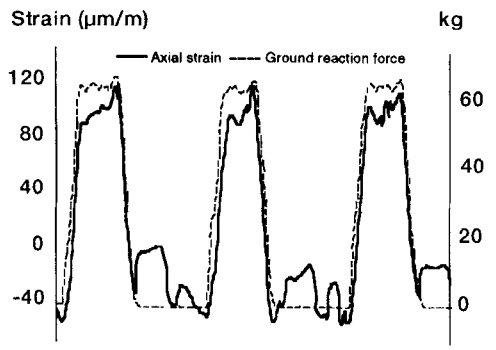

Figure. Dynamic in-vivo measurement of lateral femoral strain during walking on a force platform. Tensile strain is positive, and compressive strain negative.

Conclusion: Our in-vitro strain measurements show tensile axial strain at the proximal/lateral femur in a loading configuration simulating the action of the abductor muscles (ABD). The ITB loading configuration reduced the lateral axial strain by 45% whereas the combined ABD and ITB configuration reduced the axial strain by 26% compared to the ABD configuration. During in-vivo strain measurements in two women we consistently recorded tensile strain on the proximal/lateral femur during several loading situations of the extremity.

39. The diagnosis of deep vein thrombosis after hip replacement surgery—a clinical and venographic study

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Hip replacement is associated with a high frequency of postoperativ DVT. As a part of an on going multicenter study dealing with prolonged thromboprophylaxis, we performed a substudy at our department to find out if routine bedside questioning and examination by the visiting doctor possibly could discover DVT formation in the legs of the operated on patients.

Patients and methods: Written informed consent was obtained from 84 patients (64 women and 20 men) with mean age 75 (47–87) years. Thromboprophylaxis (dextrane, low molecular weight heparine and graded elastic stockings) according to the protocol was given. Bilateral venography was performed on all patients on day 7 (±2 days) after the operation.

Results: No patients were suspected by the visiting doctor to have DVT. Venography visualized an overall DVT incidence of 15% (13 women). 7 of the patients had thrombosis in the calf, 4 patients had thrombosis both in the thigh and calf and 2 had thrombosis in the thigh. Bilateral DVT in the thighs were found in 1 patient. In 10 patients DVT was visualized in calf of the operated side and in 2 patients in the calf of the nonoperated side.

Discussion: Although almost every sixth patient had DVT during their hospital stay, none were suspected to have DVT by the visiting doctor. This may be due to obligatory postoperative painful and swollen legs of the patients which effectively mask signs and symptoms of DVT. This emphasises the importance of improved thromboprophylaxis to further

Table. In vitro and in vivo measurements of proximal femoral strain

	In vitro (n=9)			In vivo (n=2)	
	ABD	ITB	ABD+ITB	Pat. 1	Pat. 2
Axial strain[a] (μm/m)	1982 (±407)	1040 (±268)	1442 (±320)	1266	1260
Principal strain (E1)[a] (μm/m)	1993 (±412)	1054 (±270)	1454 (±324)	1406	1281
Direction of E1	0° (±4)	0 ° (±6)	0 ° (±5)	20°	–8°

[a] 0° = longitudinal axis of femur

minimize the risk of thromboembolic complications since subclinical DVT may represent a source of fatal pulmonary embolism after hospital discharge.

40. Uncemented hip arthroplasty in patients under 30 years

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Secondary arthrosis of the hip in younger patients traditionally has been treated by arthrodesis. Today, however, most persons refuse a hip fusion. Total arthroplasty, then, may become the only alternative to disability.

Patients and methods: During the years 1989–1991, we have operated on 11 female and 8 male patients with uncemented total hip replacement; all of them were totally disabled because of unilateral arthrosis in 17 cases and bilateral in 2. The age of the patients ranged from 15–30 years. The causes of arthrosis were sequele of congenital dislocation, Calve-Legg-Perthes' disease, osteonecrosis, epiphysisolysis, coxitis and fracture. The patients have been followed for 4–6 years.

Results: Prior to operation, all patiens were disabled from work/school, 14 used daily analgetic drugs and 8 were in need of crutches. At follow-up, all the patients had returned to work/school, 2 for only 50%, and no one used analgetics or crutches. Two patients had been reoperated because of mechanical failure, and at follow-up, stem loosening was found in one case. However, in many cases excessive wear of the polyethylene cup was observed.

Conclusion: Although long-term results of total hip arthroplasty in younger patients are uncertain, these patients return to normal way of living in an extremely important phase of their life. However, polyethylene wear in these cases seem to be a major problem.

41. Prognosis of total hip replacement—surgical and cemented technique in THR—a revision-risk study of 134,056 primary operations

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Register studies can be used for describing the efficacy of a surgical procedure. Type of implant, the surgical and cementing technique are important factors for the long-term outcome of THR.

Methods: All THR producing units in Sweden report yearly specific details concerning implant, surgical and cementing technique. Copies of the medical records for all revised THR are collected and computerized. Poisson models are used to estimate the hazard functions for revision due to aseptic loosening and septic loosening for different types of implant, surgical and cementing technique and time after the index operation. The material is classified in an old, early and modern cementing technique.

Material: The result of 130,000 primary THR are presented. The range of follow-up is 3–15 years. 322,001 observation years and 3,862 revisions are the basis for the statistical analysis concerning cementing technique. 20 different implants are included in the presentation.

Results: Survival curves with revision for septic and aseptic loosening as failure end-point definition are presented. Tables with risk ratios based on different gold standards with respect to both implant and implantation technique show up to 600% increased risk for certain implant designs compared to the average implant. The improved cementing technique reduces the risk for revision due to aseptic loosening with more than 25%. The included hip replacement system shows different degree of improvement for different designs; not all implants have an improved long-term behaviour in spite of a more sophisticated implantation technique.

Conclusion: The type of implant and fixation mode proved to be detrimental for success or failure. The surgical and cementing technique was of outmost importance for the long-term prosthetic survival. Different implants seem to have different sensitivity to improved implantation technique.

42. Migration and inducible displacement of an anteverted femoral stem with HA-TCP coating

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The aim of this study was to measure micromotions of an anteverted femoral stem with extended hydroxyapatite (HA) coating, using radiostereometry (RSA).

Patients and methods: 21 patients were operated on. The proximal porous coating was supplied with 75–100 µm layer of HA (75 ±15%) and tricalciumphosphate (TCP) to balance. Distal to the porous surface the stem was coated with HA leaving only the distal third without any coating. Repeated supine RSA examinations were done up to 2 years. At 24 months RSA examinations were also undertaken with the patient standing on both legs and thereafter on the operated leg with the hip in about 15°–20° of flexion. The precision (mean ±2.9 SD) was 0.26 mm for translation of the stem center and varied between 0.4° and 1.7° for rotations.

Statistics: Wilcoxon Matched-Pairs Signed-Ranks Test. Mann-Whitney U-Wilcoxon Rank Sum W Test.

Results: Two years after surgery the mean subsidence was 0.09 mm. Rotations about the three cardinal axes were small (mean < ±0.4°). When standing on 2 legs a minimum mean proximal migration of 0.06 mm was recorded. This proximal migration increased to 0.15 mm ($p<0.05$) and rotation in valgus (0.1°; $p<0.05$) was noticed when standing on one leg.

Conclusion: The small migration data up to 2 years are compatible with results earlier presented for other designs of cementless stems with a proximal HA-coating and indicates a favorable clinical result up to at least 5-8 years. Proximal inducible displacement of the prosthetic center during weight bearing might be an effect of high resistance to subsidence in combination with smaller resistance against tilting movements.

Knee prosthesis

43. Wear assessment in a total knee arthroplasty

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The purpose was to detect clinically significant wear of the heat pressed high density polyethylene tibial insert in a 5–10 year follow up of a large material of PCA total knee arthroplasty.

Patients: In the Dept. of Orthopedics, Malmö General Hospital from 1982–1987, a total of 323 patients (352 knees) were operated on with PCA total knee arthroplasties due to arthrosis or rheumatoid arthritis. In 1992, 120 had deceased and 42 could not or would not participate in a follow-up examination, leaving 158 patients (181 knees) to be examined. 129 patients (139 knees) had arthrosis and 29 (42 knees) had rheumatoid arthritis.

Method: Clinically, the HSS score was used. Radiographic examination consisted of exposures in provoked varus and valgus. The tibial inserts were measured on a digitizing table. Wear was calculated after correction for magnification.

Results: After a mean follow-up of 84 (58–116) months wear was significantly higher for patients with OA than RA, i.e.; 1.4 vs 0.7 mm medially ($p=0.0001$)) and 0.7 vs 0.4 mm laterally ($p=0.01$). A low age or varus alignment contributed slightly to the amount of wear. 7 knees had obvious tibial insert fracture, which led to direct revision. In the remaining 6 knees the suspected wear was verified by arthroscopy and followed by revision. Revision of the whole knee was performed in 2 knees due to wear into the metal tray and in all other knees the tibial insert was replaced. Delamination wear was found in all knees and in some knees combined with insert fracture. One investigated knee was found to be mechanically loose. Prior to this study, 4 knees had been revised due to wear, 7 knees after mechanical loosening, and 4 knees due to infection. In the records of the deceased patients there were no clinical signs of wear reported such as synovitis with instability.

Discussion: Wear of the polyethylene tibial insert may be caused by delamination wear in the heat pressed polyethylene tibial inserts. Our clinical and radiographic 5-9 year follow-up of 352 knees revealed a 6% revision or recommended revision rate due to delaminating wear tibial insert of the PCA total knee. The failure due to mechanical loosening in our study revealed only one knee. Thus the delaminating wear exceeds any other factor causing revision.

44. Cemented total knees in patients suffering from osteoarthrosis and rheumatoid arthritis—a Norwegian multicenter study of survival

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The rate of success with total knee arthroplasty is affected by many factors. One topic discussed is the influence of diagnosis on the long-term result.

Patients and methods: 1701 patients had cemented RMC/Tricon total knees implanted at 21 Norwegian hospitals from 1978–1991. Of these arthroplasties 39% were in knees affected by osteoarthrosis (OA), 54% by rheumatoid arthritis (RA), and 7% by posttraumatic and other arthritides. The mean age at operation was 66.5 years, 73 years for OA patients and 63 years for RA patients. The patients in both groups were about 80% women and 20% men, and about 1/3 of the patients had previously been operated on in the index knee.

Results: Revision was performed in 4.1% of the 1701 arthroplasties. The failure rate was 4.2% for OA patients and 4% for RA patients. There were more revisions due to infection in the RA group than in the OA group. In the OA group aseptic loosening and instability seemed to be the major causes of revision. The Kaplan–Meier survival analysis revealed a 12-year survival of 91.4% for the total knees. The survival rate was 87.3% for AO patients and 92.4% for RA patients (ns). Patients who were 60 years or less or had been previously operated on, had a lower 12-year survival rate than patients above 60 or previously not operated on. The survival rate of patients above 60 years and without any previous operation in the knee was depending on the diagnosis. RA patients had significantly better survival rate of their total knees than OA patients (98% versus 88%).

Conclusion: In this study there was no great difference in the survival rate between prosthesis in OA and RA knees. The main variables of importance for a good result of a total knee implantation were age above 60 years at operation and no previous surgery performed on the knee. Given these two premises also a diagnosis of rheumatoid arthritis was favorable to osteoarthrosis.

45. Tibial component fixation after major bone transplantation in total knee arthroplasty

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The purpose was to study the fixation of a cemented tibial component where major autogenous bone grafting was used at surgery due to deficient bonestock.

Patients and methods: 9 patients, 6 men and 3 women, with a mean age of 68 (50-86) years were operated on by TKA of resurfacing type. There was a deficient bonestock due to advanced OA (7) or due to defects from a previous arthroplasty (2). Bone grafting was performed by screwed solid autologous bone (8) or homologous bone from the bone bank (1) to the noncontained decfect which engaged at least half of one of the tibial condyles.

Results: At 6 (2–9) years follow-up the clinical results were excellent (7) , good (1) or fair (1). In the one knee with fair clinical result, RSA showed a migration of 16.3 mm. This was the only case operated on by homologous bone grafting. The mean migration in the remaining 8 knees was 0.5 (0.2–1.5) mm.

Conclusion: Cemented tibial components supported by major autologous bone graft had a migration pattern similar to cemented nongrafted tibial components.

46. 8–11-year follow-up of the Biomet AGC 2000 total knee

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The aim was to study the survival and function of the Biomet AGC 2000 total knee after a follow-up of 8-11 years.

Patients and methods: 66 patients with with 73 knees operated on between April 1985 and Sept.1988 were followed for mean 9 (7.5–11) years. 7 patients had both knees replaced, the second knee was operated on 7 (4–9) months after the first.

Results: 51 knees were operated on because of osteoarthritis, and 22 because of rheumatoid arthritis. 34 knees had had previous surgery (synovectomy 13, osteotomy 12, prosthesis 5, meniscus surgery 4). 20 patients (23 knees) died during the follow-up period, all of diseases unrelated to the knee surgery or the prosthesis. Time between surgery and death was 6 (2–9.5) years. None of the prosteses in this group had been revised.

1 prosthesis was removed 13 months after surgery because of deep infection, 2 other patients had signs of deep infection that resolved on antibiotics and the prostheses have since worked well for 7 and 10 years, respectively. 2 were reoperated beause of patellar problems (one rupture of the patellar ligament, one disintegration of a metal backed patella). Of the remaining 49 knees, 29 have a good function, 8 fair and 1 poor, while 11 have not yet been to a follow-up examination.

Conclusion: The Biomet AGC 2000 total knee gives satisfactory results in rheumatiod arthritis and in osteoarthritis after 8–11 years.

47. Does a previous high tibial osteotomy influence the fixation for a future knee prosthesis?

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The purpose of this study was to investigate if the fixation of the tibial component differs between primary arthroplasties and those performed as a revision after a high tibial osteotomy as measured using radiostereometric analysis (RSA).

Methods: 26 patients with a previous closed wedge osteotomi were identified in the RSA data base and matched with patients operated on with a primary prosthesis. The time from the proximal tibial osteotomy to the prosthetic operation was a mean 11 years. The clinical evaluation included quantitative knee rating and radiographic analysis.

Results: 4 patients in the osteotomy group later had a prosthetic revision, and one patient was revised twice. In the group operated on with a primary knee arthroplasty one patient was revised (p=0.2).

There were no differences between the two groups regarding the MTPM at 1 year (p=0.6; MTPM osteotomy group was 1.2 ± 1.4 mm and for the primary prosthetic group 0.8 ± 0.6 mm). At 2, 5 and 10 years there were no differences. There were no differences in alignment or prosthetic position, nor in the clinical rating.

Discussion: Even if there was a slightly increased migration and some more revisions (not significant) in the group operated on by TKA after a previous osteotomy, a previous high tibial osteotomy does not invalidate fixation and quality of a later TKA.

48. Results after revision for failed knee arthroplasty—a clinical and radiostereometric study with up to 2-year follow-up

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Revision for failed knee arthroplasty have shown results inferior to primary TKA in retrospective studies. Prospective studies of knee revision have been sparse. In a prospective

manner we have treated all consecutive revisions according to a specified protocol and analyzed the results with radiostereometric analysis (RSA).

Patients and methods: Treatment protocol: 1) Failed uniprostheses were revised using standard TKA with stemmed tibial component. 2) Failed TKA with no instability and only minor boneloss were revised using slightly modified standard TKA (PCA or Miller-Galante revision prostheses). 3) Failed TKA with instability and/or boneloss were revised using bone graft and special modular TKA revision prostheses with press fit intramedullary rods (IB2 CCK, PFC revision or AMK-Coordinate). All components were cemented, however, the stems were not cemented. 47 knees were operated on: 18 (group 1), 15 (group 2), and 14 (group 3). Mean age was 68 years in all groups. Fixation of the tibial component was investigated using RSA regularly up to 2 years. The clinical results were assessed with Knee Society knee score. The results were compared with 26 primary TKA:s in patients with OA (mean age 72).

Results: A) Migration: Revision for failed uni prostheses (group 1) displayed migration almost equal to primary TKA, however anterior/posterior tilt tended to be slightly larger. Revision for failed TKA with the PCA or MG revision prostheses (group 2) revealed migration 2 times larger than primary TKA. Typically there were tilting of the tibial components into varus/valgus or anteriorly/posteriorly. The migration in group 3 was also about twice that of primary TKA. Typically there were only minor tilting of the components, but rather subsidence of the entire tibial component into the tibia. In all groups about 50% displayed continuous migration during the second year.

B) Clinical results: Preoperatively the failed TKA:s had lower knee scores than the group with primary TKA. Postoperatively there were no differences between the groups with revised TKA and the group with primary TKA, all reaching a knee score of 92–94 at 2 years.

Conclusion: Revision for failed uni-prosthesis displayed equal migration as primary TKA, which is in accordance with the findings in the Swedish Knee Registry. The PCA and MG revision prostheses tended to tilt significantly indicating that the stems were inadequate or that the stems should have been cemented as well. The special modular revision prostheses were used in the most serious cases with instability and boneloss. They displayed minor tilting due to the press fit stems. The increased subsidence of the entire tibial component were probably due to insufficient intraoperative impaction of the bone graft. This calls for better bone grafting techniques.

49. Noncemented or cemented total knee?—a Norwegian multi-center study of survival

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With the improved results of cemented total knee arthroplasties the indications have been expanded to younger patients. Since this set higher claims to durability of the implant, noncemented fixation has been devised as an alternative to cemented fixation in an attempt to diminish loosening.

Patients and methods: 221 noncemented and 1,219 cemented RMC/Tricon total knee prosthesis were implanted at 21 Norwegian hospitals from 1985–1991. In the noncemented and cemented group the mean age of patients at operation was 68 years, and the women/men ratio was 4/1. In the noncemented group the ratio of arthroplasties performed in knees affected by osteoarthrosis versus rheumatoid arthritis was greater than in the cemented group, 2.3 versus 0.9, respectively. About one third of the patients had had previous surgery in the index knee.

Results: Revisions were performed in 4.1% of the arthroplasties in the noncemented group and 3.2% in the cemented group. Infection was a more common cause of revisions in the cemented group, whereas aseptic loosening dominated as the cause of revision in the noncemented. Whether the arthroplasty was cemented or not, had no significant influence on the 7-year survival rate which was 92%. In the noncemented group, total knees in patients 60 years or less had a significantly lower survival rate than in patients above 60. In the cemented group total knees in patients who had been operated in the knee previously had a lower survival rate than previously not operated.

Conclusion: In the current study, the 7-year follow-up of noncemented and cemented total knee arthroplasties shows no difference in general survival rate. However, for patients younger than 60 cemented total knee arthroplasties had higher survival rate than noncemented. We found no indication that noncemented total knees were superior to cemented ones.

50. Cemented, porous-coated and hydroxyapatite-coated tibial implants in TKA—a randomized radiostereometric study

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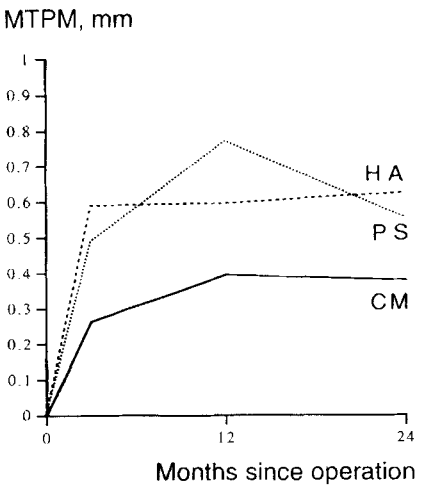
We performed a prospective RSA study in 90 patients to compare three different types of fixation of the tibial component.

Patients and methods: 90 patients, mean age 72 (59–80) years, with primary arthrosis of the knee, were operated on with the Press Fit Condylar knee (Johnson and Johnson). With respect to the tibial component, randomization was made into three groups; cemented (CM), porous coated (PS) and hydroxyapatite coated (HA). Radiostereometric analysis (RSA) was performed at 3 months (n 68), 12 months (n 68) and 24 months (n 34). Results are presented as maximum



migration (MTPM).

Results: The median values of the MTPM in the 3 groups are plotted in the Figure. CM migrated less than PS and HA at all time points (p=0.001–0.03; Mann-Whitney test). There was no difference between PS and HA (p=0.3–0.9).

Discussion: Uncemented tibial components migrated more than cemented ones. In TKA, HA-coating does not seem to imply any advantage over porous-coating with respect to early micromotion.

51. Cementless fixation using hydroxyapatite coated tibial knee implants

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The purpose of this study was to measure the micromovement for HA coated knee prostheses compared to standard porous coated implants.

Method: 62 patients were randomized to 4 noncemented groups: group 1) porous-coated Osteonic 7000 tibial component, group 2) as group 1 using a standard saw blade, group 3) HA-coated Osteonic tibial component, and group 4) HA- and porous-coated Duracon tibial component. In group 1, 3 and 4 the bone cuts were made by a cooled saw blade.

All patient were followed clinically and by radiostereometric analysis (RSA). The one year results are presented.

Results: There was no difference between the groups regarding clinical outcome. One knee was revised (group 2) after one year due to loosening of the tibial component. The maximum migration (MTPM) at one year was 1) 1.7 mm, 2) 1.9 mm, 3) 1.3 mm and 4) 1.0 mm (p<0.05; group 2 vs. 4). The inducible displacement was 1) 0.6 mm, 2) 0.5 mm, 3) 0.4 mm and 4) 0.4 mm. (p<0.05; group 1 vs. group 3 and 4).

Discussion: HA coating had a slight effect on the tibial component fixation. The RSA results for HA-coated components were the same as identical cemented tibial components in comparable consecutive studies.

52. Does HA/TCP improve fixation in uncemented total knee arthroplasty?

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Bone ingrowth is a prerequisite for stable fixation of uncemented implants with a porous coating. The addition of ceramic on a titanium mesh have in animal studies proved to enhance bony ingrowth. In this study we used radiostereometry (RSA) to measure the migration of the tibial component in total knee arthroplasty with identical design of the joint area and titanium-mesh undersurface, with and without a ceramic coating.

Patients and methods: 36 patients (40 knees) with osteoarthrosis were randomized to a Miller-Galante II prosthesis with or without ceramic coating (thickness: 80–130 µm, hydroxyapatite 65% and tricalciumphosphate 35%). RSA examinations were done postoperatively, at 2 months and 1 year. 30 knees have a complete follow up (clinical scores, RSA).

Results: At 1 year, the mean HSS-score was 88 with 95% good or excellent in both groups (n.s.). With RSA evaluation at 2 months and 1 year the mean maximal total point motion (MTPM) was 0.5 and 0.6 mm in the group with no ceramic and 0.3 and 0.5 mm in the group with HA/TCP (n.s.). Rotation around the transverse axis (anterior-posterior tilt) was 0.3° / 0.6° and 0.2° / 0.3°, respectively (n.s.).

Conclusion: The migration of the Miller-Galante knee was small. Adding a ceramic coating aimed to be resorbed or dissolved from the titanium mesh during the postoperative months did not improve the fixation.

53. BMD of the proximal tibia and migration of the tibial component after uncemented TKA

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The quality of the subchondral trabecular bone of the proximal tibia has been considered the critical biological determinant for the fixation of the tibial component in uncemented total knee arthroplasty.

Patients and methods: 22 patients with primary knee arthrosis had a preoperative measurement of bone mineral density (BMD) in the proximal tibia prior to uncemented to-

Table. Influence of weight relievement on tibial migration (abstract 54)

	MTPM (mm; mean,SEM)			Inducible displacement
	6 weeks	1 year	3 years	1 year
Weight bearing	0.63 (0.09)	1.09 (0.18)	1.04 (0.13)	0.48 (0.06)
Weight relievement	0.75 (0.12)	1.09 (0.15)	1.22 (0.12)	0.47 (0.05)

tal knee arthroplasty (TKA) with the PCA Modular® knee. BMD was measured in the coronal plane of the proximal tibia by dual photon absorptiometry (Gammatec GT-50 tibia 1a) in the trabecular bone below the subchondral plates. 6 weeks (n 21), 1 year (n 22), and 3 years (n 19) postoperatively micromotions of the tibial component were calculated by radiostereometric analysis (RSA). The relation between migration of the tibial component expressed as maximal total point motion (MTPM) and preoperative BMD was evaluated by linear regression analysis with calculation of the p-value and the coefficient of correlation (r).

Results: Regression analysis showed that a positive relation between BMD and MTPM after 6 weeks ($p=0.03$, $r=0.47$), 1 year ($p=0.0005$, $r=0.68$), and 3 years ($p=0.02$, $r=0.54$) existed. MTPM between 1 and 3 years showed a negative relation between BMD and MTPM ($p=0.04$, $r=-0.47$), while inducible displacement calculated as MTPM obtained from stress examinations at 1 year postoperatively was not related to BMD ($p=0.37$, $r=0.20$).

Conclusion: The preoperative quality of the tibial trabecular bone showed to be a significant determinant for migration of the tibial component. But the level of the r-values indicated that other unknown parameters may also be important for the migration. The relation between BMD and MTPM between 1 and 3 years (the clinically most important parameter with respect to later loosening of the tibial component) indicated that the tibial component of knees with preoperative high tibial BMD showed less continuous migration.

54. Weight-relievement does not influence tibial migration or fixation in cementless total knee arthroplasty

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Prerequisites for bone ingrowth into porous coated implants are biocompatibility of the porous layer, optimum pore size, remodelling of the periprosthetic bone and restricted movement between implant and bone. The purpose of the present study was to evaluate the significance of weight relievement on migration and fixation of the PCA Modular tibial tray using radiostereometric analysis (RSA).

Patients and methods: 34 consecutive patients (34 knees) with arthrosis who had cementless TKA with PCA Modular components were randomized to early, unrestricted weight bearing or 6 weeks weight relievement. The knees were prepared for RSA which was performed 6 days, 6 weeks, 1 year and 3 years postoperatively. One year after operation inducible displacement was measured.

Results: Most migration occurred during the first year but without differences in migration (MTPM) or inducible displacement (Table).

Discussion: Weight protection is difficult for the patient and the present study failed to show any advantage on the bone-prostheses stability 3 years after operation. This conclusion may also include other tibial designs.

55. Augmentation of the initial fixation by cement in non-cemented prostheses

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Fixation by partial cementation of uncemented tibial components was studied using RSA.

Patients and methods: In three consecutive series of 10 gonarthrotic patients (3 men and 27 women, age 74 (60–87) years) each, partial cementation of the PCA Primary total knee by a 1 cm peripheral rim of standard cement,1 cm peripheral rim of pressurized low viscosity cement and low-viscosity cement pressurized into the holes of the fixation pegs was used, respectively. Postoperatively and at 6 weeks, 6 months, 1, 2, 4 and a mean 8 years, RSA examinations were performed in the supine position. After 1 year a stress investigation was performed. Clinical scores and standard radiographs were obtained at the yearly controls.

Results: Three patients died before the 8 year follow-up and one was revised due to wear. Distinct radiolucencies adjacent to uncemented portions of the interface was a constant finding. There were no differences regarding migration or inducible displacement between the three groups.

Conclusion: The RSA results indicate that the partially cemented prostheses were bonded to bone in a similar way as fully cemented prostheses. From an RSA point of view, there was little evidence of additional fixation from bony ingrowth. This has been corroborated by histologic analysis in one retrieved case.

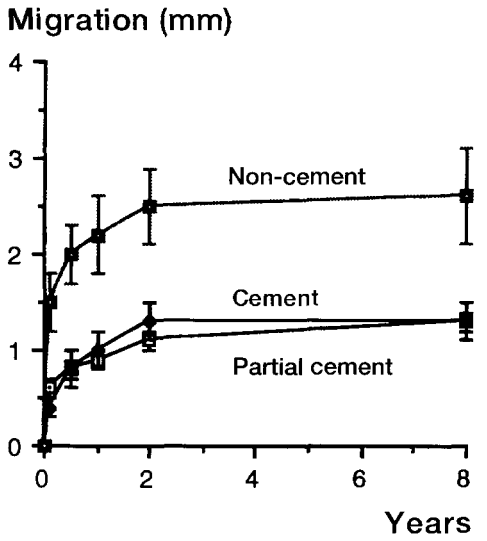

Figure. Migration of partially cemented PCA prostheses and two groups of similar prostheses from historical controls.

56. Boneloc vs Palacos bone cement in total knee arthroplasty—a prospective randomized radiostereometric study

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Boneloc bonecement was introduced to the market some years ago, claiming to be less toxic than conventional cement, and thereby achieve a better fixation of orthopedic implants. Inferior results with this cement when used in total hip arthroplasty has recently been published (Thanner et al.), and has led to its withdrawal from the market (autumn 1995). The aim of the study was to evaluate the efficacy of Boneloc when used in TKA.

Patients and methods: Between 1993 and 1994, 19 consecutive knees (10 women, 9 men) with primary gonarthrosis grade III-V (Ahlbäck) undergoing TKA with the Miller-Galante II prosthesis were randomized to Boneloc (8 knees) or Palacos (11 knees) bone cement for fixation of the tibial component. The groups were comparable regarding gender, weight, preoperative alignment and knee score. The quality of the fixation was evaluated with radiostereometry (RSA) at regular intervals up to 24 months (Nilsson and Kärrholm). The clinical results were assessed using the Knee Society Knee and Function Scores.

Results: The tibial components fixed with Boneloc displayed significantly larger migration than Palacos during the 2-year follow-up. The difference was clearly visible already at 3 months, and was increasingly pronounced from 12 months and onwards. At 2 years the migration was about three times larger in the Boneloc group: 2.9 ± 1.0 vs 0.9 ± 0.4 mm ($p < 0.05$). The typical pattern of migration in the Boneloc group was subsidence of one part of the tibial component combined with lift-off of the opposite part, this occurring either in the sagittal- or coronal plane. The Knee Score and Function Score did not differ significantly between the two groups.

Conclusion: The fixation of the tibial components was significantly inferior when Boneloc was used. The difference was increasingly accentuated with time. It has recently been found that Boneloc has inferior mechanical and chemical properties compared to Palacos (Thanner et al). It seems that these findings are valid also in knees. However, due to the different forces at the implant-bone interface in the knee as compared to the hip, the manifestation of the inferior properties in the knee occurs somewhat later than in the hip, where significant differences were seen already at 3 months (Thanner et al). Boneloc should not be used in total knee arthroplasty.

References: Nilsson and Kärrholm: J Bone Joint Surg 1996; 78-B: 1-3. Thanner et al: Acta Orthop Scand 1995; 66: 207-14.

57. Tourniquet release in blood conservation after knee arthroplasty

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Knee arthroplasty is associated with major blood losses, for which transfusion is often needed. The purpose of this investigation was to study the effect of tourniquet release for hemostasis on blood loss and transfusion requirements.

Patients and methods: 77 consecutive primary knee arthroplasties in 75 osteoarthrotic patients (52 women, 23 men), with a mean age of 71 (44–86) years, were prospectively randomized into two groups. In Group 1, the tourniquet on the upper thigh was released before soft tissue closure, in order to allow cautery of bleeding vessels. In Group 2, the tourniquet remained inflated throughout the operative procedure. Bleeding during the operation, the loss of drainage blood, prescription of blood transfusion, hemoglobin values and wound complications were noted. The two groups were comparable with respect to age, sex distribution, height, weight, preoperative hemoglobin values, and fixation techniques.

Results: The total blood loss averaged 860 (200–1880) mL for Group 1, and 670 (150–1500) mL for Group 2 (n. s.). 35% of all patients received blood transfusion, but there were no differences in the numbers of blood transfusions given in the two groups, the postoperative drop in hemoglobin values or wound complications.

Conclusion: Our study questions the efficacy of tourniquet release for hemostasis in knee arthroplasty.

Posters

58. Hydroxyapatite coated total knee replacement in a canine model

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Coatings in total knee implants have been based on experiments with coatings used on total hip replacements. Bone characteristics, forces and loading within the knee, are, however, completely different.

Material and methods: In order to verify a canine knee as a model for total knee replacement studies we operated on 3 Mongrel dogs bilaterally in two stages. Pre- and postoperative radiographic evaluation, gait analysis using a pressure plate and dexascanning to analyse bone density beneath the implant were introduced. After confirming the canine knee as a good experimental model, two groups of 5 dogs were operated on using two different types of hydroxy apatite coatings in an identical uncemented total knee implant.

Results: In the initial study, all 6 operations were succesful and after 6 weeks all animals were fully weight bearing on both hind legs. Radiographic analysis showed no signs of loosening at 20 weeks and histologic analysis showed promising data on ingrowth of bone in the hydroxy apatite coating.

Conclusion: The canine knee is a good experimental model for total knee replacements. The animals function normally after implantation and the range of motion of the knee is almost unchanged. After killing of the animals, the ingrowth can be analysed using histologic staining techniques and a dexascan will give data on bone-density changes directly beneath the implant. Radiographic loosening is monitored and pre- and postoperative gate analysis will give data on weight bearing of each hind leg. Different coatings being the only variable in this model make data interpretation correlated with the changes in coatings possible.

59. Sick-leave and occupation after knee prosthetic operation for arthrosis

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To identify preoperative factors predicting the working capacity following knee prosthetic operation for primary gonarthrosis, the working status during 2 years before and 2 years after surgery in patients younger than 60 years was investigated.

Patients and methods: Through the Swedish National Knee Registry, 162 patients (76 men, 86 women) younger than 60 years when receiving a knee prosthesis during 1993 were identified. Information regarding pre- and postoperative type of work, time on sick-leave and disability pension was obtained from the Social Insurance Office and from questionnaires sent to all patients.

Results: The Social Insurance Office could supply data on all patients, and 92% of the patients answered the questionnaires (Table). Long preoperative sick-leave increased the risk for post-operative disability pension (p 0.01), which was not influenced by the type of work. There was a positive correlation between the duration of pre- and postoperative sick-leave in the 52 patients returning to work after knee replacement (p 0.01).

Table. Working status of 162 patients with primary gonarthrosis and under 60 years of age at knee prosthesis operation. DP50% and DP100% = 50% and 100% disability pension, respectively

	Postoperative			
Preoperative	Working	DP50%	DP100%	Sum
Working	52	12	24	88
DP50%	0	9	9	18
DP100%	0	0	56	56
Sum	52	21	89	162

Conclusion: Long sick-leave before knee prosthetic operation can increase the risk of long postoperative sick-leave and of being retired by disability pension.

60. Rheology of postoperative filtered drain blood

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Postoperative retransfusion of filtered autologous drain blood can save blood during orthopedic surgery. However this blood has been questioned for its quality.

Materials and methods: Rheology was studied, in 17 osteoarthrosis patients, operated with a knee prosthesis. ConstaVac® autotransfusion system was used. Blood status, WBC differential count, P-glucose, P-pH, lactate and cytokine (C3d) was measured at 2 hours and 5 hours postoperatively in venous and drain blood. Static incubation, 22 °C, of the 2 hour drain and venous blood was analyzed at 5 hours. Drain blood at 24 hours was also analyzed.

Results: In drain blood, neutrofilic granulocytes and lymfocytes were significantly reduced ($p<0.001$). Glucose, lactate, and pH showed an anaeorobic and acidic incubation (Dalén et al. 1995). An increase in C3d indicated an inflammatory reaction in drain blood, however, of relatively low

magnitude. Whole blood filtration index and clogging rate was reduced to 55% and 93%, respectively. When WBC were eliminated, to measure only the RBC rheology in drain blood, filtration index was still reduced to 83%, whereas clogging rate was increased to 326% ($p<0.01$) compared to venous blood, thus suggesting a damage to the RBC which is masked in the whole blood measurements due to the reduced number of WBC in drain blood.

Conclusion: We conclude that the whole blood filtrability of drain blood is improved compared to venous blood, because the WBC are trapped in the wound. The increased clogging rate of resuspended RBC indicates some traumatized red cells, but in view of the improved whole blood filterability appears to be less important. Although a small inflammatory reaction was seen, drain blood is considered acceptable for retransfusion.

Reference: Dalén, Broström and Engström. Acta Orthop Scand 1995; 66(4): 329-333

61. Adaptive changes in BMD of the distal femur following uncemented TKA

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Finite element studies on strain distribution in bone after total joint replacements have suggested that the location of porous coating on the surface of the implants might be an important determinant for the development of stress shielding.

Patients and methods: 29 patients with primary knee arthrosis accomplished the study. The knees were randomized to receive a PCA Modular® femoral component (n 9) or a modified version of the same prosthesis with the porous-coating removed from the anterior and posterior flanges and coating added to the pegs (n 9). The remaining knees (n 11) were a consecutive series with the Duracon® femoral component. Postoperatively and with follow-up after 3, 6, and 12 months bone mineral density (BMD) was measured by dual photon absorptiometry (Gammatec GT-50 femur-1a) in the distal femur. Anterior to the fixation pegs (ROI 1) and above the pegs (ROI 2) respectively, two regions of interest were selected for analysis of BMD.

Results: No significant differences between the Modular component and the modified version regarding the changes in BMD was seen. In both ROI, the highest bone loss rate was observed during the first 3 months after surgery. On average (n 29) a significant bone loss of 44% ($p<0.00005$) and 19% ($p<0.00005$) for respectively ROI 1 and ROI 2 was reached at the 12 months follow-up compared to the initial values.

Conclusion: The substantial loss of bone mineral of the distal femur following TKA must be considered an important determinant for periprosthetic fracture, and later failure of the femoral component. The altered location of porous-coating could not prevent the bone loss in the distal femur.

62. Occupational factors and the development of knee arthrosis

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The aim of this study was to detect occupational activities important for the development of arthrosis of the knee, taking into account the confounding factors that were suspected or could be identified.

Method: In the archives of the Department of Diagnostic Radiology in the Malmö General Hospital all weight-bearing radiographs of patients with painful knee joints 1982–1986 were reassessed. We found 340 probands with arthrosis of the knee of at least grade 1 in the Ahlbäck classification. These probands and their age and sex matched controls (n 680) were analyzed by a validated questionnaire for details of their knee moment inducing activities at work over three 15 year periods as well as their history of knee injuries at work or in their leisure time.

Results: The questionnaire was answered by 266 (80%) probands and 463 controls (70%). The results of the questionnaire answers and recorded history of knee injuries were statistically analyzed by logistic regression. The relative risks of arthrosis were slightly increased (RR= 1.7) in probands with heavy knee moment at work whereas knee injuries (meniscal and/or ligamentous) showed an increase up to RR=13.2. High knee moment without controlling for confounders gave a significantly (RR=2.3) increased risk. Overweight was in our investigation observed to increase the relative risk to RR=2.6. A sedentary profession had on the other hand a protective value to the probands' knees (RR=0.4). The knee injuries (n 66) were, but for 9 probands, sustained in leisure activities, mainly soccer.

Conclusion: A goal for our investigation has been to improve control of actual knee moment in the probands work situations and of back ground factors of knee injuries and obesity. We thus conclude that work inducing high knee moment by itself significantly increases the risk to develop arthrosis of the knee. In addition life style factors—sport activities with knee injury and obesity—increase the risk manifold.

63. Improved fixation of porous versus blasted surface texture of hydroxyapatite coated implants

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Recently, hydroxyapatite (HA)-coated femoral components with blasted surfaces were the first to be on the market for clinical application. The purpose of this study was to evalu-

ate the effects of porous and blasted surface texture of HA-coated implants on mechanical fixation, bone ingrowth and resorption of HA coating.

Material and methods: 8 skeletally mature mongrel dogs had non-loaded titanium (Ti-6AI-4V) implants inserted bilaterally into the proximal humerus. The surface texture of the implants was either porous-coated or grit-blasted and was plasma-sprayed with HA. The dogs were killed after 25 weeks. Non-inserted implants served as control for resorption parameters of the HA coating. Mechanical fixation was evaluated by push-out test. Histomorphometry was determined on vertically cut sections ground to 50 µm. A new stereology software program was applied ICAST Grid®, Olympus, Denmark A/S).

Statistics: Data are presented as mean values, and standard error of mean (SEM) is given in brackets. Paired or unpaired t-test was applied. $P<0.05$ was considered as significant.

Results: Push-out tests of porous coated implants showed, that energy absorption was increased significantly by 81%, and shear stiffness was reduced significantly by 32% compared with blasted implants. Ultimate shear strength was 3.1 (0.5) MPa for porous, and 3.3 (0.3) MPa for blasted implants (NS). Failures of porous implants occurred predominantly in the HA-tissue interface. In contrast, all blasted implants had pronounced delamination of the HA coating. Delamination of the HA coating was not observed during implantation. Bone ingrowth was 49 (3.2) % to porous coated implants, and 66 (4.0) % to blasted implants ($p = 0.02$), however, the absolute area did not differ. The HA coating was totally resorbed on 6.3 (2.8) % of the surface for porous implants ($p<0.05$), and by 0.5 (0.4) % for blasted implants (NS). The difference between porous and blasted implants was significant.

Discussion and conclusion: This is to our knowledge the first controlled study comparing porous versus blasted surface texture of HA coated implants in a gap model in trabecular bone. HA-coated implants with plasma-sprayed porous surface texture were stronger fixated than blasted implants. Grit-blasted implants had pronounced delamination of the HA coating during push-out testing compared to porous-coated implants.

Acknowledgment: Biomet Inc. kindly delivered the implants, and BioInterfaces Inc. kindly provided the ceramic coatings. The study was financially supported by the Danish Rheumatism Association, the Danish Medical Research Council, the University of Aarhus, Denmark, and the VELUX foundation.

64. Total knee arthroplasty in rheumatoid arthritis—a report from the Swedish National Register 1985–1994

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This report is based on the Swedish Knee Arthroplasty Register starting 1976, which during 1985 through 1994 recorded 3,992 primary knee arthroplasties in patients with rheumatoid arthritis (RA) and their revisions.

We report on the structure of the register, demographic data and survivorship. The mean age of the RA patient was 65 years for both sexes and we found that women accounted for 3/4 of the operations. The use of tricompartmental knee prostheses has increased over the years, mainly at the expense of the unicompartmental concept, and now accounts for 94% of the operations in RA. The total number of knee arthroplasties has been relatively unchanged and was found to be 1,943 during 1985–1989 and 2,049 during 1990–1994.

The 10-year cumulative revision rate (CRR) demonstrates that unicompartmental prostheses are clearly inferior to total knee replacements and the latter have improved prosthetic survival over time. The smaller hospitals in Sweden have increased their proportion of operations in RA patients from 8% during 1985–1989 to 14% in 1990–1994. Their CRR was, however, significantly higher than at the larger hospitals and this could probably partly be explained by the fact that smaller hospitals more frequently use the unicompartmental prostheses, although this use of uni prosthesis has decreased from 21% of cases during 1985–1989 to 9% in 1990–1994.

Analysing the four most used TKR implants we could not find any statistically significant difference in CRR. Younger men were found to have higher risk of revision than elderly females. The risk for the most severe complications, such as infection, and their treatment, such as extraction and arthrodesis, has considerably decreased in recent years.

Fractures

65. Fractures of the scapular neck—a therapeutic problem?

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Dislocated fractures of the scapular neck and the combination of scapular neck and clavicular fractures represent a therapeutic problem and have in the choice of treatment to be differentiated from other fractures of the scapula. An analysis of 7 patients with these types of fractures demonstrates this therapeutic problem.

Patients: 7 patients, 5 men and 2 women, median age of 46 (24–79) years, were treated for a isolated fracture of the scapular neck (5), or combined with a fracture of the lateral clavicle (2). Observation time was 8 (4–22) months.

Methods: 3 patients with an isolated dislocated fracture of the scapular neck were treated by ORIF. 2 patients with an unstable shoulder girdle were treated with ORIF of the clavicle and immobilization in a mitella for 3 weeks. 2 patients

with an isolated nondislocated scapular neck fracture were treated conservatively with immobilization in 3 weeks. The follow-up included functional examination of the shoulder girdle, discomfort registration and radiographic examination.

Results: All patients treated with ORIF because of a dislocated scapular neck fracture had an excellent functional result without any discomfort and were back in normal occupational activities at the latest control. 2 patients with an unstable shoulder girdle treated by ORIF of the clavicle had a good functional result but one of the patients had discomfort and needed analgetic medication. Both patients treated conservatively for nondislocated scapular neck fractures had a functional impairment at the follow-up, but no pain. One of these patients, a carpenter, was still not back to work 4 months after the accident. No secondary fracture dislocation was oberved.

Conclusion: ORIF is advocated in dislocated fractures of the scapular neck. Fracture of the lateral clavicle combined with fracture of the scapular neck should be stabilized by ORIF of the clavicle. The dislocation of the glenoid have to determine wether this component should be approached surgically.

66. Surgical treatment of unstable lateral clavicle fractures

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Since 1992, twelve cases of unstable lateral type II fractures (Neer 1984) have been operated on. This fracture is characterized by associated ruptures of the coracoclavicular ligaments, often leading to instability, dislocation and development of pseudarthrosis. In this study, the results of surgical treatment in a consecutive series of fractures are presented.

Patients and methods: 12 patients (4 women and 8 men) underwent surgical reconstruction with ORIF and temporary screw fixation of the clavicle. The trauma situation was in 5 cases bicycle accidents, 4 car or mc accidents and in 3 trauma by falling. The mean age at the time of operation was 38 (20–50) years. The right clavicle was involved in six cases as was the left. Anteroposterior and axial radiographs were taken preoperatively and showed in all cases significant dislocation (>2 clavicle diameters). The axial view was taken to disclose possible horisontal dislocation of the fracture. In 3 shoulders with pseudarthrosis the time interval between injury and operation was 4-12 months. In these cases the operation also included a bone transplant. 8 patients were operated on within 1 week after injury. The follow-up examination was performed on average 27 (5-47) months postoperatively. Data collections postoperatively consisted of a questionnaire, clinical and radiographic examination.

Results: At follow-up, 9 patients were symptom free. Two felt fatigue in static work situations and one had some discomfort from the scar region. Objective examination revealed slight limitation of shoulder motion in one patient, the rest had full and pain free ROM. At radiographic examination all twelve fractures were healed in exact position. A slight subluxation (<1/2 clavicle diameter) of the AC-joint was observed in 3 patients. The strength of the shoulder muscles was assessed manually and was normal for flexion, abduction and external and internal rotations. All patients could return to their pre-injury levels of work and sport activities.

Conclusion: ORIF according to our technique seems to be a valuable alternative for treatment of type II fractures of the distal third of the clavicle.

67. Intramedullary screwnail fixation in subcapital fractures of the humerus

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Dislocated subcapital fractures of the humerus are common but often difficult to treat, particularily in elderly osteoporotic patients. Technical failure with pin migration or plate loosening is commonly seen. A number of operative techniques are in use.

Patients and methods: A newly constructed screwnail developed at our hospital represents an alternative method. The screwnail consists of a one piece 180–210 mm long flexible cord, 2.5 mm thick with a 15 mm long head with 6 mm self-tapping threads. At the proximal end a hexagonal hole fits a standard screwdriver. The nails secure a flexible fixation with minimal shearing forces and disturbance of blood supply. The threaded head prevents nail migration.

A pilot study with 6 patients was performed in 1994, with a 1-year follow-up. Later another 12 patients have been treated (15 women and 3 men), with median age 76 (38–88) years. The fractures were classified as Neer type 2, 3 or 4. Sixteen of the fractures were reduced by open reduction through an anterior deltoid splitting incision. Two or three screwnails were inserted through the lateral part of the rotator cuff or the greater tubercle, pushed or hammered through the humeral head into the medullary canal. Each screwnail was secured proximally by screwing its head into the proximal fragment(s). Reduction and nail positioning was verified by fluoroscopy. Two patients were treated with closed reduction and insertion of nails through a short radial incision lateral to the acromion. At follow up we recorded pin migration, fracture redislocation and healing, shoulder mobility, pain, patient satisfaction and complications.

Results: All fractures healed without redislocating. In two patients there was a slight (less than 5 mm) migration of the nails without clinical impairment. Most patients had little or no pain after two months and regained normal/adequate function after 2– 6 months. There were no serious complications.

Conclusion: The new screwnail fixation method seems to be simple and safe in retaining the fracture fragments and in fracture healing. The nail does not seem to migrate. We

found a good preservation of shoulder function and a low risk of complications.

68. A prospective randomized comparison between metallic and self-reinforced polyglycolide implants in the fixation of malleolar fractures in the elderly

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Operative treatment of displaced malleolar fractures has been shown to be superior to conservative treatment also in the elderly despite osteoporosis and difficulties in restricting weight bearing postoperatively. Self-reinforced polyglycolide rods and screws have been succesfully used in adults. Our purpose was to find out whether these implants can be used in the osteoporotic bone of the elderly as well.

Patients and methods: 35 elderly patients with mean age 73 (65–90) years and with displaced malleolar fractures without lateral comminution were randomly fixed with metallic AO-implants (19 pts) or SR-PGA implants (16 pts). In the metallic fixed, 1 patient had a Weber A bimalleolar fracture and 1 had a medial malleolar fracture only. All the others were Weber B with 11 trimalleolar fractures in both groups and 3 and 5 syndesmosis ruptures, respectively. A below-the-knee plaster cast was maintained for 6 weeks.

Results: There were 1 failure of fixation and 5 slight redisplacements in both groups. The functional score using the method of Olerud and Molander before the trauma was 91 (55–100) in the metallic group and 93 (55–100) in the SR-PGA group. 5 patients were lost to follow-up at 3-14 weeks. After one year follow-up, the score was 76 (40–100) and 87 (50–100), respectively. 15 metallic removal operations were performed.

Conclusion: Fixation of malleolar fractures in the elderly with degradable implants gives equal results in comparison with metallic fixation when comminution does not require plate fixation.

69. Stable lateral malleolar fractures treated with Aircast ankle brace and DonJoy R.O.M.-Walker—a prospective randomised study

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As treatment for stable malleolar supination-eversion fractures (Lauge-Hansen SE-II) various immobilisation methods and braces have been described. The purpose of this study was to allow early mobilisation and compare two different dynamic ankle braces.

Patients and methods: 33 (4 men, 29 women) were randomized to Aircast Air-Stirrup ankle brace and 33 (15 men, 18 women) were randomized to DonJoy R.O.M.-Walker. Median age in both groups was 45 (18–84) years. Both braces make plantarflexion and dorsiflexion possible and prevents inversion and eversion. Full weight bearing was allowed from the start, and the grade of mobilisation and pain was evaluated from a diary. Follow-up examinations were performed after 1, 4, 6 and 12 weeks.

Results: Bracing time averaged 5 weeks, and return to work averaged 6 weeks from injury. After 4 weeks 70–80% were able to walk without pain. Subjective satisfaction with comfort and ease of use was significantly higher with Aircast, though it was high in both groups. Activity level, pain relief and inflammatory score were significantly better with R.O.M.-Walker after 4 weeks. Three months from injury no difference in activity level, pain, swelling, range of motion or inflammatory score was found between the two braces.

Conclusion: Both braces can highly be recommended, but which brace to choose must depend on the priority of high comfort versus better pain relief.

70. Open reduction and internal fixation in 46 calcaneal fractures

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The treatment of comminuted displaced intraarticular fractures of the calcaneus has been a controversial subject during the years. Our experience with ORIF of 46 comminuted displaced intraarticular fractures of the calcaneus is the subject of this report.

Patients and methods: 40 patients with 46 fractures of the calcaneus were treated by ORIF in the period 1988–1995. Median age was 32 (20–62) years. Preoperative evaluation was done by conventional radiography including Brodén projection and CT. The patients were operated on in general or regional anesthesia. Regularly, a tourniquet was used and in all fractures but two bone grafting was performed. A lateral approach was used and stabilization achieved by compression screws and a cervical H-plate. The final results were evaluated by a clinical and radiological examination. A score system designed by the authors, including photographic documentation of the planta pedis during weight bearing and position of the heal from a posterior wiew, were used to evaluate the final result.

Results: Median time between accident and operation was 6 (0–12 days). Median hospitalization time was 21 (16–68) days. In 12 fractures, a skin necrosis with secondary superficial infection occured. No deep infections were recorded. In 3 patients, an early implant removal was necessary (6, 7 and 13 weeks after index operation, respectively). The results in 10 fractures were rated as excellent, in 20 fractures as good,

in 9 as satisfactory and in 7 as unsatisfactory. In 5 patients a subtalar or triple arthrodesis, because of invalidating pain, had to be performed during the observation period. The result in these 5 patients was, according to the score system, rated as unsatisfactory.

Conclusion: ORIF of comminuted displaced intraarticular fractures of the calcaneus is advocated. If an arthrodesis has to be performed after index operation, the result may be satisfactory as the configuration of the hindfoot has been reestablished. Skin necrosis with secondary infection after surgery is still a problem in these patients.

71. Differentiated treatment protocol for fractures of the calcaneus—a retrospective study of 115 fractures

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100 patients (28 women and 72 men) with median age 43 (10–75) years, with 115 fractures were treated. 48 fractures were operated on, 44 of these were intraarticular. Surgery included elevation of the depressed lateral joint fragment and restoration of Böhlers angle, followed by fixation by pins or screws as described by Soeur and Remy 1975, without bone transplantation. Evaluation was based on subjective scoring with an ankle score, and measurements of ROM in talocrural and subtalar joints, as well as postoperative and late radiographic findings.

Results: 3 patients had deep wound infections, 14 had loss of skin sensation in the sural nerve area. No other complications were recorded. Median score of the operated intraarticular fractures (B2+ B3) was 77.5, and the corresponding value in nonoperated intraarticular fractures was 57.5. This difference was statistically significant. Good functional long-term results were positively correlated to postoperative posterior joint facet integrity, a positive Böhlers angle, and a wide range of motion in the subtalar joint at follow-up. All bone defects were spontaneously healed, but in some cases, especially in the more comminuted cases, some loss of correction of Böhlers angle took place.

Conclusion: The funcional results correlated to the anatomic position of fragments, and our results support the indication for operative reconstruction in displaced, intraarticular fractures. The loss of correction of Böhlers angle indicated that pin fixation was to weak in some cases, and we now use plate and screws in most cases, and usually a more extensive exposure. Bone transplantation does not seem to be neccesary if the fixation is stable.

72. Preliminary experience with the Point Contact Fixator (PC-Fix)—a new device providing a biological osteosynthesis in diaphyseal fractures

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The AO-Development Institute (ADI) has created and experimentally evaluated a new system for fracture treatment. The PC-Fix aims at the optimal realization of so called biological internal fixation. This report is a handling test with the new device.

Patients and methods: Since August 1994, 18 men and 6 women with a median age of 30 (11–68) years have been operated on. The indications for the PC-fix have been forearm shaft fractures in 19 patients, a non-union of the ulna in 1 patient, a fibulashaft fracture in 2 patients and a clavicle fracture in 2 patients. Preservation of the blood supply of the bone by an appropriate surgical technique in connection with the use of the PC-Fix was emphasizied. The patients were followed by routine controls at 6, 12 and 18 weeks.

Results: Median observation time was 6 (2–16) months. All fractures were clinically healed, while radiographic consolidation in 3 patients at the latest examination at 8, 11 and 13 weeks was not evident. No infections were observed and no functional impairment could be recorded in the forearm fractures at the last control. Radiographic signs of implant loosening could be observed in 1 patient with a proximal ulna fracture. Metal removal has been done in one patient with a clavicle fracture due to local irritation.

Discussion: Necrosis beneath the plate may disturb fracture healing as well as favorize infection in conventional plate osteosynthesis of diaphyseal bone. The use of an internal fixator like the PC-Fix with monocortical screws that exerts no pressure on the bone, preserves the cortical blood supply. Thus a biological healing may be anticipated as indicated by animal experimental works.

Conclusion: Stimulated by the very promising results in this handling study, we will participate in an open multicenter study comparing conventional plate osteosynthesis with the PC-Fix in forearm shaft fractures.

73. A threshold pressure of 30 mmHg in the anterior tibial compartment after medullary nailing of tibial fractures gives a high incidence of fasciotomies

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Acute compartment syndrome is a serious complication to tibial fractures. Clinical signs and symptoms can be difficult

to interpret, and measurement of tissue pressure is an important adjunct to the decision of fasciotomy. During the last years most patients treated with intramedullary nailing of tibial fractures have been surveilled with tissue pressure measurements, and 30 mmHg used as a threshold for fasciotomy. The purpose of this study was to evaluate this practise.

Patients and methods: All patients treated during the period 1992–1994 were retrospectivly investigated. The indications for measurment of tissue pressure were sedation of the patient or clinical findings suggesting an impending acute compartment syndrome. A fiberoptic transducer (Camino 110-4D, San Diego, USA) was placed in the anterior tibial compartment and kept for 24–72 hours. If the pressure exceeded 30 mmHg for more than 30 min, a four-compartment fasciotomy was performed. All patients were followed with radiography and clinical investigations until the fracture had healed. Fasciotomized patients were reviewed separately and the muscle strength in the lower leg was tested isokinetically (Cybex).

Results: 63 patients were included in the series. 43 fractures were closed, 18 grade I (Gustilo) and 2 grade II. 52 patients were operated on within 48 hours, 11 patients within the next 5 days. Tissue pressure measurments were performed in 43 patients (Table). Fasciotomy was performed in 18 patients, 3 fasciotomies were performed after clinical findings alone and 15 after measurement of pressure >30 mmHg. This gives a fasciotomy rate of 33%. At follow-up, 2 of these patients were dead. All fractures were healed, and there were no complications resulting in deep infection, extensive muscle necrosis, paresis or short-foot syndrome. 3 patients had significantly reduced muscle strength compared to the contralateral leg.

Table.

Pressure (mmHg)	No. patients
0–30	28
31–40	6
41–50	3
51–60	4
61–80	2

Discussion: The established criterion for the diagnosis of acute compartment syndrome is according to Mubarak et al (1) a tissue pressure of 30 mmHg or more. In our series this treshold resulted in a fasciotomy frequency of 33%. No patients had obvious signs of missed or delayed diagnosis, but 3 patients had reduced muscle strength. These changes seemed to be related to lack in physical training and not to sequelae after compartment syndrome. In a prospective series we have raised the pressure threshold to 40 mmHg.

Reference: 1. Mubarak SJ, Hargens AR. Compartment syndromes and Volkman's contracture. Philadelphia: Saunders, 1981.

74. Mechanical effects of different localizations of the point of entry in femoral nailing

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It is recommended that Grosse-Kempf nails are inserted from the tip of the great trochanter, while the more rigid Russel-Taylor nails are inserted from a more medially placed entry point in the fossa piriformis. The latter entry point allows for a more straight insertion channel of the nail, but may weaken the femoral neck and give a fracture predisposition.

Material and methods: 20 pairs of human femora were reamed alternatively on the right or left side, with the opposite side as unreamed control. The tip of the greater trochanter (group I) or fossa piriformis (group II) were chosen for introduction of the intramedullary reamer (Howmedica type). Reaming was performed to 14 mm diameter beyond the most narrow part of the medullary cavity. Radiographs were taken in the frontal projection, and the femora were tested in vertical compression in a MTS mechanical testing machine until failure, at a speed of 1 mm/sek. New radiographs were obtained after testing.

Results: In group II, (entry portal in the piriformis fossa), all femora fractured through the entry portal. This happened in only 3 out of 10 in group I, where 7 fractured through the medial part of the femoral neck remote from the portal. The difference is statistically significant. Reduction in strength between the unreamed control side and the reamed femur was median 506 N (8.5%) in group I, and 1486 N (23%) in group II. Reduction in energy absorption between control side and reamed side was 1142 Nm (10.5%) in group I and 9786 Nm (44.5%) in group II. The difference in energy absorption reduction between group I and II was statistically significant ($p = 0.04$).

Conclusion: Reaming through an entry point (portal) in the piriformis (trochanteric) fossa weakens the femoral neck and creates a localizing point for fracture.

75. Ultra-high strength bioabsorbable polymer composites for orthopaedic applications

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We have developed methods by which thermoplastic, linear, partially crystalline or amorphous bioabsorbable polymeric implants can be transformed into the ultra-high strength, self-reinforced form. Self-reinforcing means that at least part of the molecular chains of polymer are oriented to a cer-

tain direction (usually parallel or helically) in relation to the long axis of the implant.

Materials and methods: The most efficient method to create self-reinforced, oriented structure is mechanical deformation, like drawing of a polymer billet. The draw ratios between 2 and 12 are used typically in self-reinforcing of bioabsorbable polymers. As a consequence of drawing the normal spherulitic crystalline structure is transformed partially to an oriented, fibrous structure, leading to a significant increase of strength, modulus and toughness of the material. Also the strength and toughness of amorphous bioabsorbable polymeric materials can be increased significantly with the drawing-reinforcing technique.

Results: Self-reinforcing transforms brittle polymers, like polylactides to tough ones simultaneously with the significant increase of mechanical strength properties. We have increased the bending strength of partially crystalline poly-L-lactide from ca. 100 MPa up to 300 MPa by drawing-reinforcing technique. Self-reinforced polylactides can be machined conveniently by means of mechanical processing methods and/or treatments. We have developed different types of bioabsorbable implants for orthopedic and traumatological applications using self-reinforced polylactide as raw material. Typical applications of bioabsorbable pins, rods, screws, bolts, tacks etc. are fixation of fractures and osteotomies and treatment of connective tissue (like ligament and knee meniscus) injuries.

Conclusions: Ultra-high strength bioabsorbable polymer composites implants can be safely used in orthopedics and traumatology.

76. Generation of a biomembrane using polyglycolide implant

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Proliferation of fibrous tissue around implanted biomaterials is a well known phenomenon. Induced fibrous tissue formation leads to capsule formation around these implants. In case of absorbable implants, the fibrous tissue invades the degrading implant and replaces it. When an absorbable sheet is implanted, it leads to the formation of a membranous structure; we called it biomembrane.

Materials and methods: 204 Wistar rats and 46 New Zealand rabbits were used. Self-reinforced polyglycolide (SR-PGA) membranes, 0.15 mm thick, were applied over femoral cortical and cancellous bone, osteotomies and bone defects. The tensile strength retention of the SR-PGA biomembrane was studied in vivo by implantation of SR-PGA membrane in the subcutis and around the bone of rats. For the in vitro, SR-PGA membranes were immersed in saline and kept at room temperature. The animals were followed-up for 1, 3, 6, 8, 12, 24 and 30 weeks. Radiography, histology, planimetry, microradiography, oxytetracycline fluorescence and strength measurements were performed to study the forming biomembranes.

Results: SR-PGA membranes degraded totally by 30 weeks. They enhanced new bone formation. This was especially beneficial when membranes were applied over non-grafted bone defects. Membranes also induced periosteal thickening as well as fibrous tissue proliferation that had invaded the PGA structure leading to formation of biomembranes. Biomembranes have exhibited a prolonged strength retention, compared to membranes tested in vitro.

Conclusion: SR-PGA membranes are biocompatible with osseous tissue and lead to formation of biomembranes that can be utilised to treat bone defects. These are recommended for clinical application for bone defects and cancellous bone augmentation.

77. Bone mineral measurements among adolescents, comparing two regions in Southern Sweden

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Previous studies have shown higher incidence of hip and fragility fractures in an urban (Malmö) area compared with a rural area (Sjöbo) and lower bone mass among elderly (1, 2). The explanation for this could be differences in lifestyle (3). In Sweden today, adolescents have a low activity level, which is alarming concerning the future.

Materials and methods: In this population-based study, with DEXA measurements, we have compared the differences among 15-year-old boys (n 58) and girls (n 44) in Malmö with 82 boys and 67 girls of the same age from Hässleholm which is a rural area.

Results: We found significantly higher BMD levels in the rural area regarding lumbar spine (14% for the boys and 13% for the girls) and total body (6.9% for the boys and 3.4% for the girls). These differences remained significant also when adjusted for age, BMI and menarche. We found no significant differences in the hip BMD.

Conclusion: Adolescents in rural areas have the possibility to develop a higher peak bone mass thereby avoiding future fragility fractures. These measurements are the first part of a project where the question is whether it is possible to increase peak bone mass in a population by enhancing their physical activity both in and off schooltime.

References: 1. Gärdsell P et al. J. Bone & Min Res 1991; 6: 67-75.
2. Jónsson B et al. Osteoporosis Int 1992; 2: 269-273.
3. Jónsson B et al. Calcif Tissue Int 1993; 52: 425-433

78. Open reduction and internal fixation of acetabular fractures

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Management of displaced fractures of the acetabulum represents one of the greatest challenges in fracture surgery. This prospective study reports the results of operatively treated acetabular fractures.

Patients and methods: Betweeen June 1993 and February 1996, 79 consecutive patients with 80 acetabulum fractures were treated in our department. The evaluation of the fractures is based on radiographs in three projections (anteroposterior, oblique obturator view and iliac oblique view) and CT at admission and three projection radiographs at follow up. 42 patients with 43 displaced fractures were operated on (54%) and 37 patients (46%) were treated conservatively. Among the operatively treated fractures, 34 (79%) were complex (6 anterior column and wall, 9 both column, 15 transverse and posterior wall, 1 posterior hemitransverse and anterior column and 3 T-shaped fractures) and 9 were elementary (1 anterior wall, 3 anterior column, 4 posterior wall, 1 posterior column and 1 transverse). There were 27 hip dislocations (63%) and 4 sciatic nerve palsies.

Results: Anatomic reductions (1 mm or less step on the 3 radiograph views) were achieved in 37 (86%), satisfactory (2–3 mm step) in 2 and unsatisfactory (>3 mm step) in 4 (9%) patients. If gap was included in the evaluation of the postoperative radiographs, anatomic reductions (1 mm or less step and/or gap) were achieved in 24 (56%), satisfactory (2–3 mm step and/or gap) in 12 (28%) and unsatisfactory (>3 mm step and/or gap) in 7 (16%) patients.

Four patients had pulmonary embolism and one of these had deep vein thrombosis. Deep infection was seen in one patient with open pelvic and acetabular fracture and in an elderly alcoholic patient with a posterior wall fracture. Partial sciatic nerve palsy was seen in two patients (5%).

Conclusion: Good to excellent reduction was achieved in 85% of the patients with an acceptable complication rate. The results are comparable with data from other international trauma centers.

79. Stabilization of ligamentous pelvic ring disruptions

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Ligamentous pelvic ring dislocations occur by rupture of the symphysis or ligaments of sacroiliac (SI) joint. In such cases the pelvic ring is unstable except for the isolated rupture of the symphysis. Conservative treatment requires a prolonged period of hospitalization and is frequently associated with complications.

Patients and methods: 37 patients with unstable pelvic ring disruptions were studied following external fixation (10 cases) and/or open reduction and internal fixation (31 cases). All dislocations had greater than 1 cm of displacement. 22 patients had severe associated injuries. The average time to surgery was 10 days, but in 4 cases internal fixation was performed in association with emergency laparotomy or urologic exploration. Isolated rupture of symphysis was fixed with a four-hole AO plate (3 cases) or tension band wire (12 cases). External fixation with an anterior frame was employed in 6 patients with polytrauma in order to achieve stability with minimal surgical trauma. Dislocations of the SI joint were fixed with two anterior two-hole plates (6 cases) or two tension band wires (3 cases). 4 cases of SI joint dislocation and/or fracture were stabilized using two threaded compression rods. Patients sustaining pelvic disruptions with combined anterior and posterior instability were managed in two steps: first ORIF or external fixation of anterior ring and later posterior ring stabilization.

Results: The duration of bed rest ranged from 3 to 17 days. None of the fractures were complicated by infection. The obtained reduction was maintained in all cases except 3 vertical shear injuries treated with external fixation alone. All patients were assessed at an average follow-up of 34 (12–54) months. 27 patients claimed to have no discomfort. 5 had moderate back pain. 3 of them were fixed with the external fixation frame alone and radiologically had residual displacement of the SI joint. 3 patients had neurological complications. 4 patients walked with a limp, and 2 of them had leg length discrepancy of 15 mm.

Conclusions: Operative stabilization of pelvic ring disruptions is preferable in treating these multiply-injured patients. An anterior frame alone is insufficient in stabilizing the vertical shear injuries.

80. Transiliacal screw fixation of the sacrum in unstable pelvic ring fractures

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External fixation alone is insufficient in the stabilization of the posterior instability in some pelvic ring fractures. The experience with transiliacal screw fixation is reported.

Patients: 10 patients, 8 men and 2 women, with fractures of the sacrum combined with anterior fractures in the pelvic ring or disruption of the symphysis, were operated on. Median age was 37 (23–69) years and observation time 24 (5–49) months. 5 patients had paramedian fractures through the foramina sacralia while two patients had iliosacral luxation fractures. All patients were polytraumatized and 5 patients had neurological symptoms prior to surgery.

Method: Preoperative evaluation with conventional radiographic examination and CT was performed. Signs of instability and neurological status were recorded. Operation was performed with the patient in prone position and under general anesthesia. After reduction of the fracture, a K-wire was

introduced as a guide through the iliosacral joint and the pedicle into the body of the first sacral vertebra under fluoroscopic control. Stabilization was obtained by one or two AO/ASIF 6.5 mm cancellous bone screw(s) with washer(s) to prevent cutting through the ilium. Two patients had additionally a disrupted symphysis stabilized by a plate osteosynthesis. Postoperative control of the fracture reduction and screw position was performed by conventional radiography and CT. All patients were mobilized on the second day after surgery or as soon as the other lesions permitted it.

Results: Consolidation of the fracture without secondary dislocation could be confirmed in all patients. 2 patients had remission of their neurological symptoms while 3 patients had remaining neurological symptoms like radicular pain and dysesthesia. No iatrogenic neurological symptoms were recorded at the follow-up examinations.

Conclusion: Iliosacral screw fixation of the sacrum in unstable pelvic ring fractures provides good stability. Early mobilization is possible. Good anatomical knowledge, and the use of fluoroscopy in different projections, is mandatory.

Hip fractures

81. Treatment of displaced femoral neck fracture—internal fixation versus bipolar endoprosthesis—a preliminary report of a prospective randomized study

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The treatment of displaced femoral neck fractures differs around the world. Many prefer initial treatment with arthroplasty due to the high risk of healing complications. Others, mostly in Scandinavia, prefer initial treatment with internal fixation and a later reoperation with arthroplasty in case of complications.

In the purpose of finding the advantages and disadvantages of the two treatments we started a prospective randomized study of displaced femoral neck fractures in Sundsvall february 1992. This is a preliminary report.

Patients and method: All displaced femoral neck fractures (Garden 3-4) in patients over the age of 70, with walking ability and without concurrent hip diseases e.g. rheumatoid artritis, were randomized to either bipolar hemiprosthesis ad modum Variokopf or intermal fixation with von Bahr screws.

The patients were followed with clinical and radiographic examinations at 4 months, 1 year and 2 years. 90 patients have been followed for at least 1 year until the end of Dec. 1995.

Result: Each group contains 45 patients with a mean age of 80 years and a mean hospitalisation time of 17 days. In the group with internal fixation, 27 required a reoperation: 6 screw extractions, 13 total hip replacements and 8 hemiarthroplasties.

In the bipolar group, there has been 7 reoperations including 4 closed reductions because of early postoperative luxation, 2 open reductions due to interprosthetic dislocation and 1 reoperation with a total hip because of recurrent dislocations.

Conclusion: In selected patients with displaced femoral neck fractures, a primary bipolar hemiarthroplasty may be used.

82. Osteosynthesis of femoral neck fractures with 3 Ullevaal screws

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Our aim was to investigate the results after osteosynthesis of femoral neck fractures with 3 Ullevaal screws.

Patients and methods: In a period of 27 months from January 1993, 49 femoral neck fractures was osteosynthesized with 3 Ullevaal screws. The preoperative radiographs were classified according to degree of osteoporosis and Garden classification. The postoperative fracture dislocation was determined by Gardens alignment index on the postoperative radiographs. Failures of screw position were evaluated. Preoperatively and at the latest visit to the outclinic, social and functional conditions was recorded. The latest radiographs were evaluated according to healing complications and loosening of the screws.

Results: Mean age was 75 (SD 14.4) years. The mean follow-up period was 12.2 (SD 4.9) months. Two patients died within the first two months. 61% of the fractures were undisplaced, 39% were displaced. In 15 cases, the screws were removed after mean 7.1 (SD 3.5) months, in 7 cases because of local symptoms from the end of the screws, in 8 because of healing complications. There were 3 cases of avascular necrosis. 3 patients were reoperated on with a hemiarthroplasty and 2 with a total hip replacement. 2 patients were reoperated on within 3 months, both because of healing complications. 6 of the undisplaced and 6 of the displaced fractures had healing complications (NS). There was no significant correlation between healing complications and failure of screw positioning. Among the displaced fractures there was no significant correlation between healing complications and the results of fracture reduction. The degree of osteoporosis had no significant influence on loosening of screws or failures in healing.

Conclusion: 6% of the patients developed avascular necrosis and a total of 31% of the screws were removed, but only in half of these cases because of healing complications or loosening of the screws. The degree of osteoporosis and placement of the screws had no influence on the frequency of complications. 32% of the displaced fractures had healing complications.

83. The evaluation of suspected hip fractures—presentation of an algorithm

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In the literature it is recommended that patients suspected of a hip fracture with normal radiographs are evaluated by scintimetry, CT or MRI to reveal a possible occult hip fracture. We present a prospective study of a systematic diagnostic approach (algorithm) evaluating patients suspected of a hip fracture.

Patients and methods: During 1994, an algorithm was applied to all patients suspected of a hip fracture. Patients with an earlier hip fracture, rheumatoid arthritis involving the hip or arthrosis were excluded.

Results: Radiographs revealed 394 hip fractures in 573 patients. The remaining 179 patients were examined for suspected high intracapsular hip pressure (SHIP), painful flexion and internal rotation. This was present in 31 patients in whom CT revealed 10 hip fractures and in one patient with hemarthrosis without a fracture. However, subsequential MRI in this case showed a femoral neck fracture. Of 148 patients with normal radiographs and without SHIP, 116 patients were mobilized at home, whereas 32 needed some days in hospital because of additional lesions. During a 3-months follow-up, 3 patients without SHIP presented 2 femoral neck fractures and one trochanteric fracture, all nondisplaced.

Conclusion: Compared to earlier studies, the presented algorithm is a reliable diagnostic tool, minimizing the use of extensive diagnostic modalities.

84. Hip-protectors—primary acceptance and compliance after 3 months

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External hip-protectors are a new supplement to prevent hip fractures, but only few data are available regarding primary acceptance and compliance.

Method: In an orthopedic department patients aged 75 years or more were offered three pairs of impact-dispersing hip-protectors (SAFEHIP®). The patients who accepted were three month later asked about there use of the hip-protectors.

Results: Hip-protectors were offered to 671 patients with a primary acceptance of 57%. The acceptance was unaffected by differences in sex, living in the community/nursing-home or by self-reported visual impairment. On the contrary, primary acceptance was influenced by the presence of a hip fracture or tendency to fall. Fear of falling and dizziness increased the acceptance. Questionnaires were posted to 172 patients and 151 (87%) replied. Regular use was reported by 116 patients and 112 continued to use hip-protectors. This was unaffected by the above mentioned factors.

Conclusion: Primary acceptance of external hip-protectors was 57% in old inpatients in an orthopedic department. After three months between 65% (112/172) and 75% (112/151) continued to use hip-protectors.

85. Preoperative skin vs. skeletal traction in patients with hip fractures—the effect on pain and on patient flow characteristics

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In order to compare the effect on the reduction of preoperative pain of skeletal and skin traction, all dislocated hip fractures (cervical, sub- and pertrochanteric) were randomized in a prospective series after informed consent. 153 patients have been considered for the series. 75 were excluded because informed consent could not be obtained usually due to senile confusion, leaving 78 patients for randomisation.

Patients and methods. 57 women and 21 men with an average age of 81 (58–97) years were included. There were 43 cervical and 35 pertrochanteric fractures. 40 (22 cervical and 18 pertrochanteric) had skin traction and 38 (21 cervical and 17 pertrochanteric) had skeletal traction. In the excluded group there was a similar sex (15 men, 60 women) and age (83, range 67–101 years) distribution but somewhat more pertrochanteric fractures (34 cervical and 41 trochanteric). Pain was evaluated before and after the application of traction with a Visual Analog Scale and by the number of doses of analgesics given. The time elapsed between arrival at the hospital and the taking of radiographs, the application of traction and transport to the ward as well as to operation and operation time were recorded. Pain was correlated to fracture type and to type of traction.

Results: Use of analgesics: There was no difference in the use of analgesics between the groups before application of traction. The skeletal traction group required slightly fewer doses of analgesics on the ward, 1.7 compared to 2.5 ($p=0.03$) On the VAS scale there was a significant reduction of pain both after the administration of analgesics (6.7 to 4.3) and after the application of traction (3.4) $p<0.0001$, but there was no difference between skin and skeletal traction. There was also no difference between fracture types with regard to pain. 1/5 of skin traction patients and 1/2 of skeletal traction patients found the application of traction painful, ($p=0.03$, chi-square).

Patient flow characteristics: There was no significant difference between the groups with regard to the length of time it took for the patient to go through radiography to the ward after admission. Complications: No complications were seen with either traction type.

Conclusions: Both types of traction were equally effective in reducing immediate pain when measured with the VAS scale. Analgesics given were also effective in reducing

pain. The skeletal traction group required fewer doses of analgesics on the ward, but the difference has no clinical significance. On the other hand, the application of skin traction caused the patients less discomfort. Although skin traction could be applied by the nursing staff alone it did not expediate the patients' transfer to the ward from the emergency department. When used to reduce pain, we recommend skin traction before skeletal traction.

86. Enquiry in Sweden on the use of traction preoperatively in patients with hip fracture and a radiological study on the effect of the traction on ten displaced cervical hip fractures

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The routine use of traction in hip fracture patients awaiting operation has been advised against in three reports (1–3). We reviewed how common the use of traction was in hip fracture patients preoperatively in Sweden and examined whether skeletal traction could have any impact on the reduction of the displacement of cervical hip fracture.

Method: In Nov. 1995, we conducted a nation-wide enquire including 78 hospitals on the use of traction preoperatively on cervical and trochanteric hip fracture. The radiologic study on 10 patients, aged 81 (70–88) years with displaced cervical hip fracture, compared the initial displacement of the fracture with the position of the fracture just prior to the operation and after skeletal traction (4–5 kg).

Results: One fourth of the 78 hospitals applied a skin traction as a routine before the operation of the fracture (Table). In the radiographic study, none of the ten displaced cervical hip fractures was improved by the skeletal traction and in 3 the position of the displacement was even aggravated.

Conclusion: We do not recommend the application of traction as a routine to patients with hip fractures.

References: 1. Finsen et al. Injury 1992; 23: 242.
2. Needoff et al. Injury 1993; 24: 317.
3. Anderson et al. J Bone Joint Surg 1993; 75B: 794.

Table. Use of traction for hip fractures in 78 Swedish hospitals

Traction	Cervical	Trochanteric
Skeletal to all	0	4
Skeletal to displaced	10	10
Skeletal if long waiting time	5	5
Skin traction to all	23	26
Skin traction to displaced	19	14
Skin traction if long waiting time	11	10
No traction	6	5
Others	4	4

87. Seinsheimer's classification of the subtrochanteric fracture—an assessment of the reproducibility of 4 observers in 50 cases

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The objective of this study was to examine the reliability of the Seinsheimer[1] classification system of subtrochanteric fractures of the femoral bone with special interest in type 3A.

Patients and methods: 50 consecutive sets of preoperative radiographs of subtrochanteric fractures were included in the study. The radiographs were assessed independently by 4 observers twice. All radiographs were classified according to the Seinsheimer classification system. Kappa- (κ-) statistics were used when focusing on type 3A.

Results: The interobserver variation was large; only 13 of the 50 radiographs were classified identically by all 4 observers. The intraobserver variation showed identically classification in 26–37 of 50 radiographs. When only assessing whether the fracture was subtype 3A or not, the 4 observers agreed in 31 of 52 radiographs with corresponding κ-values showing fair to moderate strength of agreement. The κ-values of intraobserver variation showed fair to good strength of agreement.

Discussion: Our results suggest that different observers apply the Seinsheimer classification differently. On this basis we do not find the Seinsheimer classification of subtrochanteric fractures valuable as a tool when planning the proper method of osteosynthesis preoperatively.

Reference: 1. Seinsheimer F. Subtrochanteric fractures of the femur. J Bone J Surg:1978; 60-A: 300-306.

88. Unstable per- and subtrochanteric femoral fractures—a comparison of treatment with the Gamma nail, Compression Hip Screw, or Dynamic Hip Screw with a Trochanter Stabilizing Plate

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Unstable trochanteric fractures represent a considerable treatment problem. Failure rates of up to 15% are reported with sliding screw-plate systems, and high reoperation rates have been reported with the Gamma nail. A Trochanter Stabilizing Plate (TSP) has recently been developed for lateral mounting on the Dynamic Hip Screw (DHS) to increase the trochanteric support in these fractures. In this prospective

study we compared the results after treatment of unstable trochanteric fractures with CHS, Gamma nail or DHS with the TSP.

Patients and methods: 99 patients with unstable per- and subtrochanteric fractures (according to Steen-Jensen and Zickel) were included in a prospective, randomized study from 1990–1992, and operated on with either CHS (n 44) or Gamma nail (n 55). In the successive period 1992–1994 all unstable fractures were consecutively operated on with DHS with a TSP, in a prospective series (n 109). 170 of the total of 208 patients were followed for 6 months, 38 died or were lost to follow-up, leaving 50 patients in the Gamma group, 35 in the CHS group, and 85 in the DHS/TSP group for calculations. Intraoperative fracture reduction, positioning of implant, operation time, postoperative complications, number of blood transfusions, and hospitalization time were recorded. At 3 and 6 months follow-up we recorded functions of daily living, healing of the fracture, and secondary fracture dislocation.

Results: The three experimental groups were demographically equal, and the different fracture types were evenly distributed between the groups. The operation time and the number of blood units used was equal in the groups. There were no differences in the rates of postoperative DVT, lung embolus or pneumonia. Wound infections, however, were more frequent in the Gamma and CHS groups as there were 8 superficial and 1 deep infection in the Gamma group (18%), 5 superficial infections in the CHS group (14%) compared with 2 superficial infections in the DHS/TSP-group (2.4%, p=0.02). All patients but one in each group received prophylactic antibiotics. Stay in hospital was mean 12.9 days in the Gamma group, 10.2 in the CHS, and 14.9 in the DHS/TSP groups (p>0.05). Concerning the patients' level of daily function, 8 patients in the Gamma group still used a wheel chair after 6 months, compared with 2 patients in the DHS/TSP group (p=0.001) and 2 patients in the CHS group. Lag screw cut out and delayed unions were equally frequent. The secondary displacement was less in the DHS/TSP group compared to the other groups, as lag screw sliding was less, and only 2.4 % of the fractures healed in >10° secondary varus dislocation (Table).

Group	Lag screw cutout %	Not healed %	Healed in sec. varus %	Lag screw sliding mm
Gamma	4.0	2.0	12.0	10
CHS	8.6	2.9	14.3	13
DHS/TSP	5.9	2.4	2.4[a]	6[b]

[a] p = 0.030 vs. Gammagroup, p = 0.022 vs. CHS- group.
[b] p < 0.001 vs. Gammagroup, p = 0.006 vs. CHS group

Discussion: The three different operation methods showed satisfactory results compared to previously reported series, both regarding postoperative complications and fracture healing. The Gamma patients had significantly more wound infections than the others, and recovered slowlier in regard to their walking ability. The failure rates for the Gamma, CHS and DHS/TSP groups were comparable regarding lag screw cutout. However, the Trochanter Stabilizing Plate reduced the degree of secondary fracture impaction and dislocation, as lagscrew sliding and secondary varus malalignment were less in the DHS/TSP group.

89. Two-way compression along the shaft and the neck of femur with the new Medoff sliding plate—94 unstable intertrochanteric fractures with a 1-year follow-up

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A new device for the treatment of unstable intertrochanteric fractures, originally called the axial compression screw, was introduced by Medoff in 1991. The device allows compression along the axis of the femoral shaft, while sliding of the lag screw is impeded by a locking set screw. In a series of 104 patients, 7 technical failures were recorded, all lag screw penetrations. In a modified version of the device, the new Medoff sliding plate (MSP), the locking set screw has been omitted to allow two-way compression along the shaft and the neck.

Patients and methods: 94 consecutive patients with unstable intertrochanteric hip fractures were treated using the new MSP and followed clinically and radiologically for one year. Technical failure was defined as lag screw penetration, breakage or loosening of the implant or non-union of the fracture.

Results: All fractures were united radiographically at one year. No postoperative technical failures were recorded. There was one intraoperative lag screw penetration of the femoral head. All plate sliding occurred during the first four months.

Conclusion: Two-way compression with the MSP is a challenge to other fracture fixation systems for the treatment of unstable intertrochanteric fractures.

Wrist/Hand

90. Percutaneous A1 pulley release—a simple reliable operation method

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The interest in percutaneous release of the A1 pulley has increased as the method is faster and less traumatic than open A1 pulley release.

Patients and methods: 36 consecutive patients (45 digits) were operated on between 1993 and 1995. All patients had reproducible triggering with intermittent locking at operation. 17 thumbs and 28 fingers were percutaneously released using a 1.4 mm hypodermic needle after subcutaneous local anesthesia. The follow-up was performed as a telephone questionnaire median 9 (1–26) months after surgery.

Results: 40 of the 45 operations were completely successful. 5 fingers developed recurring triggering. None of the patients reported any nerve damage or infection.

Conclusion: We consider this operation method to be reliable and safe with decreased efforts at operation and reduced costs. No patient was on sick leave postoperatively. Earlier studies have emphasized the potential risk of nerve injury especially in thumbs. In our material, more than half of the fingers were thumbs. We did not observe any increased complication rate with thumbs.

91. No improvement in strength when immobilising the wrist after open carpal tunnel surgery

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Some authors recommend immobilising the wrist with a splint or orthosis after carpal tunnel surgery in order to prevent loss of strength. We have found no documentation of this and performed a randomised prospective study in a consecutive series of 90 open carpal tunnel releases.

Patients and methods: 44 patients were randomly selected to wear a plaster of Paris splint for 2 weeks and then a wrist orthosis for a further two weeks. The remaining 46 patients were randomised to no postoperative immobilisation. Grip, keypinch, and opposition pinch (between thumb and 4th + 5th finger tips) were measured preoperatively, and 6 weeks and 6 months after surgery with Jamar dynamometers. Three measurements of each manoeuvre were made and the middle value recorded.

Results: Median grip and keypinch strength were identical in the two groups. For grip it was 76% after 6 weeks in both groups and after 6 months 104% of the preoperative value. Keypinch was 83% after 6 weeks and 90% after 6 months in both groups. Strength in opposition of the thumb was 67% in both groups after 6 weeks. After 6 months, however, it was 72% (95% confidence interval 57–83) in the immobilised patients and 83% (95% CI 73–100) in the not immobilised patients (p=0.04).

Conclusion: 4 weeks of postoperative immobilisation does not improve strength during the first 6 postoperative months.

92. Analysis of results following endoscopic carpal tunnel surgery

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Our aim was to analyze the outcome of endoscopic carpal tunnel release and to identify the factors associated with patient satisfaction with the results of surgery.

Patients and methods: 179 patients (135 women and 44 men), mean age 51 (21–87) years, with idiopathic carpal tunnel syndrome underwent unilateral endoscopic carpal tunnel release. All patients were evaluated preoperatively and 3 and 6 months postoperatively by an independent examiner. Evaluation included patient history, symptoms, sensibility, grip strength, distal motor latency, scar/pillar tenderness and ability to perform 12 activities of daily living (ADL) scored 1 to 5. For statistical analysis the chi-square test, the Spearman correlation coefficients and multiple logistic regression analysis were used.

Results: 81% of the patients were satisfied with the results of surgery at 3 months and 85% at 6 months postoperatively. Neither univariate nor multivariate analysis showed any correlation between patient satisfaction and the preoperative variables sex, dominance of the operated hand, type of occupation, duration of symptoms, two-point discrimination, Semmes-Weinstein monofilament sensibility and thenar atrophy or weakness. However, both types of analyses revealed significant correlation between patient dissatisfaction and the preoperative variables unemployment and normal distal motor latency ($p<0.05$) as well as prior heavy vibration exposure ($p<0.001$). Multivariate analysis of all preoperative and postoperative variables showed that the factor having the strongest correlation with patient dissatisfaction at 3 and 6 months postoperatively was high (i.e. poor) postoperative ADL score ($p<0.001$).

Conclusion: Difficulties in performing activities of daily living seem to have a strong and consistent association with patient dissatisfaction with the results of surgery in carpal tunnel syndrome.

93. The Use of a self-administered outcome instrument in carpal tunnel syndrome

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Standardized instruments that measure outcomes of concern to patients including symptoms, function and satisfaction are being increasingly used in clinical practice. A self-administered questionnaire for the assessment of symptoms and functional status in carpal tunnel syndrome (CTS) has been introduced and shown to have high reliability and validity[1]. We developed and prospectively evaluated a Swedish ver-

sion of the CTS Instrument consisting of two multi-item scales measuring symptom severity and functional status. Each item is scored from 1 (no symptom or functional disability) to 5 (most severe symptom or functional disability). The score of each scale is the mean of the scores of all items in the scale.

Patients and methods: 63 consecutive patients (46 women and 17 men), mean age 51 (23–88) years were given the self-administered CTS Instrument prior to carpal tunnel release. Three months post-operatively the patients were evaluated by an independent examiner and given the CTS Instrument including in the last 48 cases an item regarding satisfaction with the results of surgery. Internal consistency of each scale was assessed with the Cronbach alpha. Sensitivity of the instrument to clinical change was assessed by calculating the effect size for each scale. Scores were also analyzed as related to patient satisfaction.

Results: Internal consistency: The Cronbach alpha was 0.83 for the symptom severity scale and 0.88 for the functional status scale indicating high inter-item correlation. Sensitivity to clinical change: The mean preoperative symptom severity score was 3 (SD 0.7) and functional status score 2.5 (SD 0.8). Three months postoperatively the mean symptom severity score was 1.5 (SD 0.6) and functional status score 1.5 (SD 0.7). The effect size was 2.1 for the symptom severity scale and 1.2 for the functional status scale indicating a large change in health status. The mean postoperative symptom severity score was 1.3 (95% Confidence Interval 1.1–1.5) for the 35 patients who were satisfied with the surgical outcome, 2.1 (CI 1.7–2.5) for the 10 patients who were somewhat satisfied and 2.8 (CI 1.6–4.1) for the 3 patients who were dissatisfied. Similarly the mean functional status score in the three groups was 1.3 (CI 1.2–1.4), 2.2 (CI 1.7–2.7) and 2.8 (CI 1.9–3.7), respectively.

Conclusions: The two scales of the CTS Instrument appear to be internally consistent and sensitive to clinical change. The instrument can provide a reliable standardized measure of the severity of symptoms and functional status in CTS.

Reference: Levine et al. J Bone Joint Surg 1993; 75A:11.

94. Digit replantation and revascularization in children

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We have studied the survival rate and functional results of 26 replantations and 20 revascularizations in 34 children carried out in our hospital from 1984 until June 1995. The mean age of the children was 8 years (20 months–15 years). The overall survival rate was 37/46. Complete and incomplete amputated digits had a survival rate of 19/26 and 18/20, respectively. The survival rate varied with the nature and degree of injury. All 5 digits with a guillotine amputation survived (3 complete and 2 incomplete). Of the 3 digits injured by mild crush 1 went to necrosis. In the diffuse crush-group we found a survival rate of 12/17 for complete amputations and 12/14 for incomplete amputations. Avulsion injuries had a survival rate of 4/5 and 2/2 for complete and incomplete amputations, respectively.

The 27 children with 37 successfully replanted/revascularized digits had a mean follow-up of 17 months. We graded the overall function according to the Tamai score (J Hand Surg 1983; 8: 730-2). 9 children with complete amputations were tested at an age of 6.5–16 years. Excellent results were seen in 2 children, good in 3 and fair in 4. None had poor result. 11 children with incomplete amputations were tested at an age of 6–16 years. Excellent results were seen in 6, good in 3 and fair in 2 children. None had poor result.

We conclude that any child suffering a traumatic amputation of a digit should be evaluated for possible replantation.

95. Hand and distal forearm replantations/ revascularizations

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We report the results of 58 hand and distal forearm replantations/ revascularizations performed at our hospital from 1983 to March 1995.

Patients and methods: There were 9 double level amputations. The mean age of the patients was 39 (6–75) years, the male-female ratio 51/6, and 10 patients had attempted suicide. The amputation level was metacarpal in 11 cases, carpal in 16, distal radius in 17 and mid radius in 14 cases. 26 amputations were complete. Of the 32 incomplete amputations 24 were revascularized by arterial reconstrucion alone and 8 by both arterial and venous reconstructions.

Results: We achieved total limb salvage in 42 cases. 12 limbs were partly salvaged, 9 of which belonged to the double level group. A total number of 22 digits were lost in these 12 patients. 3 severe crushed hands were removed in the early postoperative period, and 1 revascularized hand was removed after 2 weeks due to severe soft tissue damage. Patients with complete and incomplete amputations achieved a grade I or II function after Chen/Axelrod/Buchler in 56% and 73% of the cases, respectively. Corresponding numbers for grade IV function (poor results) were 16 and 7%.

Conclusion: Hand and forearm replantation provides useful hand function in most of the patients.

96. Thumb reconstruction using microsurgery

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The best treatment of thumb amputation is replantation. Since 1983 we have replanted/revascularized 146 thumbs with a success rate of 73%. In those cases where replantation was not possible, or surgery was not successful, we offered the patients reconstruction of the thumb.

Patients: In 33 cases (32 patients) we did a second-toe transplantation to replace the thumb. In 5 patients we used the wrap-around technique, while in 2 cases we did thumb reconstruction by thumb transfer from the contralateral paralyzed hand. The second-toe transplantation was chosen to affect the function and apperance of the foot as little as possible. The wrap-around technique was prefered when the patient had a distal amputation or had a glove lesion of the thumb. The wrap-around transfers have been performed as an acute procedure in 3 cases where the demand for soft tissue and skin have been solved by the wrap-around toe including skin from the dorsum of the foot. In 1 case the skin was allowed to heal before surgery, while in the last case the surgery was performed 13 years after the accident.

Results: The second-toe transfer failed in five cases, while the wrap-around transfers as well as the cross thumb transfers all succeeded.

Conclusion: Cosmetically, we find that the wrap-around toe is preferable compared to the second-toe transplantation. The donor-site morbidity in the wrap-around toes is less than feared. The function is good in both procedures. In the future we prefer useing the wrap-around technique whenever possible.

97. Prediction of falls—a prospective population based study

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Fractures are usually caused by falls. An increase of fracture incidence in urban population during the last decades renders identification of future fallers important. In the present study, various physical variables and social background factors were evaluated in a prospective registration of falls and fractures during a 1-year period.

Material and methods: 242 men aged 50–80 and 328 women aged 40–80 were included in the original study group. General health and physical performance were evaluated and falls were reported during the following one year period.

Results: 50 women and 18 men were recorded as fallers. 13 women and 5 men had a fracture. Slow walking speed and more steps among the older men and younger women was observed among fallers. Older men and younger women fallers were weaker in their knee extensors and flexors respectively. However, knee flexor strength was better among older women fallers. The most likely predictor for a future fall was impared stability for men and reduced walking speed for women. Of the background factors, reduction in outdoors walking ability and bad health perception were found to be predictive of a fall.

Discussion: Several risk factors could be altered. Screening in order to detect future fallers may be aimed at probands with reduced outdoor walking ability. They could be invited and tested using simple tests such as measuring walking-speed, counting the number of steps together with the ability to balance on one leg.

98. Changes in the incidence of forearm fractures in Malmö

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An increase in the incidence of forearm fractures was discovered in Malmö, when comparing the 1950's with the 1980's. The purpose of this study was to add a further decade of observation of the same population.

Material and methods: Data on all forearm fractures during 1991 and 1992 were collected at the Department of Radiology. All films were examined and fractures caused by neoplastic metastases and old fractures were excluded. The fracture incidence was calculated and compared with previously published data from 1953–1957 and 1980–1981.

Results: For men, a 40–70% increase was found in the incidence in age groups 10–19 and 50–69 and a 50% reduction in the 70–79 group compared with the 1980's. Compared with the 1950's the incidence increased 1.8–6 times in all age groups, except for 70 and older. For women, a reduction of the incidence by 40–55% was found in age groups 30–69, comparing the 1990's with the 1980's. Comparison between the 1990's and the 1950's revealed no significant changes in the incidence except for a 2.5–3.4 fold increase in the age groups over 70.

Days of ambient temperature below 0 °C were on average 82.6 during 1953–1957, 107 in 1980–1981 and 46.5 in 1991–1992. When adjusted for this, the difference in incidence between the 1980's and 1990's seems to disappear.

Discussion: The secular increase in incidence of forearm fractures among women appears to be interrupted, when comparing the years 1991–1992 and 1980–1981, but not when comparing the 1950's and the 1990's. Among men, the incidence appears to be increasing, even since the 1980's. The reduction in incidence among women may partly be explained by warmer weather during 1991–1992 than in 1980–1981. However, the incidence is a higher in the 1990's compared with the 1950's even if there were fewer sub-zero days during the former period. This indicates more prevalent osteoporosis in the 1990's.

99. Internal fixation of articular fractures of the distal radius

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Difficulties in achieving and maintaining a congruent articular surface by closed means have led to an increasing advocacy of open reduction to restore the distal radial joint surface. The aim of the present study was to assess the anatomical and functional outcome in patients with open reduction and internal fixation of articular fractures of the distal radius.

Patients and methods: 31 consecutive patients (10 women, 21 men), mean age 43 (SD 15) years with articular fractures in which reduction of the joint surface could not be obtained by closed means, had open reduction and internal fixation of the fragments with a T-plate and small fragment screws, with or without K-wires and bone grafts. Dorsal or palmar approach was used depending on the dominant primary displacement and angulation. All high-energy injuries and all patients with a palmar approach had the carpal tunnels opened. The length of the radial styloid distal to the ulna in the AP-view, the dorsal angulation in lateral radiographs, the articular step-off, and the intra-articular gap between major fragments were measured before and after the operations and at union. Osteoarthrosis and the functional outcome were assessed after a mean follow up of 48 (SD 13) months.

Results: The mean dorsal angulation improved from 18° to –4°, the radial length from 2 mm to 11 mm. The articular step-off and intra-articular gap improved significantly after surgery, leaving only one patient with step-off and two with gap of 2 mm, respectively. At follow up 6 patients had no osteoarthrosis, 15 had minute osteophytes, and 10 had moderate changes. No patients had severe osteoarthrosis. 16 patients had no pain, 9 had some discomfort in activities, 3 had occasional pain, and 3 frequent pain. The median Gartland and Werley's demerit point score was 2. The results were classified as excellent or good in 26 patients (84%), and fair in 5. Two patients had rupture of the EPL tendons, one developed a severe wound infection followed by carpal tunnel syndrome, and one developed compartment syndrome.

Conclusion: Articular incongruity in young and active elderly patients should be treated aggressively. With open reduction and internal fixation, an improved fragment alignment is generally attained, resulting in satisfactory function of wrist and fingers.

100. The operative treatment of unstable Colles' fractures

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In spite of the numerous treatment modalities used for resolving the problem of the intraarticular distal radial fractures, there are some cases where the good results can not be anticipated using the well known methods. A subgroup of the AO type 23C2 fractures in which the dorsal cortical bone is fragmented, its buttress function is lost, the thin distal fragment bearing the joint surface can not be completely stabilised by a buttress plate or a fixateur externe. For this type of fracture a new operative solution has been developed in which a rectangular part of the dorsal cortical surface of the radius in the vicinity of the fracture line is oscillated and advanced so that it holds and stabilises the reduced joint surface. The method has been applied in three cases by the authors. After a 6-months follow-up period, good radiological and functional results were found. These early results are encouraging and we continue the examination of this method on larger groups of patients.

101. Arthroscopic treatment of TFCC lesions in the wrist

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The Triangular Fibrocartilage Complex (TFCC) is an important, though often underestimated, anatomical structure.

Patients and methods: 25 patients (group A) with peripheral TFCC lesions (13 women, 12 men, age 31 (17–59) years) were treated with debridement and outside-in suturing technic arthroscopically. Duration of symptoms were 21 (5–60) months and 23/25 patients reported clicking. 20 patients had a history of falling on outstretched hand or forceful hyperextension. Concomitant lesions were common, mainly radius fractures. 43 patients (group B) with central/radial lesions (21 women, 22 men, age 35 (11–52) years) were debrided with forceps and motorized burr. Duration of symptoms were 24 (2–60) months, 32 patients reported clicking. Common concomitant lesions were radius fractures (11) and osteochondral lesions (16). Postoperatively the patients had unrestricted rehabilitation.

Results: In group A 15 patients (63%) were assessed as excellent/good, 9 as fair/poor (follow-up time 8 (2–18) months). We had three complications with temporary neuropraxias of the dorsal sensory ulnar nerve branch. In group B 30 patients were assessed as excellent/good (71%), 12 as fair/poor (follow-up time 4 (1–11) months), no complications.

Conclusion: Both peripheral and central/radial TFCC lesions are adequately treated arthroscopically with respectively percutaneous suturing or resection. Patients with isolated lesions of TFCC have a good prognosis, patients with significant concomitant lesions often need additional treatment.

102. Reconstructive procedures for posttraumatic wrist deformity

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Impaired function and pain after malunion of distal radius fractures may be caused by derangements of the radiocarpal, ulnocarpal, and distal radioulnar joints. We report our experiences with radial osteotomy and/or ulnar shortening with or without reattachment of the triangular fibrocartilage complex (TFCC).

Patients and methods: 30 consecutive patients (19 women, 11 men), median age 43 (10–70) years were operated on. The aim of the procedure was anatomical correction of the distal radius and realignment and stabilisation of the distal radioulnar joint. Corrective osteotomy of the radius and corticocancellous bone graft (length 5–20 mm) from the iliac crest was performed in 25 patients without degenerative changes in the wrist joint. Two of these were combined with ulnar shortening. In 5 patients with only moderate dorsal angulation of the radius, shortening of the ulna was performed. In 4 of the operated on patients the TFCC had to be reattached because of persistent instability of the distal radioulnar joint. The median time between the fracture and the corrective osteotomy was 1 (0.5–6) years.

Results: The median preoperative dorsal angulation had been reduced from +19° (–35° to +30°) to –2° (–20° to +15°) (normal values –12° [–4° to –23°]), the radial inclination from 11° (–5° to +40°) to 21° (10°–29°) (normal values 23° [16°–35°]), and the ulnar variance from 6 (2–15) mm to –1 (–4 to +5) mm (normal values –1 [–4 to +2] mm). The median range of motion at follow up (4 years) was 87% of the joint on the opposite side. Pre-operative symptoms with pain were improved in all but 2 patients. 4 patients were reoperated: one because of loosening of the graft, one had resorption of the graft and fracture of the plate, one had non union of the ulna, and one because of progressive pain. The latter had a wrist fusion 20 months after the osteotomy. The 4 patients with open reattachment of the TFCC all had adequate stability of the distal radioulnar joint.

Conclusion: These procedures are effective if correct orientation of the distal radius is achieved together with congruency and stability of the distal radioulnar joint.

External fixation

103. The Ex-fi-re external fixator versus locked intramedullary nailing in tibial fractures—a prospective randomized study

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The aim was to compare the Ex-fi-re external fixator with locked intramedullary (IM) nailing in tibial fractures needing operative stabilisation.

Patients and methods: Ex-fi-re is a unilateral, dynamic axial fixator. A reduction unit can provide accurate fracture reduction. The Grosse-Kempf nail with reaming was used for the nailings. 79 fractures entered the study (41 Ex-fi-re, 38 IM nails).

Results: Time to fracture union and full weight bearing was identical, but unprotected weight bearing (no crutches or brace) was achieved earlier in the nailed group (12 vs. 20 weeks; $p<0.001$). Infection problems were equally distributed. There was a tendency to more reoperations due to secondary dislocation in the Ex-fi-re group. There were no differences in angular or shortening deformities, but there was a tendency to more torsional deformities after IM nailing.

After 6 months there were no differences in knee motion, ankle motion, fracture site pain or ankle pain. 60% of the nailed patients developed anterior knee pain.

Conclusion: Anterior knee pain is a frequent problem after IM nailing. Unprotected weight bearing is achieved earlier after nailing. The results were comparable in most other respects.

104. External fixation of ipsilateral fractures of the femur and tibia

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The concomitant ipsilateral fractures of the shaft of the femur and tibia result from severe trauma. These fractures are often combined with extensive soft tissue injuries. All the relevant reports in the literature emphasize the importance of early mobilization of these patients to facilitate their better care and quick respiratory recovery.

Patients and methods: We reviewed 66 simultaneous fractures of the ipsilateral femur and tibia in 64 patients. Both femoral and tibial fractures were treated with circular Ilizarov (22 cases) or Kalnberz (44 cases) external fixation devices. There were 44 men and 20 women with an age range of 14–82 years. The main indication for external fixation was open fractures of one (39) or both (3) segments with extensive soft tissue trauma. Two patients sustained open fractures of both the femur and the tibia, 19 patients had at least one concomitant fracture in another extremity and 21 had other associated injuries. External fixation devices were applied at patients admission (22 cases) or within 21 days after injury (44 cases). In most cases both femur and tibia were operated on simultaneously with two separate teams of surgeons.

Results: The period of hospitalization was mean 29 (14–

109) days. The patients who had no associated injuries were mobilized within the first day after fixation. The incidence of pin tract infection was 27%, but there were no cases of deep infection or osteomyelitis. The average time spent in the external fixator for femoral fractures was 15.7 weeks, while the tibial fractures healed in average in 19.2 weeks. All 66 femoral fractures healed without additional surgery, but there were 8 cases of tibial refracture. They healed after plating and application of an autogenous bone graft. Of the 55 patients who had long-term (2–12 years) follow-up, 46 had normal function without major orthopedic problems. The remaining 9 patients (16%) had a compromised result due to limb-length discrepancy, angular deformity, or instability of the knee.

Conclusions: External fixation is a well-proven technique for managing ipsilateral fractures of the femur and tibia. It provides stable fixation with minimum surgical trauma.

105. Increased fixation with hydroxyapatite-coated pins for external fixation

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Patients operated on with the hemicallotasis of the tibia were randomised to either standard or hydroxyapatite-coated cortical pins. The indication for surgery was medial gonarthrosis, grade I-III.

Patients and methods: There were 12 men and 7 women, age 54 (38–75) years. An external T-shaped fixator was mounted on the ventral proximal part of tibia. The osteotomy was made at the level of the tibial tuberosity. Angular distraction started 7–10 days later and aimed for a valgus correction of 4°. The fixator was locked and kept in place until healing. The torque-force was measured at insertion and extraction time.

Results: The standard pins lost their fixation during fixation time, most pronounced in the metaphyseal bone, but the fixation with the hydroxyapatite-coated pins was significantly increased (Table).

Table. Extraction torque force. PM - proximal medial pin, PL -proximal lateral pin, DP – distal proximal pin and DD – distal distal pin. Nmm

	Standard pins	HA-coated pins	P-values
PM	2 (0–10)	482 (0–780)	<0.001
PL	2 (0–20)	478 (200–700)	<0.001
DP	277 (25–700)	585 (250–800)	0.003
DD	249 (25–440)	620 (300–800)	<0.001
Fixation(d)	98 (76–129)	105 (61–155)	n.s.

There were no statistical difference in pain, pinsite-problems, distraction- or fixation time.

Conclusion: The pin fixation was enhanced using HA-coated pins compared to standard pins for external fixation.

106. Hemicallotasis and gonarthrosis—a 1-year follow-up of a pilot study

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The results of high tibial closed wedge osteotomy are correlated to the achieved correction and the operation technique is quite demanding. We report the results of a pilot study concerning valgus correction with the hemicallotasis technique.

Patients and method: 16 patients, 12 men and 4 women, age 50 (33–61) years, with medial gonarthrosis degree I–III (Ahlbäck) were included.

A partial corticotomi was performed at the level of the distal third of the tibial tuberosity. A ventral T-shaped external fixator was used and angle distraction began 7–10 days postoperatively. The correction aimed for was a valgus angle of 4° (HKA). Fixation was continued until healing. Full weight bearing was allowed immediately.

Results: Preoperative HKA angle was 171° (161°–179°), and postoperatively 184° (178°-187°). Sick-leave was 16 (2–37) weeks. HSS-, Lysholm-, Tegner-, and the NHP-scores of pain and physical mobility were significantly improved at the 1-year follow-up ($p<0.05$).

Complications: There was 25% pin site inflammation/infection. One case of deep vein thrombosis and one case of complete corticotomy due to a fall trauma were recorded.

Conclusions: Hemicallotasis is a simple method with good opportunities for a precise correction. The complications were minor.

107. Monitoring of distraction forces and load-share in Ilizarov frames during limb lengthening procedures—preliminary results

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Maturation of the callus in the regenerate zone during the consolidation phase in limb lengthening is usually hard to assess by radiographic methods. Correspondingly, the due time for removal of the external device is not easy to decide on and the incidence of refractures is relatively high. The aim of this study was to explore if measurements of the involved forces and the distribution of load between the external frame and bone regenerate would give us more exact information about the mechanical properties (i.e strength) of

the new bone. Consequently, the frame could be removed as early as possible without risk of fracture occuring under normal loading conditions.

Patients and methods: Three force transducers were evenly suspended across the callutasis lengthening zone between the proximal and distal Ilizarov ring systems, and measurements were recorded at various times during the distraction and consolidation phases of the lengthening procedure. During weight bearing, the reaction force from the ground was measured by a force plate, and the corresponding increase in frame forces as a percentage of total reaction force was calculated as the frame's load-share.

Results: Forces increased during lengthening and were measured up to 560 N at the end of the distraction period. Load-share measurements corresponded well with radiographic findings and decreased under 10% at the end of the consolidation period. At this time the fixator was removed. No fractures have been seen postoperatively in these patients.

Conclusions: Force and load-share monitoring looks promising and useful to control and secure optimal conditions during distraction and consolidation in limb lengthening procedures.

108. Tibial lengthening over an intramedullary nail by callutasis using the Ilizarov external apparatus

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Lengthening over a nail with application of an external device for the distraction period only has been started in patients with bilateral lengthening procedures to see if a reduction of time with external fixator will be profitable.

Patients and methods: 4 girls and 1 boy aged 16–19 years with a constitutional short stature have at the present time been lengthened on nine tibial segments by use of a proximal metaphyseal callutasis osteotomy, an Ilizarov external ring fixator and a Russel-Taylor intramedullary nail locked proximally. Two weeks after the desired length had been achieved, distal locking was performed and the external apparatus was removed.

Results: Because of short observation time for the last operated side, results are given only for the first leg. Deep intramedullary infection occurred in one patient. The remaining four patients had an average lengthening of 6.6 (5.3–7.3) cm. The mean observation time after removal of the frame was 14.4 (12–17) months. At the latest follow-up examination, full consolidation was not seen in any of the patients and the average lengthening index (treatment time/cm lengthening) in this study will be more than 2.7. In one patient an equinus deformity occurred. The four patients were subjectively satisfied and wanted the same procedure on the opposite side.

Conclusion: Lengthening of the tibia over an intramedullary nail using Ilizarov external distraction reduces the time in the external fixator. However, bone regeneration is slow. This has resulted in a change to the traditional callutasis lengthening.

109. Femoral lengthening and axial correction with the Ex-fi-re external fixation system

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With the reduction unit of the unilateral Ex-fi-re system, pinned fragments can be moved 3-dimensionally under full control of stability by turning of adjustment screws. These facilities can be used to correct axial deformities, and to prevent varus angulations often encountered in femoral lengthening, resulting from soft tissue tension and weigth bearing. Also translational displacement can be corrected by the adjustment screws.

Patients and methods: 11 femurs were lengthened on average 54 (40–110) mm in 10 patients by diaphyseal callus distraction. The average age was 19 (13–26) years, and the follow-up time was average 8 (4–12) years. There were 6 straight lengthenings and 5 combined lengthenings and axial corrections.

All the lengthenings were diaphyseal callus distractions at a speed of 1 mm daily, starting 2 week after the primary operative procedure. 4 osteotomies were performed with an open technique, and 7 percutaneously by multiple drill holes and blunt blow. In the 5 patients with axial deformities, the corrections were performed during the primary procedure. However, most patients had moderate varus and flexion angulation during distraction, which was corrected by the correction screws of the reduction unit at the outpatient clinic.

Complications: One patient sustained a femoral fracture during distraction at the site of the proximal unilateral pins, 1 had a delayed union, and 1 a reduced knee motion related to the procedure.

Results: All lengthenings fused without change of procedure but repinning, realignment and bone grafting was performed in one patient. Average 1.2 (1–2) surgical procedures and average 2.2 (1–4) anesthesias were given, including anesthesia at removal of the pins in 8 of the lengthenings. There was correct axis in all patients at follow-up. Time to removal of the fixator was 32 (20–51) weeks.

Conclusion: The unilateral reduction unit of the Ex-fi-re system is a reliable tool for femoral lengthening. It has the advantage of two plane correction by which axial deformities and displacements can be controlled. The use of inconvenient circular frames can be avoided

Spine

110. Clinical history in lumbar disc hernia

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Patients and methods: Clinical history data from 160 patients who underwent primary spinal surgery for lumbar disc hernia were investigated. At surgery the patients were classified into two groups: intact anulus (negative exploration and protruding disc) and ruptured anulus (subligamentary perforation and complete perforation).

Results: Logistic regression analysis revealed that the strongest variables predicting degree of herniation were duration of sciatica, progressive sciatic pain, educational level, and previous nonspinal surgical procedures. In patients with ruptured anulus the median duration of low back pain and sciatica was 16 and 10 weeks, respectively. The corresponding figures for the group with intact anulus were 79 and 50 weeks. This may suggest a different pathogenesis in the two groups. Moreover, 18% of those with ruptured anulus and 39% of those with intact anulus were under medical or psychiatric treatment for other diagnoses; 32% and 55% had previously undergone nonspinal surgery, indicating the importance of behavioral factors.

Conclusion: Our results and the previously reported paradox—that the best outcome after surgery befalls those with the most severe tissue injury—suggests that the two diagnostic groups are different, emphasising the importance of preoperative assessment of comorbidity and behavioral factors to explain discrepancies between impairment and disability.

111. A consecutive retrospective study of the result of microscopic lumbar disc surgery in 244 patients

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Since 6 years I have preferred using microscope in lumbar disc surgery. Two years ago I had the opportunity as an independent observer to control three of my collegues (two neurosurgeons, one orthopedic surgeon) results by this type of surgery.

Patients and method: A consecutive retrospective study of 244 patients operated on for posterolateral first time disc herniation was performed. The results were assessed by patient inquiries and by studying the medical charts. The minimum follow-up time was more than 2 years after the operation. 231 patients have answered. The symptom duration before operation, the average operation time, the bleeding and the clinical signs connected to radiography and operation findings were recorded.

Results: In 77% the pain in the leg disappeared directly after the operation, in 14% later on. In 8% the pain persisted. 94% described themselves as excellent or good, and 6% as the same or worse. 94% went back to work. Average sick leave after operation was 11 weeks. The only complication in this material was relapsed hernia in 11 patient (5%) which led to a second operation.

Conclusion: Microscopic disc surgery is, in a trained surgeons hand, when radiography is in accordance with clinic signs of lumbar disc herniation, a safe method which often leads to a good result and restored patients.

112. Neurologic signs in lumbar disc herniation—preoperative affection and postoperative recovery

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In assessing patients with radicular leg pain, the neurological examination is a most important factor. This investigation is focused on the neurologic signs of patients with lumbar disc herniation, preoperatively and sequentially during 2 years after the operation, with special reference to incidence and recovery of reflex/EHL-power disturbances and relation to the result of surgery.

Patients and methods: All the patients (n 165) operated on for disc herniation were included in a prospective and consecutive study with serial follow-up investigations. Mean patient age was 42 years and there were 72 women and 93 men.

A standard protocol was used preoperatively and 4, 12 and 24 months postoperatively. The protocol included data on result from SLR-test, crossed SLR-test, as well as results from neurological examination. Tendon reflexes and power of the extensor hallucis longus muscle were graded as normal, reduced or absent. The patient's opinion on the effect of the surgical procedure was evaluated using a 4-grade scale (excellent, fair, unchanged, deteriorated). The result of the postoperative neurological examinations were compared to the preoperative findings and the difference was classified into 4 possible categories: 1) improved, 2) unchanged normal, 3) unchanged deficient and 4) deteriorated.

Results: A relevant preoperative reflex/EHL-power disturbance was seen in 69% of the patients. Patients with a positive SLR-test more often had a neurologic disturbance. A short preoperative duration of sciatica correlated to a high frequency of reflex/EHL disturbances.

Of the patients with neurological afflictions preoperatively, improvement compared to preoperative findings was seen in 46% at 4-months follow-up, in 59% at 1 year and 63% at 2 years. Recovery was seen more often in patients with a preoperative symptom duration of less than one year.

The most favorable surgical results was seen in patients with neurological improvement: of these 89% reported excellent results, 8% fair and 3% unchanged at the 2-year fol-

low-up. Patients without deficit at pre- and postoperative examination and patients with unchanged neurological disturbance had similar results while patients with deteriorated neurological findings had the least favorable results.

Chi-square analysis yielded a significant correlation between excellent result and neurological recovery (p=0.018)

Conclusion: Reflex/EHL-power disturbances was seen in 69% of patients with lumbar disc herniation. Recovery was seen in half of the cases at 2 years postoperatively, the main part occured within the first 4 months after the operation. Neurologic recovery significantly correlated to a good surgical outcome.

113. Single and double level nerve root affliction in single level lumbar disc herniation

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The most common neurological affliction in disc herniation at the L3–L4 level is reduction of the patellar tendon reflex and at the L4–L5 level reduction of EHL-power. The nerve root medial to the nerve root overlying the afflicted disc, however, might be afflicted as well probably due to an intradural medial dislocation. Therefore, disc herniation at the L3-L4 level might cause reduction of the EHL-power and herniations at the L4-L5 level might cause reduction of the ankle reflex. This study evaluates the prevalence of this "double-level" nerve root affliction in patients operated on for lumbar disc herniation at L3–L4 and L4–L5 levels and also studies the pre- and postoperative clinical appearance and surgical outcome.

Patients and methods: All the patients operated on for primary disc herniation were included in a prospective and consecutive study with serial follow-up investigations. From this database, all 74 patients with disc herniation at the L3–L4 and L4–L5 levels were selected for this presentation. Mean patient age was 46 years and there were 31 women and 43 men.

A standard protocol was used preoperatively and 4 and 12 months postoperatively. The protocol included data on pain at rest, at night and on coughing. Use of analgesics and walking ability was recorded. Result from SLR-test was recorded as well as results from neurological examination. Tendon reflexes and EHL-power were graded as normal, reduced or absent, and according to the level of herniation, the type of nerve root affliction was graded into 4 categories: adequate level, adequate and distal level, distal level only and no deficit.

Results: A neurological disturbance was noted in 66% of the patients; in 49% involving adequate level only, in 15% adequate and distal level, in 3% distal level only. Pain was equally common in patients with single and double level affliction while a severe reduction of walking ability was commonest in patients with neurological disturbance. The SLR-test was positive < 30° in 53% of the patients with single level affliction compared to 17% in patients with engagement of the distal level. Surgical results were similar in patients with single and double level affliction and the neurological recovery was also similar at both levels, i.e. deficit of adequate and distal level recovered to the same extent.

Conclusion: Double level nerve root affliction in single level lumbar disc herniation was noted in 15%. Preoperative pain, surgical outcome and neurological recovery were similar in single and double level herniation.

114. Reduction of sick leave for back- or posterior pelvic pain in pregnancy

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Back- and or posterior pelvic pain is experienced by the majority of pregnant women, and 30% are on sick leave for that reason for an average of 7 weeks during pregnancy.

Patients and methods: This prospective, consecutive, controlled cohort study analysed the impact of an individual treatment program on sick leave for back- and posterior pelvic pain during pregnancy.

Results: The intervention group contained 54 women compared to 81 women in the control group. 33 women were on sick leave for an average of 30 days in the intervention group versus 45 women for an average of 54 days in the control group. Pain intensity was reduced and the expenses of extra physiotherapy was regained by a factor 10 through reduced costs from sick leave.

Conclusion: Sick leave from back- and/or posterior pelvic pain in the intervention group was significantly reduced with the treatment program. Large social insurance costs can be saved in this group of women.

115. Mobility provocation of lumbar fusion evaluated by radiostereometric analysis

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Fusion healing in the lumbar spine is difficult to evaluate by clinical and conventional radiographic examinations, but 3-dimensional radiostereometric analysis (RSA) can detect residual mobility within the fusion induced by change in position from supine to erect with high accuracy. The effect of more powerful spinal loading on the intervertebral mobility is not known. In the present study, RSA was used to determine the effect of enhanced mobility provocation on noninstrumented lumbar fusions considered healed.

Patients: All the patients in a previous study with noninstrumented posterolateral fusion between L5–S1 or L4–S1 considered healed as defined by RSA in supine and erect positions 1 year postoperatively were reevaluated with RSA at enhanced mobility provocation 4–6 years later. Mean age at the current follow-up was 39 (23-66) years for the 8 men and 2 women included. Indication for fusion had been spondylolysis-olisthesis grade 1–2 in 9 cases and disc/facet joint degeneration in 1.

Methods: All the fusions were RSA examined with the patients in the standardized positions: 1) supine , 2) normal standing, 3)sitting and 4) standing with sandbags weighing in total 20 kg on their shoulders. The translatory movements of the fused vertebrae induced by the change from the supine position to the other three intervertebral mobility provoking positions were calculated. The technical accuracy of this RSA set-up was calculated by double examinations of all patients in all positions. Conventional radiographs were obtained at the same occasion.

Results: The standard deviations for the measurement error between the repeat examinations were 0.15, 0.16 and 0.22 mm for the transverse (x), vertical (y) and sagittal (z) axis, respectively. These values correspond to the minimum significant translations of 0.41, 0.42 and 0.60 mm (99% confidence limits in Student's t-distribution). Measured translations of the fused vertebrae were not considered significant unless they exceeded 0.5, 0.5 and 0.7 mm along these axes, i.e. the technical accuracy of this RSA set-up.

In 8 patients, no intervertebral translations whatsoever could be elicited in any of the examined positions. There were minor vertical translations of < 0.7 mm in normal standing and standing with sandbags in 1 patient fused between L4 and S1. In another patient fused between L5 and S1 sitting and standing with sandbags elicited small sagittal translations < 0.8 mm. There was also a small vertical translation of 0.6 mm in standing with sandbags. Conventional radiographs disclosed good osseous fusion with bridging trabecular bone bilaterally in all patients including the two with minor translations.

Discussion: The mobility of the lower lumbar spine decreases 3-6 months after a successful noninstrumented posterolateral fusion, and the fusion may either become rigid as defined by RSA or permit small intervertebral translations probably due to an osseous springing effect. The findings of the present study show that well healed noninstrumented posterolateral lumbar fusions remain rigid even with enhanced mobility provocation of the spine. Minor mobility due to osseous elasticity may persist in single cases. The combination of the presented standardized provocation method and RSA should be a powerful tool in all types of kinematic spinal studies as well as in the identification of clinically suspect fusion malunions.

116. The spondylolytic vertebra and its adjacent segment—mobility measured before and after posterolateral fusion

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Progressive degeneration of the intervertebral disc, facet joint hypertrophy and even acquired spondylolysis are described clinical phenomena indicating increased stress on the segment adjacent to a lumbar fusion. According to prior cadaveric studies, the intradiscal pressure in the juxta-fused segment is increased in flexion and the center of rotation in flexion/extension is shifted towards a more cranial level by fusion of the lumbosacral segment. This study is focused on the kinematics for the in vivo situation applying radiostereometric analysis (RSA) with the aim to measure the mobility over time from the preoperative situation during the course of fusion consolidation.

Patients and methods: 6 patients with spondylolysis-olisthesis grade 1-2 had a diagnostic external fixation test using the Magerl frame. The pedicular screws used for the external frame were applied in general anesthesia and during this procedure metal markers were implanted with percutaneous technique into the L4, L5 and the sacrum for the subsequent RSA. 2 months after the external fixation test was completed all 6 patients had an uninstrumented posterolateral fusion of the olisthetic lumbosacral segment. Each patient had 4 separate examinations using RSA. The first examination was carried out before fusion, two months after the removal of the external frame with soft tissues healed and the patients having regained their usual low back symptoms.The remaining 3 examinations were performed 3, 6 and 12 months after the fusion procedure. The patients were examined in a standardized manner in supine and erect positions without active mobility provocation. The translatory movements of the fifth lumbar vertebra in relation to the sacrum and of the fourth lumbar vertebra in relation to the fifth, induced by the positional change from supine to erect, were calculated.

Results: For the juxta-fused L4–L5 level 3 different mobility patterns were identified during the period of fusion consolidation. For 2 patients increasing mobility was recorded and a transformation of the preoperative mobility in the lumbosacral segment to the L4–L5 segment was verified. In 2 patients the mobility of the segment was verified. In 2 patients the mobility of the segment decreased significantly over time. For the remaining 2 patients the preoperative mobility was small and not affected by the fusion in the lumbosacral level.

In the spondylolytic L5–S1 level, there were great interindividual differences considering preoperative mobility especially for the sagittal translation varying from 1.0–4.6 mm. All patients had a solid fusion as defined by osseous trabecular bridging assessed from conventional radiography at the 1-year follow-up. These radiographic results correlated to the RSA with mobility disappearing after 1 year postoperatively.

Conclusion: Fusion of the lumbosacral level, apart from

increasing the intradiscal pressure of the adjacent segment, also may, although not a general phenomenon, alter the kinematics redistributing the mobility towards a situation of relative hypermobility in the juxta-fused segment. A protracted length of follow-up, which is our ambition, will reveal any consequences in the form of progressive degeneration induced by the altered mobility situation.

117. The angle of trunk rotation in scoliosis

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A valid, reliable, noninvasive and yet simple method is needed for spinal screening programs for scoliosis to be effective and minimize over-referral of children to hospital. We evaluated our 3-year experience of inclinometer measurements of the angle of trunk rotation (ATR) and the corresponding Cobb angles with special regard to curve type and direction.

Patients and methods: 150 patients referred for evaluation of scoliosis after a primary school screening underwent a secondary assessment for scoliosis with Scoliometer (Pedihelath ky, Oulu, Finland) measurements of the ATR and a posteroanterior standing radiograph of the spine.

Results: In thoracic or right convex curves no patient with a Cobb angle of 25° or higher had an ATR below 9°. In thoracolumbar, lumbar or left convex curves, 7° ATR was occasionally associated with scoliosis of 25° or more. With few exceptions, these patients were older and more physically mature why treatment of their scoliosis was not indicated.

Conclusion: We conclude that a referral criterion of 8° ATR for thoracic or right convex curves and 7° ATR for thoracolumbar, lumbar or left convex curves seems adequate for identification of those patients who need further observation or treatment outside the routine medical school screening program.

118. Disc pathology after whiplash injury—a prospective MRI and clinical investigation

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The aim of the present prospective MRI and clinical study was to identify initial soft-tissue damage after whiplash injury and development of disc pathology and its relationship to the symptoms.

Patients and methods: This prospective study includes 39 patients, 20 women and 19 men, with a mean age of 32 (18–52) years at the time of accident. All of the patients were injured in car accidents. The patients were continuously followed with repeated neurological examinations and standardized questionnaire including VAS-scales 6 weeks, 6 months and 2 years after injury. Initial MRI was performed within (4–15) days after injury and the second examination 2 years after injury.

Results: Initially, 3 patients had disc herniations with medullary impingement and 7 with dura impingement. 16 patients showed slight ventral disc bulging. At follow-up, 2 of the 3 cases with disc herniations and medullary impingement were operated on with discectomy and anterior fusion. The third patient with medullary impingement showed a reduced herniation and he had no symptoms 6 weeks after injury.

One patient with slight disc protrusion and 2 patients with dura impingement at initial MRI examination had all developed herniation with medullary impingement. These patients had significant symptoms at follow-up.

Ventral disc bulging did not change over time and this finding was not accompanied by a progress of dorsal disc herniation.

Conclusion: Disc pathology seems to be one contributing factor to the pathophysiology after whiplash injury and in some patients disc injury is not detectable early after injury but develops over time.

119. Subaxial cervical spine subluxation in rheumatoid arthritis

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Clinical and radiological outcome was evaluated in 16 patients with rheumatoid arthritis, 15 women and 1 man with a mean age of 65 (55–77) years, on average 2 (1–5) years after decompression and stabilization for subaxial subluxation of the cervical spine. The duration of rheumatoid arthritis averaged 30 (10–67) years and neck symptoms 15 (1–60) months.

Preoperatively, 12 of the patients had pain in the neck, all 16 suffered from arm rhizopathy and varying degrees of myelopathy. 4 patients with severe myelopathy died within 3 months of surgery. Failure of fixation occurred in 7 patients but was without clinical significance in 5. There were 1 deep infection and 1 nerve root lesion resulting in deltoid weakness. Other complications were dysphagia and donor site pain. 4 reoperations were performed, 2 extension of fusion, 1 revision of infection, and 1 foraminotomy.

Neck pain was reliably relieved while arm rhizopathy was less positively affected. Myelopathy carried a poor prognosis for relieve and correlated with an increased mortality.

Decompression, both via realignment and bone resection followed by fusion of the entire cervical spine is advocated. Unreliable bone anchorage, due to osteoporosis and lack of

appropriate cervical fixation implants, frequently demands simultaneous anterior and posterior fixation.

120. Results following instumented lumbosacral fusion with Roy-Camille vs Cotrel-Dubousset with a mean follow-up of 4 years

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The aim of this study was to compare the Roy-Camille (RC) and the Cotrel-Dubousset (CD) implant used for lumbosacral fusion.

Patients and methods: The study comprised 76 consecutive patients with mean age 42 years (RC=36, CD=40). Mean follow-up was 4 years. Questionnaires were returned from 96% of the patients.

Results: 73% in both groups stated improvement compared to the preoperative condition. About 65% in both groups stated that they were satisfied with the result of the operation. There was no difference between the RC and CD group in satisfaction with surgery, ability to work, rate of sick leave and symptoms leading to reoperation. The rate of reoperation was 18% in the CD group and 25% in the RC group. The pseudarthrosis rate was not significant different between the groups.

121. Transpedicular internal fixation in unstable fractures of the thoracolumbar spine

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Transpedicular fixation techniques have improved the reduction possibilities and make stabilization of the injured segments possible without involving noninjured parts of the spine. The method, however, has by some authors been claimed to have a high complication rate and a loss of kyphotic correction have been reported.

Patients and methods: From 1988–1994, 78 patients were treated according to Dick for 82 unstable fractures of the thoracolumbar spine. Median age was 27 (14–59) years. One patient had a fracture of Th10, 5 of Th11, 6 of Th12, 22 of L1, 17 of L2, 12 of L3,12 of L4 and 7 of L5. Four patients had unstable fractures of different vertebras. 22 patients were multitraumatized, 18 patients had moderate additional lesions, and 28 patients had no additional lesions. 18 patients had marked neurologic deficiency preoperativly.

Median time from injury to operation was 2 (0–11) days. In 63 fractures transpedicular bone grafting according to Daniaux was performed. Laminectomy was done in 1 patient and hemilaminectomy in 2. Posterolateral fusion was performed in 3 patients.

Results: The median observation time was 25 (5–48) months. Median preoperative heigth reduction of estimated anterior heigth of the fractured vertebra was 30 (0–90)%, postoperative 10 (0–20)%. Correction of kyphotic deformity could be obtained in all patiens. 17 patients with preoperative neurologic deficiency improved postoperatively. 4 infections were recorded. Fatigue fractures of one or more pedicular screws were seen in 5 patients. Pedicular, but extracorporal position of screws, were seen in 3 patients without consequences for the fracture healing or reduction.

Conclusion: Our experience during 7 years with transpedicular stabilisation of unstable fractures in the lumbar spine according to Dick combined with transpedicular bone grafting to the fractured vertebra does not confirm reports of other authors concerning a high complication rate and loss of kyphotic correction.

122. Lumbar posterolateral fusion—the consequences of pedicle screw instrumentation

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Lumbar and lumbosacral posterolateral fusion is advocated both with and without supplementary rigid pedicle screw fixation. A higher fusion rate may be counterbalanced by higher complication rates with screws. Our aim was to evaluate the variables operation time and blod loss, functional outcome and complication rates in the two different surgical procedures.

Patients and methods: In a prospective trial including 130 patients with spondylolisthesis grades I–II and degenerative segmental instability randomisation to either no instrumentation or pedicle screw fixation a.m. C-D to supplement a posterolateral autologous bonegraft was performed. The two groups were comparable regarding all significant parameters. Mean age was 44 and 46 years, respectively.

Results: Results are given as without/with C-D. Operation time was 127 / 211 min ($p<0.0001$), blod loss1159 /1644 cc ($p<0.001$), improved functional outcome according to Dallas Pain Questionnaire ($p<0.01$ / $p<0.05$) for both groups at 1 year, and no difference in outcome between the groups.

Complications: 3 patients (5%) suffered from misplaced pedicle screws. Minor and major general complication rates including infection did not differ in the 2 groups.

Conclusion: Lumbar posterolateral fusion with pedicle screw fixation increased the operation time and blod loss and led to a significant risk of nerve injury. The functional outcome improved significantly with or without instrumentation.

123. 1-year radiographic follow-up of lumbar fusions using the PSF-instrument

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Whether to fuse or not is a major topic for discussions and studies. Patient selection is a crucial issue in fusion surgery. This study offers nothing new on this subject, but tries to answer the question "How often do we reach our primary surgical goal and achieve a real bony fusion with our present methods?"

Patients: The study comprises 45 patients consecutively operated on in late 1993 and 1994 with posterolateral fusion with (n 27) or without (n 18) the PSF instruments.

Methods: To evaluate the fusion rate 1 year after surgery, normal A-P and lateral radiographs were taken and sometimes completed with oblique projections. It is known that this does not always give the true answer on healing of a fusion, but it is known that at least most of the evaluations give the right answer.

Results: 43 of 45 patients had bony fusion as evaluated by normal radiography. There were no screw breakages or misplaced screws. Two patients had radiographic nonunion. One of these was operated on with posterolateral fusion from L4–S1 with nonunion between L5 and S1. The other occured in a patient with a pseudolisthesis between L4 and L5 operated on with instrumented fusion at this level. One patient had a deep infection in her leg 3 months after surgery, and developed septicemia. The surgical site was infected and 3 of 4 screws were loose but the fusion healed.

Conclusion: Modern techniques and instruments are able to give such a high frequence of bony healing in lumbar fusions, that we can put all our effort in developing methods to select the right patients for such an operation.

124. Spinal fusion for postpoliomyelitis scoliosis—minimum 15-year follow-up of 88 patients

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Postpoliomyelitis scoliosis remains a current problem in countries such as China, where 60,000 polio patients are expected to need spinal fusion.

Patients: From 1975–1979, 118 patients underwent fusion using Dwyer and/or Harrington instrumentation and cast. 88 patients were re-examined in 1995. 31 were men and 57 women. Age at surgery averaged 16 years. 84 patients had a double curve, with the lumbar (major) curve averaging 108°. 58% had both curves fused, 42% had only the lumbar curve fused.

Results: Postoperatively, the major curve averaged 48°. This correction was maintained over the years. When only the lumbar curve was fused, the thoracic curve did not progress if it was less than 40°. When pain, sitting, ambulation, and ADL scores were compared, there was no difference between 1) fusion of both curves vs. the lumbar curve only, 2) fusion to S1 versus just to L5, and 3) iatrogenic lumbar kyphosis vs. a straight back. Being able to sit without using hands for support was the major surgical benefit cited by the patients. Hardware failure occurred in 11 patients, including 5 out of 15 patients who had posterior fusion only. Back pain was rated as significant by 6 patients. Vital capacity improved from 56% to 60% of predicted. ADL scores were affected more by the extent of polio paralysis than by the scoliosis. Only 33% are married. Caesarean section was used in 94% of deliveries.

Conclusion: The severity of the underlying poliomyelitis should be kept in mind. The primary surgical goal is a balanced spine that allows sitting without hand support. Fusion of the lumbar curve only, and just to L5, provides similar results compared with more extensive fusions.

Posters

125. A national registry for lumbar spine surgery

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An increasing number of surgical techniques applicable to degenerative lumbar spine disorders, and decreased economical resources for hospital care emphasize the need for documentation and quality assurance also in lumbar spine surgery.

With this background, an outcome protocol for surgery for lumbar spine diseases has been designed. It includes preoperative demographics, work conditions, and consumption of analgesics, walking distance and pain grading on a visual analogue scale. A preoperative clinical investigation also is included. Diagnosis, type of surgery, level, side, type of implant and complications are recorded. Follow-up including subjective outcome, functional and life quality scores are included, as are the pain parameters presented preoperatively. A 2-year follow-up is recommended.

This protocol is combined with a computer application suitable for PC as well as Macintosh. The majority of data is gathered as category data. Registration is peformed on the FileMaker Pro program and the application is available for free.

Using this protocol and data application, the individual department achieves its on registration regarding the parameters described. A national follow-up is also in the development, and is also supported by the National Board for Health

and Wellfare. To date, 20 orthopedic departments in Sweden have adopted the protocol.

Preliminary data on 450 cases treated at the University Department of Orthopedics will be presented, documenting type of surgery and subjective as well as work related outcome.

The protocol presented is also available in English, as is also the data application, and this would enable international comparisons regarding surgery for degenerative lumbar spine disorders.

127. Surgical treatment for metastatic epidural compression in the thoracic and lumbar spine

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Patients and methods: 137 cancer patients with neurologic symptoms of epidural compression due to spinal metastases were operated on 1990-1995. There were 90 men and 47 women with a median age of 64 years. The most common primary tumors were cancer of the prostate in 37% and of the breast in 17%. The spinal lesion was a solitary metastasis in 14% of the patients, 63% had multiple skeletal metastases and 23% had visceral or brain metastases as well. The epidural compression was thoracic in 72% and lumbar in 28%. Preoperative neurologic function assessed according to Frankel (A–E) showed that 47% were bedridden (A–C), 38% could walk with aid (D), and 13% were neurologically intact (E). A posterior decompression and stabilization was performed in 126 patients, 7 had posterior decompression alone, and 4 had anterior decompression and reconstruction of the vertebral body.

Results: There were 13% local wound complications (9% infections). The perioperative mortality rate (within 2 weeks of surgery) was 4%. The 6 months survival rate was 0.51 and the 1 year 0.28. The neurologic function improved immediately postoperatively in 85 patients, was unchanged in 29 and worsened in 3. Altogether, 120 patients (88%) became walkers (Frankel D-E) during follow-up. 17 patients were reoperated; 7 for epidural compression at a new spinal level, and 10 for recurrence of compression or failure of stabilization.

Conclusion: Posterior decompression and stabilization restores neurologic function in cancer patients with epidural compression and is associated with a relatively low systemic morbidity.

Knee/Shoulder

128. ACL-reconstruction as an outpatient procedure—treatment of pain

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At the Orthopedic Department of Aalborg University Hospital, anterior cruciate ligament reconstructions are performed as an outpatient procedure. All the operations are performed in spinal analgesia and postoperatively they have a Cryo-cuff bandage put on.

Patients and methods: In a prospective, randomised, double blinded study, 30 patients, 19 men and 11 women with a mean age of 26 (19–43) years were randomised for intraoperative intraarticular injection of either morphine (2 mg in 20 mL NaCl) or placebo (20 mL NaCl). Pain was recorded via a VAS-score preoperatively, just after surgery and after 2, 4 and 24 hours. They were also asked to comment on their satisfaction with the pain treatment in the same periods. At the discharge from hospital each patient were given tablets of morphine 5 mg, panodil 500 mg and oruvail 100 mg and they were asked to record the amount of tablets used during the first 24 hours postoperatively. The patients took the Cryo-cuff bandage home and delivered it back at the first postoperative control at the fifth postoperative day.

Results: By analysing the results with a non-parametric t-test no significant differences were found between the two groups, neither in pain scores nor in use of analgetics. As for the patients' satisfaction with the pain treatment, 100% of the patients in the morphine group were satisfied/very satisfied just after surgery, 100% after 2 hours, 97% after 4 hours and 77% after 24 hours. In the placebo group the results were 100%, 100%, 100% and 93%. 3 patients were admitted to stay at the hospital during night, 2 from the morphine group and 1 from the placebo group.

Conclusion: Intraarticular injection of morphine does not seem to have a place in ACL-reconstructions as an outpatient procedure. The patients' satisfaction with the pain treatment makes ACL-reconstrution as an outpatient procedure a recommendable alternative to hospitalization. 10% of the patients needed hospitalization which corresponds to the department's general frequency of hospitalization after outpatient treatments.

129. Arthroscopic reconstruction of the anterior cruciate ligament using bone–patellar-tendon–bone grafts with and without augmentation

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Bone–patellar-tendon–bone autologous grafts are widely used to reconstruct anterior cruciate ligament (ACL) deficient knees. Animal studies have shown that these grafts undergo an initial decrease in strength, followed by a period of revascularization and remodeling. To protect the graft from streching out or rupture during the initial remodeling phase, a ligament augmentation device (LAD) has been used. The present study was designed to find out if the addition of an LAD had any positive effect.

Patients and methods: 100 consecutive patients with chronic ACL deficient knees were randomized to a reconstruction with bone–patellar-tendon–bone autograft with (n 49) or without LAD augmentation (n 51). The patients underwent an agressive rehabilitation protocol. They were followed prospectivly, and evaluated after 6 months, 1 year and 2 years. The patients subjective assessment of the knee function, the Tegner activity score, and the Lysholm functional score were recorded. The physical examination included range of motion, Lachman, pivot shift, KT-1000 arthrometer, and isokinetic strength tests.

Results: No significant functional or clinical difference between the two groups was found at any evaluation interval, and the stability of the knees did not deteriorate with time in any of the groups.

Conclusion: The LAD does not improve the outcome of ACL reconstruction, even when an agressive rehabilitation protocol is used.

130. Elongation of the bone–patellar–bone reconstructed ACL evaluated with KT-1000 arthrometer

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The right–left anterior tibial translation difference evaluated with KT-1000 with 89 N (20 lb) anterior force is less than 3 mm for 95% of normal subjects (1-2). If the anterior tibial translation is more than 3 mm for a knee with reconstructed anterior cruciate ligament (ACL) compared to the normal contralateral knee, the operation has therefore been considered a failure by many surgeons. The best discrimination between normal and ACL-deficient knees is, however, to use maximum manual force for the anterior displacement of tibia (2). Since the degree of knee laxity may be related to the test force, the purpose of this study was to compare the anterior tibial displacement after ACL reconstruction using 67 N (15 lb), 89 N and maximum manual anterior tibial force.

Patients and methods: 60 patients were subjected to ACL reconstruction with bone–patellar–bone graft using an arthroscopy assisted open procedure. All patients had a standardized postoperative rehabilitation program allowing full weight bearing after 6 weeks and without the use of a knee brace. The anterior knee laxity was evaluated in 20° of knee flextion with a KT-1000 arthrometer at 3, 6, 12 and 24 months after the operation. Both the operated on and the normal contralateral knees were tested.

Results: The mean side-to-side differences of anterior tibial displacement 2 years postoperatively using 67 N, 89 N and maximum manual force was 1.7 mm, 2.2 mm and 2.6 mm, respectively. The corresponding increase in side-to-side differences from 3 to 24 months postoperatively was 1.0 mm, 1.3 mm and 1.7 mm for the 3 testing forces. At 6 and 12 months postoperatively the side-to-side difference of anterior tibial translation was 0,5 mm higher when a maximum manual tibial force was used compared to a 89 N force.

Conclusion: The side-to-side differences in anterior tibial translation is about 1 mm higher when tested with maximum manual force compared to a 67 N anterior force. The bone–patellar–bone ACL graft elongate 1.0 mm from 3 to 24 months postoperatively when tested with a 67 N anterior tibial force and 1.7 mm when tested with a maximum manual force.

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131. Effect of force on intraarticular patella tendon graft remodeling

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Graft replacements for the anterior cruciate ligament weaken in the immediate postoperative period. Since unloaded tissue also weakens and hyperloaded tissue strengthens, it is suspected that graft force may be an important factor in graft weakening. In particular, there is a question of whether graft weakening can be reduced or prevented by applying force during the remodeling phase. We describe a new animal model where prescribed loads can be applied to a intraarticular patella tendon graft.

Methods: 12 New Zealand White rabbits had an arthrotomy laterally. The patella, patella tendon and bone block from the tibial tubercle were removed enbloc, the tibial bone block split in two, the tendon split in two and trimmed to 3

mm width. The patella was secured to the side of the tibial tubercle with a screw, each arm of the patella tendon with bone blocks passed into the medial and lateral femoral condyles respectively. Sutures were attached to the tibial bone blocks and the sutures passed subcutaneously and through an incision to exit the skin. The tendon graft segment could now be pulled from outside of the animal via the suture. The experiment was intended to assess the effect of force on the graft mechanical properties. 10 N of force was applied by hand with a calibrated spring scale to the segment exiting the lateral femur, for 60 cycles, 5 days a week for 3 and 6 weeks. One segment was left unloaded in each rabbit. At the end of 3 and 6 weeks the animals were killed and tested in tension on a Model 858 MTS hydraulic test machine.

Results: Although there was a tendency for the loaded graft segments strength to be higher than the unloaded segments, there was no significant difference between loaded and unloaded failure force at either 3 or 6 weeks. There was a reduction in strength in both the loaded and unloaded segments between 3 and 6 weeks, indicating that load did not prevent or reduce weakening. Stiffness values showed similar results.

Conclusion: Since these results are different from our previous skin pouch model, we conclude that if understanding the remodeling of tendon grafts in the knee joint are the goal, then this intraarticular model would be more appropriate as an experimental model than the skin pouch model of tendon grafts in the knee joint

132. Comparison of fixation strength between metallic and bioabsorbable interference screws

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We hypothesized that metallic and bioabsorbable interference screws have equal failure strength in bone–patellar-tendon–bone anterior cruciate ligament (ACL) reconstruction.

Material and methods: Bone–patellar-tendon–bone specimens were harvested from young human cadavers. Under completely open technique, the patellar bone block was inserted into the lateral femoral condyle tunnel and the bone block-tunnel gap was measured. A 7 x 25 mm metallic interference screw (n 10, mean age 42 years), 7 x 20 mm first generation bioabsorbable interference screw (n 8, mean age 40 years), or 7 x 25 mm second generation bioabsorbable inferference screw (n 8, mean age 51 years) was inserted over a guide pin in an inside-out direction and insertion torque was measured during insertion. A ramp displacement was applied to failure at a velocity of 50 mm/min in line with the axis of the femoral tunnel. The load-displacement curve was recorded and failure mode was recorded.

Results: Statistically significant differences in insertion torque and failure load were noted using unpaired Student's t-tests for individual comparisons. The mean insertion torques for the metallic, first generation bioabsorbable, and second generation bioabsorbable interference screws are 1.52, 0.62, and 0.30 Nm, respectively. The mean failure loads for the metallic, first generation bioabsorbable, and second generation bioabsorbable interference screws are 640, 330, and 418 N, respectively. No statistically significant differences in bone block-tunnel gap or interference were noted. The bone density from the second generation bioabsorbable screw was significantly lower than the other groups.

Conclusion: The failure load of the metallic interference screw is significantly greater than the first and second generation bioabsorbable interference screws in young human cadaver models. Preliminary reports on the clinical use of bioabsorbable screws stated that screw breakage was the main intraoperative complication. This is consistent with our results of screw fracture during insertion and thread damage following bone block pullout. The first and second generation bioabsorbable screw mean failure strength is below the estimated 450 N ACL load imposed during routine activities.

133. In vivo kinematics of the posterior cruciate ligament injured knee during a step-up

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Long-term studies of patients with posterior cruciate ligament (PCL) injured knees indicate an osteoarthritic deterioration. Can it be explained by altered knee kinematics resulting in an abnormal wear of the cartilage? Further, a main controversy in total knee replacement surgery is whether to retain the PCL or not. The objective of this study was to examine the in vivo three dimensional kinematics during weight bearing in knees with a tear of the posterior cruciate ligament compared with the contralateral intact knee. Radiostereometric analysis (RSA) was used.

Patients and methods: 8 patients (mean age 27 years) with old unilateral ruptures of the posterior cruciate ligament were examined. 4 also had a posterolateral rotatory instability. At the examination, they ascended a platform about 40 cm above the floor. At the level of the knee joint there were two cassettes holders at right angle to each other. Two x-ray tubes were placed 1 m from the cassettes for simultaneous exposures. The patient started with the knee flexed about 100° and ascended the platform to full knee extension. The motion was interrupted five to six times and for each stop a pair of radiographs were exposed. Both the injured and intact knees were examined. Previously, at the time of the diagnostic arthroscopy, tantalum beads had been implanted into the knee. Tibial rotations (flexion/extension, internal/external rotation, abduction/adduction) and translations

(medial/lateral, proximal/distal and anterior/posterior) were calculated in relation to the femur. The tibial motions were plotted in diagrams in relation to knee flexion and the values at 0°, 20°, 40°, 60°, 80°, 100° of knee flexion were interpolated. Only paired observations were included in the statistical analysis (three way ANOVA).

Results: No differences in tibial translations or rotations were observed between normal and PCL injured knees.

Conclusion: The absence of the PCL appears to have no influence on the knee kinematics during a step-up. Joint load adds stability to the knee and the kinematics seems to depend more on the joint surface congruity than on the PCL. Thus, this study indicate that knee deterioration due to PCL injury can not be explained by changed knee kinematics. The knee extension examined was not continuous, restricting the conclusions to be drawn about gait, and it does not support the retaining of the PCL in knee joint replacement surgery.

134. Anteromedial opening wedge high tibial osteotomy for treatment of posterolateral corner instabilities of the knee

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Injury to the posterolateral ligamentous structures of the knee is difficult to diagnose and treat with current soft tissue reconstructions. The purpose of this study is to evaluate treatment of posterolateral ligamentous instabilities of the knee with an anteromedial opening wedge osteotomy of the proximal tibia.

Patients and methods: There were 10 patients included in this study, ages 18–34. All patients underwent anteromedial opening wedge osteotomy for the treatment of posterolateral corner (PLC) instability or combined (PLC) and ACL or PCL instabilities. Physical and radiographic examinations were evaluated preoperatively and at follow-up. 8 patients underwent gait analysis using the Gait Link System. 2 patients were tested preoperatively, 5 were studied postoperatively and 1 patient was studied pre- and postoperatively. In addition, a functional outcomes questionnaire was sent to all of the patients at the time of follow-up.

Results: Preoperatively, 9 of 10 patients had recurvatum as demonstrated by increased heel to table height. All preop tested patients exhibited above-normal hyperextension at heel strike on gait analysis. There were no other abnormalities at the time of gait analysis among the quadriceps moment or adduction moment for the preoperative observations. Ten of 10 patients demonstrated increased external rotation on physical examination. Bracing seemed effective in most patients in either reducing hyperextension either pre- or postoperatively. Postoperatively, 9 had improved heel height as demonstrated by the physical examination and a near normal hyperextension at heel strike during gait analysis. Radiographic evaluation of the posterior slope of the proximal tibia showed preoperative average of 7° (0°–12°), postoperative of 16.5° (13°–26°) with an average change of 9.5° (2°–18°). The anatomic femoral-tibial axis showed preoperative average of 0.9° valgus (5° varus to 11° valgus), postop average of 7.3° valgus (2°–17°), and an average change of 6.5° (1°–9°). 9 of 10 had an increase in the level of function by the Lysholm and Tegner scores. 1 patient had no change in his score. 4 patients required additional surgery; 2 underwent subsequent ACL reconstruction, 1 a PCL reconstruction, and 1 a fibular collateral ligament reconstruction.

135. Biomechanical and histological evaluation of a collagen meniscus regeneration template

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Meniscal injury is one of the most common orthopedic problems, resulting in 600,000 knee arthroscopies annually in the United States. Stone et al. (1992) developed a meniscal regeneration template using reconstituted bovine Achilles tendon collagen. Substantial regeneration was noted in 63% of the knee joints implanted with the collagen template after undergoing a 80% subtotal meniscectomy. No biomechanical evaluation of the regenerated meniscus and no histological evaluation of the femoral and tibial articular cartilage has been reported. We hypothesized that an implanted collagen meniscus regeneration template would result in a meniscus capable of transmitting load and protecting the articular cartilage from degenerative changes.

Material and methods: Collagen sponges were fabricated from reconstituted Type 1 bovine collagen. A meniscus regeneration template was constructed of a collagen sponge-poly lactic acid film-collagen sponge laminate (Kensey Nash Corp., Exton, PA). The regeneration template was implanted in 14 New Zealand white rabbits after a total lateral meniscectomy. The regeneration template was sutured to the anterior and posterior horn remnants for fixation. The contralateral knee served as a control knee and 4 additional rabbits had total lateral meniscectomies without implantation of a regeneration template for surgical controls. The animals were killed at 3 and 6 months. The femur and tibia were mounted in a MTS Bionix material testing system (MTS Systems Corp., Mpls., MN). The medial femoral condyle was excised parallel to the tibial plateau with the cruciate ligaments preserved. An axial compression load-displacement curve of the isolated lateral joint compartment was measured to 150 N with the lateral meniscus intact. The anterior and posterior horns of the lateral meniscus were

transected. A repeat compression load–displacement curve of the isolated lateral joint compartment was measured to 150 N. The percentage of the load transmitted by the lateral meniscus was calculated. The joint was fixed in phosphate buffered formalin, decalcified, and the lateral femoral condyle and lateral tibial plateau were sectioned sagittally. The sections were stained with safranin-O-fast green stains. The structure, cellularity, and safranin-O staining were graded according to the Mankin scale. Additionally, the cartilage thickness, zone of calcified cartilage thickness, and zone of safranin-O staining thickness were measured.

Results: Statistically significant differences in the percentage of load transmitted by the meniscus were noted between the 3 month implant and meniscectomy groups ($p=0.002$) and the 6 month implant and meniscectomy groups ($p=0.009$). No statistically significant differences in modified Mankin scores were noted between the 3 month implant, 6 month implant, and meniscectomy groups with unpaired t-tests. However, all modified Mankin scores compared between implant/meniscectomy and control groups using a paired t-test were significantly different ($p<0.05$), except the meniscectomy femur comparison ($p=0.08$). The implant and meniscectomy groups had a higher Mankin score representing greater degenerative changes compared to the controls.

Conclusion: Conclusions regarding the biomechanical function of a regenerated meniscus cannot be drawn from these preliminary results. However, the statistically significant increase in the modified Mankin score between the implant/meniscectomy and control knees suggests that the regenerated meniscus does not protect the articular cartilage. Further studies are recommended to evaluate the functional performance of collagen meniscus regeneration templates.

136. Isokinetic rotational muscle strength before and after subacromial injection of Prilocain in patients with unilateral impingement syndrome of the shoulder

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Imbalance of the internal and external rotator musculature of the shoulder have been implicated as an etiologic factor in impingement syndrome of the shoulder. The purpose of this study was to determine whether any imbalance was present in a well defined patient group with unilateral impingement syndrome of the shoulder and, if so, how this would be affected by a subacromial injection of Prilocain.

Patients and methods: 12 male patients (47–59 years) with a clinically distinct unilateral subacromial impingement, a positive impingement test and no cuff rupture on MRI were analysed in a Biodex system 2 (Biodex Corp., Shirley, N.Y., U.S.A.). Isokinetic strength was assessed in 30° of internal and external rotation with the arm in the scapular plane and 45° of abduction. Concentric and eccentric contractions with an angle velocity of 60°/s were analysed both in the involved and uninvolved shoulder. The involved shoulder was also analysed after a subacromial injection of Prilocain.

Results: All the patients displayed less average power, lower peak torque and an increased work fatigue in the involved shoulder. The ratio internal/external strength was significantly higher in the uninvolved shoulder than in the involved shoulder both when average power and peak torque were analysed. For average power the mean ratio was 1.3 for the uninvolved shoulder versus 1.1 for the involved shoulder and for peak torque the mean ratio was 1.6 and 1.4, respectively. After subacromial injection of Prilocain in the involved shoulder the internal/external muscle strength ratio was almost normalised.

Conclusion: Patients with unilateral subacromial impingement syndrome of the shoulder were shown to have reduced muscle strength and an increased work fatigue in the involved shoulder. In the involved shoulders there were also a decrease in internal/external rotational strength ratio even after subacromial injection of Prilocain. This would indicate a primary or secondary change in the normal internal/external rotator ratio in shoulders affected by subacromial impingement syndrome.

137. Lateral ligament injuries in the knee

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Lateral ligament injuries of the knee are relatively rare, and the literature sparse. They are often more serious than injuries involving the medial compartment, and are often part of combined injuries. In this retrospective study, the results of our treatment protocol is evaluated.

Patients and methods: Between 1985 and 1994, 29 patients (with exception of one in 1991) were treated for knee ligament injuries in the lateral compartment. 26 of these patients, 11 women and 15 men, with median age at injury 25.5 (16–75) years came for follow-up. 7 patients had isolated injury of the lateral collateral ligament/capsular structures, the remaining patients had the following additional ligament injuries in the knee: anterior cruciate ligament (ACL) 9, posterior cruciate ligament (PCL) 3, ACL + medial collateral ligament 1, both ACL and PCL 5. The following other injuries in the knee were found: medial meniscus 1, lateral meniscus 4, both menisci 2, lateral avulsion fracture 10 in seven patients. 4 patients had affection of peroneal nerve, one total rupture. 7 patients with 1+ and one with 2+ instability were treated conservatively, one with plaster and 6 without any support or immobilization. 18 patients with 2+ or 3+ instability were operated on, 17 of these within 3 weeks. Repair/reconstruction of the cruciate ligaments were done at the same time as the lateral collateral ligament repair on 10 patients, 7 ACL

and 3 PCL. Delayed repair was performed in 2 patients with ACL and 2 with PCL rupture. Simultaneously with the ACL-repair, one patient had repair of the medial collateral ligament. Injured menisci were sutured in 5 patients, none were resected.

Results: At follow-up after median 7.5 (0.5–13) years, 10 patients had no varus instability and a median knee score of 95 (80–100). 9 had 1+ varus instability and knee score of 87.5 (60–100). 5 had 2+ and knee score of 87.5 (65–100). 2 patients with a 3+ varus instability had 42 and 67 points, respectively. All patients with a final result of 2+ or 3+ had combined ligament injuries. Two thirds of the operated on lateral ligament injuries had a good result concerning varus instability, with 1+ or less instability. The operated on cases showed an improvement in varus instability from mean 2.83+ preoperatively to mean 1.17+ postoperatively. One nonoperated patient with varus instability 2+ and one with 1+ showed no improvement. 6 nonoperated patients with varus instability 1+ were stable at follow-up.

Conclusion: Operation performed at an early stage in fresh injuries with a varus instability of 2+ or more, gives improved stability as a final result. Conservative treatment cannot be expected to give an improved stability, but is sufficient in mild instability (1+) without additional cruciate ligament injuries.

Children

138. Club-foot treatment—our way

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In evaluation of conventional club-foot treatment a varying number of fair and bad results are accepted, including feet with postoperative stiffness and re-deformation. More than one surgical procedure may be necessary, and the years-long use of splints and orthopedic footwear have been advocated during early childhood.

In order to preserve the mobility obtained by the operative procedure, and to stimulate remodeling of the joints, we adjusted our treatment regimen in 1989.

The duration of postoperative immobilisation was shortened, to allow early functional treatment with dynamic bracing, and the use of night-splints after the child has begun to walk were given up.

The methods are:

- Initial early diagnosis, information and instructions by the "varus-team".
- Manipulation, done by the parents after instruction by physiotherapist, moldable splint and controls, all in the outpatient clinic. Concentration on forefoot deformity.
- Operation at 3 months (hindfoot deformity).
- Short postoperative immobilisation (2 weeks)
- Manipulations continued and adjusted. Dynamic, functional bracing, controlled and adjusted in the out-patient-clinic.
- No further treatment after the child begins to walk.

Results untill now have encouraging. At follow-up of 21 club-feet, at mean 3 years of age, no patients have been reoperated, all wear normal shoes, and 95% score excellent in the Lehman functional rating system.

Hospitalisation was only used in connection with the operation (mean 2 days), all bracing was discontinued at mean 51 weeks, and no other therapists involved but the "varus-team".

139. Correction of persistent clubfoot deformities with the Ilizarov external fixator—experience in 10 feet after previous surgery

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The management of persistent and relapsed clubfoot is difficult. The Ilizarov external fixator (IEF) has been reported useful for correcting severe foot deformities. We reviewed our early experience with the IEF for clubfoot correction.

Patients and methods: 10 feet in 7 boys (6-15 years), with idiopathic clubfeet, treated with the IEF for foot deformities after previous surgery (1–7 operations), were reviewed. Time for application of the IEF was 75–135 min, number of admissions 2–4 with a total time in the ward of 7–18 days. The IEF was removed after 6–12 weeks when all feet were immobilized in a below knee cast for 8–14 weeks.

Results: Pin tract infections were common. No neurovascular complications or osteomyelitis occurred. The preoperative equinus was severe (>30°) in 9 feet and 1 foot was plantigrade. At the follow-up after 25–56 months, 5 feet displayed mild (5°–20°) equinus and 5 were plantigrade. The ankle joint motion measured 25.5° (5°–35)°, but no patient reported increased stiffness. 6 patients/parents were satisfied and reported better walking capacity and for 8 feet less problems finding shoes. Walking distance was slightly limited in all but one and pain was occasionally experienced from 6 feet. The functional results according to the classification of Lehman et al (1990) was fair in 3 feet and poor in the remaining 7.

Discussion: An ideal rating system for assessing results of clubfoot treatment is not available. 6 patients/parents were satisfied. With the Lehman rating system the results were considerably less successful.

Conclusion: We believe that a rating system which is more focused on function (gait) rather than on position of the foot when standing must be used. Using the IEF successfully necessitates careful selection of, and co-operation with, the patients. If these requirements are met, we believe that patients 6 years of age or older are suitable candidates.

140. Long-term results after nailing in situ of slipped capital femoral epiphysis in relation to displacement of the epiphysis at surgery—a 30-year follow-up study of 59 hips

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In the present follow-up study we have reviewed the long-term results after nailing in situ of slipped capital femoral epiphysis (SCFE). The incidence of osteoarthrosis (OA) was analysed in relation to the degree of displacement of the epiphysis at the time of surgery. We hope that the results of this study can help us to decide whether patients with SCFE should be operated on with nailing in situ or one of the available corrective osteotomies.

Patients and methods: 59 affected hips in 43 patients (26 men and 17 women) with previous SCFE treated by nailing in situ using one thin nail (Nyström nail) were re-examined. The degree of displacement of the epiphysis, measured according to Billing—slipping angle (SA)—at operation ranged from 9° to 50° (average 26°). In no hip did further slipping of the epiphysis occur after the primary nailing. The average follow-up period was 31 (27–34) years and the average age at follow-up 44 (39–50) years.

Results: Of 41 hips with an SA ≤30° at surgery 8 (20%) had developed mild OA and 1 (2%) severe OA. The corresponding figures for 18 hips with an SA ranging from 31° to 50° at operation were 6 (33%) and 3 (17%), respectively. The clinical results were assessed as fair or poor (Harris hip score < 90) in 7 (12%) hips and at the time of surgery the SA measured ≤30° in 3 of these hips and ≥31° in 4.

Conclusions: In patients with SCFE with an SA ≤30°, the long-term results after nailing in situ will be excellent with an incidence of severe OA less than 5%. For hips with an SA ≥31°, however, further long-term studies are needed before we will be able to reach a reliable decision whether these hips should also be treated with nailing in situ or corrective osteotomies.

141. Preliminary results of Ganz' periacetabular osteotomy

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Periacetabular osteotomies have been developed for cases of developmental dysplasia of the hip (DDH) where the coverage of the femoral head may be improved by reorientation of the acetabulum. For that purpose we have used the recently presented operative technique of Ganz et al. (Clin Orthop 1988; 26: 232).

Patients and methods: 37 female and 5 female patients, median age 33 (17–51) years were operated on and followed for from 5 months to 4 years. The diagnoses of 44 operated hips were: DDH in 40, Legg-Calvé-Perthes in 1, traumatic dysplasia in 1, and spastic paresis in 2. An intertrochanteric osteotomy was performed simultaneously in 9 and later in 1 patient. The early outcome was assessed clinically, radiographically and by a self-administered hip-rating questionnaire (Johanson et al. JBJS 1992; 74A: 587).

Results: The postoperative complications in 12 patients were: wound edge necrosis in 6 (3 required surgical repair), lesion of lateral cutaneous femoral nerve in 3, superficial wound infection in 2, neurapraxia of femoral and sciatic nerve in one of each, DVT in 1, sepsis in 1, and urinary retention in 1. The range of motion of the hip remained unchanged. In accordance with clinical findings, the radiographical consolidation was unreliable at 3 months in one hip. In comparison of pre- and postoperative radiographs (n 32), the interruption of the line of Shenton changed from 0.6 (–0.5 to +2.0) to 0.3 (–1.0 to +2.0) cm. The average CE angle changed from 15° (–4° to +30°) to 50° (22°–73°) and the AC angle from 22° (2°–36°) to –1° (–28° to +29°). The total score (mean [SD], n 25) improved from 63 [11] to 85 [13].

Conclusion: Ganz' osteotomy is an extensive an demanding operation with potential benefit on the outcome in DDH.

142. Ultrasound in the follow-up of patients with Perthes' disease

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The aim of this study was to evaluate if ultrasound could be used to assess the development of lateral protrusion in the follow-up of Perthes' disease.

Patients and methods: In 25 patients with Perthes' disease (Catterall groups 3 and 4) ultrasound (US) was used at most of the follow-up examinations. In addition to measurement of lateral and anterior coverage of the femoral head, ultrasound was used to diagnose joint effusion. Because we wanted to focus on the development during the early stages of the disease, the US measurements at the primary examination were compared with those obtained at the last preoperative examination in 15 patients who underwent femoral osteotomy and approximately 1 year after diagnosis in 10 patients who were not surgically treated.

Results: The mean lateral head distance (LHD) by US, which expresses the uncovered part of the femoral head, increased significantly, from 2.5 mm at the primary examination to 6.0 mm at follow-up. There was a good accordance (r=0.8) between US and radiography in assessing lateral protrusion of the femoral head. The anterior coverage was good at the primary examination and no significant change occurred with time. Of 23 patients with unilateral affection, joint effusion was seen in 17 cases (74%). By multiple regression analysis, two parameters were significantly related

to development of decreased femoral head coverage: joint effusion and LHD at the primary examination.

Conclusions: The study confirmed our previous experience that ultrasound is reliable in assessing femoral head coverage. Thus, radiography can be omitted in some of the follow-up examinations. Most patients have joint effusion in the early stages of the disease. If a patient has high primary LHD and joint effusion, the risk of developing lateral protrusion is increased.

143. Congenital pseudarthrosis of the tibia corrected with the Ilizarov external fixator

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Congenital pseudarthrosis of the tibia, with or without axis- or shortening deformities, is a difficult problem to solve in pediatric orthopedics and a variation of procedures have been described to treat patients with this disorder. In our hospital we have used the Ilizarov device and method to treat 7 children with congenital pseudarthrosis. 2 are still in the external fixator and 5 have finished the treatment.

Patients and methods: 3 girls and 2 boys, 2.5–6 years of age were treated. All had neurofibromatosis and had previously been operated on 1–3 times. The patients were operated on with resection of the pseudarthrosis and acute shortening combined with corticotomy and callutasis lengthening proximally. Correction of malalignment was performed over an intramedullary nail in all 5 patients. In 2 patients, the nail was kept during the fixator period to prevent axis deformation during the lengthening procedure. All patients were equipped with a cast or a well adjusted orthosis after removal of the Ilizarov device.

Results: The average observation time after removal of the fixator was 13.4 (4–16) months. In all 5 patients the pseudarthrosis healed, in 1, axis deformation occurred. Pseudarthrosis occurred in 1 patient in the lengthening zone. One patient sustained a fracture through a pin hole. With respect to healing of the pseudarthrosis, the result looks promising, but the observation time is short, and 3 major complications have already occurred in this small number of patients.

Conclusion: The Ilizarov procedure is a good method in the treatment of congenital pseudarthrosis of the tibia, but still we need more experience to prevent the late complications.

144. Surgical treatment of infantile tibia vara—a review of 83 cases

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The infantile form of Blount's disease appears to be more frequent in Scandinavian countries (Langenskiöld 1964, Mebdo 1964) and in black populations (Blount 1937, Schoenecker 1985). Between 1978 and 1994, we have collected 83 cases of infantile tibia vara treated by tibia osteotomy. All those cases concerned black children from French West Indies (Martinique and Guadeloupe).

Patients and method: We reviewed 83 cases (35 boys and 48 girls). 113 osteotomies where performed (30 bilateral). These patients where divided in two groups: the first group included 86 osteotomies performed in 63 children operated on before closure of the growth cartilage (age 3–9 years), with a preoperative varus of 24° (10°–45°), the second group included 27 osteotomies in 20 children performed after spontaneous closure of growth cartilage (age 9–16 years) with an average varus of 34° (18°–50°). The latter 20 cases presented with bowleg in toddlerhood which persisted later on (no case of late oneset tibia vara was included in this study).

We studied pre- and postoperative clinical and radiographical results, as well as results on last examination. Mechanichal femoro-tibial axis, metaphyso-diaphysal angle, metaphyso-epiphyseal angle and medial physeal slope were studied.

Results: The average follow-up was 10 (3–17) years. In the first group, a lateral closing wedge osteotomy of valgisation and derotation was performed. The postoperative average femoro-tibial angle was 3° of valgus. In 16 out of the 86 osteotomies (18%) a recurrence of an increasing varus with closure of the medial part of the growth cartilage and abrupt slope of the medial tibial plateau occured. The best results were obtained in osteotomies performed between 3 and 6 years of age and with an overcorrection into valgus over 5°.

In the second group, before 1986, the technique of osteotomy was the same, combined with a lateral epiphysiodesis. After 1986, a double osteotomy with external distraction and elevation of medial tibial plateau in one operation was performed when the medial physeal slope was over 25° (7 osteotomies in 5 children). The same technique was used in 10 cases of recurrence after the first osteotomy. In the 17 cases of double osteotomy we observed an average decrease of medial physeal slope of 23°. In 3 cases we have removed a fusion bar frome the medial epiphysis. This desepiphysiodesis, associated with osteotomy, was followed by 2 recurrences (1 year and 3 years later). This technique is only possible if closure of the physis is partial.

Conclusion: Early tibial osteotomy performed only when the diagnosis is certain. The best results are obtained when surgery is performed before 5 years of age with an overcorrection over 5° of valgus.

Posters

145. Fracture incidence in children, 1950–1994

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The incidence of fractures in children doubled in Malmö, Sweden (population 250,000) 1950-1979 (Landin 1983). The aim of this study was to establish the current fracture incidence and determine if a further increase has occured.

Materials and methods: In the city of Malmö, all emergency radiographic examinations are undertaken in the Department of Radiology. Virtually all fractures are on file and fractures that occured in the age group 0-16 years, in 1993-1994, have been studied.

Results: 1,673 fractures occured in 1,610 children. The annual incidence was 235/10,000 for boys and 150/10,000 for girls, a statistically significant decrease ($p<0.01$) compared to 1975-1979 for the entire group, as well as for boys and girls separately. The fracture pattern has not changed significantly since the seventies. Most common were fractures of the distal forearm (26%), the phalanges of the hand (16%), the clavicle (9%), and the metacarpals (8%).

Conclusion: The incidence of fractures in children appears to be declining, indicating that preventive measures in society may have been successful.

146. The Straight Line Graph in Dutch children

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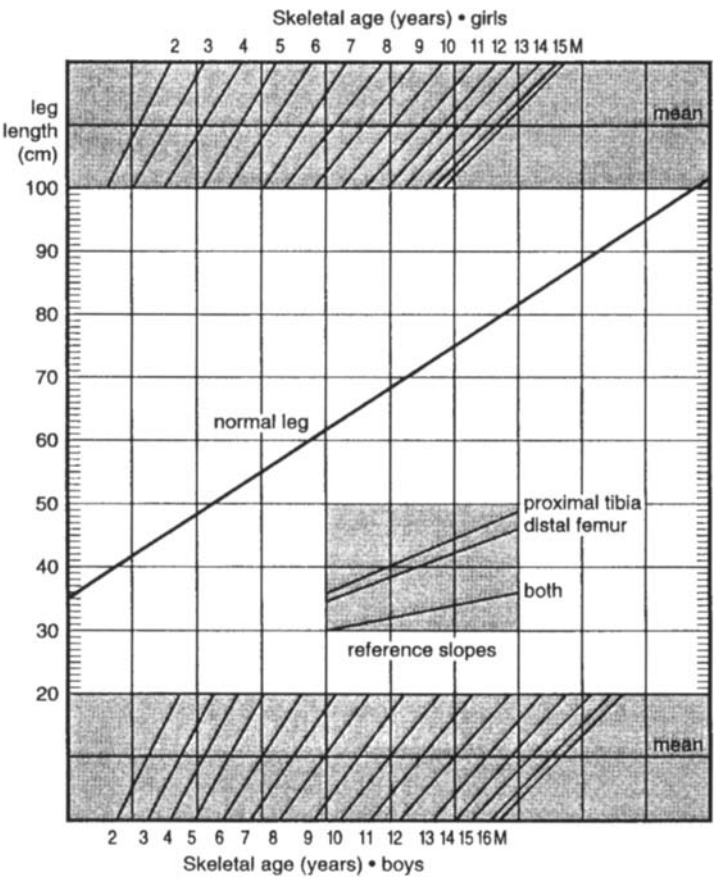
Moseley's Straight Line Graph (M-SLG), which is based on data obtained in the forties and fifties by Anderson and Green, is helpful in timing physiodesis. However, reported disappointing results may have been caused by the secular trend. We investigated whether current growth data could improve this graph.

Patients and methods: Data of 182 Dutch children, collected between 1979 and 1994, were used to estimate recent



growth curves with repeated measures analysis of variance, and to create a new Rotterdam Straight Line Graph (R-SLG). Its value was assessed by predicting the final leg length with both graphs in a subset of children.

Results: The mean length of femur and tibia had increased significantly when compared to the data of Anderson and Green. The R-SLG is shown in the figure. In 26/34 children who underwent physiodesis, the R-SLG gave better prediction of the length of the unoperated leg at maturity than the M-SLG.

Conclusion: The prediction and treatment of leg length inequality can be improved by the use of recent growth data.

Foot/Ankle

147. Ligament force and joint motion in the intact ankle—a cadaveric study

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The aims of this study were to measure the forces in the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL), and the motion in the tibiotalar and subtalar joints during simulated weight bearing in 8 cadaver ankle specimens.

Material and methods: A MTS test machine was used to apply compressive loads to specimens held in a specially-designed testing apparatus in which the ankle position could be varied in a controlled manner. The forces in the ligaments were measured with buckle transducers. The motions were measured with an instrumented spacial linkage. Force of motion measurements were recorded in 5 different positions of the ankle with and without a 375 N compressive load simulating weight bearing.

Results: From 10° dorsiflexion to 20° plantarflexion, all motion occurred in the tibiotalar joint. In contrast, the ratio of subtalar motion to tibiotalar motion was 3:1 for supination-pronation, and 4:1 for internal-external rotation. Inverse loading patterns were observed for the ATFL and CFL over the plantarflexion-dorsiflexion positions. Compressive loading did not affect CFL tension, whereas the pattern of increasing ATFL tension with plantarflexion was magnified with compressive loading. The largest increase in ATFL force was observed in supination and plantarflexion with a compressive load (38 ±12N), whereas CFL tension mainly increased in supination and dorsiflexion a compressive load (109 ±28N).

Conclusion: The results show that the ATFL acted as a primary restraint in the inverted position, where injuries typically occur (combined plantarflexion, supination and internal rotation). Axial loading increased the ATFL forces. The subtalar joint was of primary importance for normal supination-pronation and internal-external rotation to occur. The ratio of subtalar motion to tibiotalar motion was 3 to 1 for supination-pronation and 4 to 1 for internal-external rotation and this is significantly higher than previously reported. This has implications for current ankle ligament reconstructive procedures which all have a tenodesis effect on the subtalar joint.

148. Ankle arthroscopy in 45 patients

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The aim was evaluation of ankle arthroscopy due to sequelae after sprain (67%), sequelae after fracture (20%), posttraumatic arthrosis (9%) and rheumatoid arthritis (4%).

Patients and methods: 24 men and 21 women with a mean age of 36 (14–68) years had an arthroscopy performed with a tourniquet and without distraction devices. The major preoperative complaints were pain (98%), swelling (57%), impingement (40%), a limited range of motion (36%) and instability (33%).

The operative procedures included partial synovectomy (69%), removal of adhesions (29%), resection of exostosis (22%), removal of loose bodies (20%), and drilling of a chondral defect (2%).

Results: At the postoperative examination after a mean follow-up of 11 (6–16) months 62% of the patients were very satisfied, 33% were moderately satisfied and 4% were not satisfied. In the group of patients who had pain as their major preoperative complaint 41% had no pain at all and 32% had less pain than before surgery. Impingement was completely relieved in 57%, instability in 40%, swelling in 35%, and in 37% of the patients with a limited range of motion their motion was completely free. There was one postoperative complication, a neuroma which was resected and the patient is now free of symptoms. 79% of the patients could return to sports at their premorbid level.

Conclusion: In our hands, ankle arthroscopy has proven succesful in treating especially pain and impingement. We have had only one postoperative complication and a quick recovery with 79% returning to premorbid sporting activities.

149. Absorbable tacks for the treament of chronic lateral instability of the ankle joint

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For the stabilization of chronic lateral instability of the ankle joint, numerous methods has been described. We like to describe a new simple method by using absorbable tack made of self-re-inforced poly-l-lactide for the fixation of the reconstruction of the lateral ligaments of the ankle joint.

Patients and methods: 17 patients has been treated by using a new method for the fixation and reconstruction of the lateral ligaments of the ankle joint. Both ankles were operated on in one patient. The average age of the patients was 28 (15–40) years. There were 7 men and 11 women. The duration of symptoms observed before the operation was from 4 months to 15 years. The mean follow-up time was from 3 months to 2.5 years. 15 out of 17 patients were examined preoperatively with ADS radiography, which was pathologic. Earlier operative treatment was Evans procedure in 4 cases and capsuloraphy in one. If the follow-up was less than one year, the subjective result was asked by phone.

Operative technique: In 3 cases it was possible to refix FTA and FC ligaments by using 1.1 mm tack as a fixation device. In 15 operations we replaced the lateral ligaments of the lower ankle joint by using the lower third of TFA-ligament. After lateral exposure the distal third of TFA-ligament was prepared with a small piece of bone from tibia. The insertion of FTA ligament was freshened and by using 1.1 mm drill the channel was drilled for the tack. The distal part of TFA-ligament was reinserted carefully into the place of FTA-ligament and fixed with a small PLLA-tack into the talus. In the two first cases the fixation was performed by sutures. Postoperative immobilization was plaster cast for 3–6 weeks in 4 cases and Aircast brace for 3–4 weeks in 14 cases. If the instability was of the tilting type, the graft was fixed in the posterior part of the FTA-ligament in the talus and if the instability was anteroposterior, the graft was fixed more anteriorly.

Results: The operation time was 35 (20–65) min being over 60 min in patients, whose fixation was performed by sutures. The patients needed sick-leave 50 (0–80) days on average. Subjectively, all patients achieved better stability of the joint. Clinically, the stability of the joint was good in 17 out of 18 ankles at the last check-up. One patient had slight restriction of motion of the ankle joint. Superficial infection occurred in 2 patients, and both of them used Aircast-brace immobilization. One neural entrapment in the scar was observed needing operative treatment.

Discussion and Conclusion: The relatively short operative time shows, that the method is easy to perform. The use of brace as postoperative immobilization may be helpful to achieve full range of motion of the joint, but transient removal of the plastic brace daily is recommended because of risk of infection. We conclude, that small PLLA tacks are suitable for the fixation of reconstruction of lateral instability by using the method described above. In this series there were 4 late failures after Evans procedure, and therefore the patients will be checked up for later analysis of the long-term results of this method. However, the tendon replacing the ligament may suffer the risk of late instability because of structural differences between tendon and ligament tissue, and in this method we used a ligament graft to replace injuried ligament.

150. Aftertreatment with Donjoy R.O.M Walker bandage in operatively treated achilles tendon ruptures

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The aftertreatment in ruptured achilles tendons traditionally has been immobilisation in an above-the-knee plaster cast for 6–12 weeks. The purpose of this study, which was set up in 1989, was to evaluate the aftertreatment with the Donjoy R.O.M Walker. The idea was to minimize the inconvenience for the patient, and through early mobilisation to optimize and shorten the rehabilitation time.

Patients and methods: 58 patients have until now been examined. In the aftertreatment a Donjoy R.O.M. Walker bandage was used for 8 weeks. The first 3 weeks in 30° of plantarflexion. After 3 weeks, the bandage was changed towards neutral with 10° every week, and the patient was allowed to take off the bandage while in rest. No weight bearing was allowed the first 5 weeks. Complications, return to work/sport, muscle strenght, range of motion, patient satisfaction, and overall patient compliance were among the parameters recorded.

Results: The mean follow-up time was 41 (12–84) months. The mean age for all patients were 40 (10–79) years. There were 50 men and 8 women and there were 47 sports injuries (81%). We found no reruptures. One patient had a superficial infection with skin necrosis. There were no differences in muscle strenght, and range of motion in flexion, but significant difference in extension. The patients returned to sport in 25 (12–104) weeks, and to work after 8 (0–26) weeks.

Conclusion: The Donjoy R.O.M. Walker proved to be a useful alternativ to plaster immobilisation,

Poster

151. Operative or nonoperative treatment of Achilles tendon rupture

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Opinions differ on the proper treatment of Achilles tendon rupture. A comparative study between operative and nonoperative treatment of acute spontaneous Achilles tendon ruptures is presented.

Patients and methods: 38 patients with acute total rupture of the Achilles tendon were included in the study. The diagnosis was based on a palpable gap in the tendon, a decrease of plantar flexion of the foot, and a positive Thompson's test. 21 patients (19 men, 2 women), median age 39 (25–48) years were treated by operation and a below-knee plaster without weight bearing for 6 weeks. 17 patients (15 men, 2 women), median age 46 (25–65) years were treated nonoperatively with a below-knee plaster in 20° of plantar flexion for 4 weeks, and neutral position with a heel for weight bearing for 4 weeks. 19 patients in the operative group and 10 patients in the nonoperative group sustained the rupture during sports (median activity-time before rupture was 29 min), and 2 in the operative and 7 in the nonoperative group during everyday activities. The mean delay before treatment was 0.65 (0–2) days for the operative group and 3.7 (0–30) days for the nonoperative. The period of hospitalisation for the operative group was 2 (0–4) days, and the nonoperative 0.4 (0–1) days. The follow-up time was 36 (12–53) months in the operative and 51 (12–106) months in the nonopertaive group.

Results: 3 of the 17 nonoperative patients had reruptures and 10 had minor complications. In the operative group 14 had minor complications. All patients could walk and run, but two in the nonoperative group could not stand on tip toe. The mean dorsal flexion in the two groups and the plantar flexion in the operated group were not reduced compared with the uninjured side, but the plantar flexion in the nonoperative group was significantly reduced (p=0.03). The mean calf atrophy was 11 mm and 15 mm (p=0.07) and the mean increase in tendon thickness was 5 (1–19) mm and 7 (1–15) mm in the operative and nonoperative groups, respectively

Conclusion: Operative treatment of ruptured Achilles tendons is preferable, but nonoperative treatment is an acceptable alternative. Better operative technique and dynamic aftertreatment may further improve the functional end results.

Tumor

152. CT-guided excision of osteoid osteoma

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Osteoid osteoma heals spontaneously within 3–7 years, but removal of the nidus is usually advocated to have the diagnosis histologically verified, for pain relief or to avoid deformities. Traditionally surgical excision of osteoid osteoma is performed en bloc after wide exposure of the lesion. The small nidus is often difficult to locate and hard to reach. During recent years, CT-guided surgery has been advocated to avoid incomplete removal, and to prevent extensive resections of bone. We report our experiences with 3 different approaches.

Patients and methods: During the last 6 years 14 CT-guided excisions of osteoid osteoma have been performed at our hospital. The nidus was located with 1 mm CT sections, and a Kirschner wire centered in the lesion. Subsequently, the patient was transported to the operating theatre where the tumor was removed by open surgery. During the last year we used a trepine to core out the lesion. This procedure was performed percutaneously in the CT lab. In one patient the nidus was thermocoagulated. Four cases will be presented to illustrate the different techniques.

Results: The diagnosis was histologically confirmed in 10 cases. All patients were dismissed the day after surgery and weight bearing allowed. There was no major complications, but autogenic bone transplantation was done in one patient with a core diameter of 14 mm. There was no recurrence of the symptoms in any of the patients.

Discussion: Removal of osteoid osteoma should be done with intraoperative identification of nidus. Several procedures have been developed to identify the tumor nidus, but CT-guidance is probably the best adjunct to avoid incomplete removal of the nidus, wide excisions with transplantation of bone, contamination or damage of neurovascular structures. Initially we found it usefull for preoperative localization before open surgery. During the last year we have preferred a percutaneous technique which seems to be safe and effective.

153. 98 consecutive thoracolumbar spine metastases with symptomatic cord or root compression—outcome of posterior spine surgery

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Some discussion prevails whether posterior spine surgery or

more extensive anterior surgery is preferable in patients with thoracolumbar metastases. In the current study, the outcome of posterior surgery in a consecutive patient series was evaluated.

Patients and methods: Since 3 years, at our university hospital, all patients referred for thoracolumbar spine metastases causing symptomatic compression of the spinal cord or the cauda equina are subject to an initial joint examination by an oncologist, a neuroradiologist and a spine surgeon. All patients with metastases unfit for merely radiotherapy and life expectancy more than two months are offered spine surgery.

During the past 3-year period, posterior spine surgery was performed on 98 patients (67 men, 31 women), mean aged 65 (41–84) years, with metastases in the thoracic spine in 74 cases and the lumbar spine in 24. The primary malignancies were prostate cancer (n 40), breast cancer (20), kidney cancer (7), lung cancer (6), myeloma (5), miscellaneous (16) and unknown origin (4). 68 patients sustained posterior decompression and stabilizing instrumentation, and 30 merely decompression. Local pain, radiating leg pain, walking ability and neurologic function according to Frankel, and performance status according to Karnovski were documented for all patients preoperatively, and for the surviving patients 4 months and 1 year postoperatively.

Results: The overall survival at 4 months postoperatively was 61% (men 57%, women 69%), and at 1 year 36% (men 24%, women 60%). The survival was best for patients with breast cancer and myeloma. Local pain was at 4 months absent in 58 % of the patients, reduced in 27% and unchanged/worse in 16%, and at 1 year absent in 55%, reduced in 35% and unchanged/worse in 10%. Radiating leg pain was at 4 months absent in 71%, reduced in 13% and unchanged/worse in 16%, and at 1 year absent in 70%, reduced in 15% and unchanged/worse in 15%. Loss of preoperative walking ability was regained and maintained in 82% of the patients at 4 months and in 91% at 1 year. One preoperatively ambulatory patient became paraplegic postoperatively and remained so at 4 months. 2 patients were institutionalized at 4 months and 1 patient at 1 year.

Conclusions: A high degree of pain relief, improved walking ability and retained social independancy can be expected after posterior spine surgery in patients with thoracolumbar spine metastases causing symptomatic compression of the spinal cord or the cauda equina. An initial joint examination by an oncologist, a neuroradiologist and a spine surgeon seems profitable in selecting patients suitable for surgery.

154. Knee function after tumor resection and large-segment osteochondral allograft reconstruction involving the knee joint

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Limb salvage surgery for malignant tumors in and around the knee joint has increased the activities of daily living for patients previously treated by amputation. Ligament reconstruction following allograft implantation has not been addressed in the literature with the exception of Montgomery et al. (AAOS, 1993) who reported that patients undergoing ACL repair/reconstruction had a better outcome than matching controls. The purpose of the present study was to assess the knee stability, function and patient satisfaction after ACL repair in conjunction with reconstructive surgery for a skeletal defect following tumor resection.

Patients and methods: From 1985 to 1992, 22 large segment osteochondral allografts involving the knee joint were implanted at the University of Minnesota Hospital. During that time, 1 patient died as a result of the disease, 1 patient underwent a subsequent above the knee amputation, 2 underwent subsequent knee arthrodesis, and 5 underwent total knee replacements. Of the remaining 13, 9 were available for this study with an average age of 21 (9–31) years. At the time of surgery, all ligaments were repaired with nonabsorbable sutures including the posterior capsule, ACL, PCL and collateral ligaments. No ligaments were reconstructed with auto- or allografts. All but one of the osseous allografts included osteoarticular allografts with a major diaphyseal segment. The followup was done at a mean of 29 (9–66) months by an independent knee surgeon (LE).

Results: The Lysholm score showed 1 excellent, 6 good, 1 fair, and 1 poor. The Tegner score had decreased from 7 preoperatively to 5 postoperatively. The IKDC score was 5 Bs, 3 Cs, and 1 D. Only 1 patient experienced recurrent giving-way. The KT1000 showed > 3mm difference in 5 patients.

Conclusion: Although the knee may appear to be objectively loose (KT 1000), subjectively the patients are overall quite satisfied with their function. Simple ligament repair may thus be sufficient in these large segment osteochondral allografts.

Poster

155. Surgical margin in soft tissue sarcoma—assessment by frozen gross sections

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After local resection of soft tissue sarcoma, we routinely freeze the whole specimen immediately postoperatively and gross sections are taken for macroscopic evaluation of surgical margin. After photography, samples for microscopy are

taken from areas of interest. The method improves margin assessment by preventing the retraction of soft tissues thereby facilitating the identification of areas of interest for microscopic evaluation. Two groups of patients, referred for extended surgery after intralesional or marginal surgery outside the tumor center, were studied. In the frozen gross-section group, residual tumor was diagnosed in 7 out of 11 specimens. In a standard formalin fixed group, tumor was only found in 3 of 13 specimens. The histologic details are well preserved after freezing. We recommend, however, that some representative tumor tissue is taken before freezing for special analysis, e.g., chromosome analysis.

Basic science

156. Cartilage matrix constituents in primary guinea pig osteoarthrosis

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Hartley guinea pigs develop spontaneous osteoarthrosis (OA) of the knees predominantly on the medial condyle.

Animals and methods: 6, 12 and 30-month-old guinea pigs were examined with regard to synthesis and content of cartilage matrix constituents in guanidine extract of cartilage, labeled by ^{35}S and ^{3}H-leucine, after separation by ion exchange chromatography.

Results and conclusion: Proteoglycan content was 49% lower in the osteoarthrotic, medial condyle, compared to the lateral condyle with only cartilage fibrillation at 12 months. At 30 months, with increasing OA medially, the difference between condyles increased to 71%. Matrix protein content was 43% lower in the medial condyle with minimal fibrillation, compared to the lateral non-OA condyle at 6 months, and further decreased both with age and progression to severe OA. The decrease was more prominent in the osteoarthritic medial condyle, suggesting that this change is related to aging, but accentuated in progressive osteoarthritis. The radiolabeled fractions after electrophoresis showed an increase in fibronectin synthesis. The synthesis pattern resembled that of joints with intraarticularly administered TGF-beta. Other matrix proteins like the cartilage oligomeric matrix protein (COMP), the 92kDa protein, and the 39kDa protein were not increased, thereby differing from previous observations in human OA.

157. Articular cartilage proteoglycans during development of primary osteoarthrosis in the guinea pig

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Hartley guinea pigs spontaneously develop a reproducible osteoarthrosis(OA)-like condition in the medial tibial condyle between 9 and 12 months, whereas the lateral condyle remains intact.

Animals and methods: Content and synthesis of proteoglycans (PGs) and glycosaminoglycans (GAGs) in various tibial cartilage parts were studied in 6, 12 and 9 month-old guinea pigs (n 6). Proteoglyans were extracted with Gu-HCl and analyzed electrophoretically. Glycosaminoglycan content was assessed by HPLC, and synthesis by ^{35}S radiolabelling.

Results: PG content was highest in the central portion of the pre-arthrotic medial condyle at 9 months where load is highest. Values were lower periferally and in the lateral condyle. At 12 months, the osteoarthrotic central part of the medial condyle contained 25% less PGs, while the hyaluronan contents remained constant. However, the ratio large/small PGs was unchanged. OA was also associated with an increase in 4-sulfated chondroitin sulfate. However, the decreased content of PGs in osteoarthrotic tissue was only associated with minor changes in synthesis and break-down rates, in contrast to previous reports in experimental OA.

Conclusion: The increased contents of PGs seen in the pre-osteoarthrotic articular cartilage may represent a response to increased load, and the eventual degeneration of the tissue may occur when this ability becomes insufficient.

158. Favorable biocompatibility and effect on heterotopic osteogenesis by a poly-orthoester compared to copolymer of polylactide and polyglycolide

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For osteoinduction in clinical practice a bioerodible delivery system is warranted both to prevent displacement of demineralized bone matrix (DBM) particles and for sustained release of BMPs and other growth factors that otherwise are rapidly absorbed. The ideal delivery system should be biocompatible, not inhibit the osteoinduction, and resorbed as new bone is formed.

Materials and methods: DBM alone and composites of DBM and two different biodegradable carriers, polyorthoester and copolymer of polylactide (PLA) and polyglycolide (PGA) were implanted in the abdominal muscles of 45 male Wistar rats. Host-tissue response and heterotopic osteoinduction were evaluated by qualitative histologic examination and ^{85}Sr uptake 4 weeks postoperatively.

Results: Both polyorthoester and copolymer of PLA and PGA had a plastic consistency, could easily be molded and adhered well to the DBM. By qualitative histology and ^{85}Sr uptake, no differences in bone induction could be identified between DBM alone and composite of DBM and polyorthoester. Little or no inflammation was evident and only traces of the polyorthoester was seen in some implants of composite of DBM and polyorthoester. The implants of composite of copolymer of PLA and PGA and DBM showed a chronic inflammation with multinuclear giant cells and proliferating fibroblasts. Part of the copolymer was still present and the uptake of ^{85}Sr was significantly less than in the two other types of implants ($p<0.05$).

Conclusion: We conclude that polyorthoester seems favorable compared to copolymer of PLA and PGA regarding effect on bone formation, absorption of polymer and host tissue response.

159. Guided tissue regeneration and local delivery of IGF-I by bioerodible polyorthoester membranes enhances healing of rat calvarial defects

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Guided tissue regeneration, the placement of a cell occlusive membrane, prevents fibrous tissue from invading bone defects during healing and thus stimulate bone healing. A bioerodible drug delivery system, as polyorthoester, in the shape of a membrane may provide both guided tissue regeneration and delivery of growth factor. The purpose of the present study was to evaluate regeneration of rat calvarial defects by bioerodible polyorthoester membrane containing IGF-I.

Animals and methods: Thirty 8-week-old male Wistar rats were randomly allocated into three groups, A–C, with 10 rats each. A 6-mm defect in the left parietal bone was made in each rat. In the defects of the group A rats, no implant was used (control group). In the group B and C rats, we placed polyorthoester membranes without active substance and with 6 µg physically incorporated recombinant human IGF-1, respectively. Bone formation was quantified by computer-assisted measurements of the area of the residual defect on radiographs and host-tissue response was evaluated by light microscopy 6 weeks postoperatively.

Results: The area of residual bone defect was greatest in the group without implant, less in the defects with membrane without active substance and least in the defects with membrane with IGF-I ($p<0.05$). Generally, complete healing was not observed. By histologic evaluation, no inflammation was seen and only traces of the polyorthoester could be detected in the defects with polyorthoester membrane with or without IGF-I.

Conclusion: Polyorthoester membranes with IGF-I enhance the healing of parietal defects in rats. Further research on dosage of IGF-I and possibly other growth factors is necessary to ensure complete bone healing.

160. Management of waiting lists using OMR and PC database technology

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Queues for orthopedic surgery present an increasing problem. The purpose of the present study was to evaluate the use of Optical Mark Reader (OMR) technology and a PC based database in the management of long waiting lists.

Materials and methods: The OMR registration form consists af two A4 sheets. The first sheet is used to record the minimum of variables necessary to manage the waiting list and calculate statistics. The second sheet is used to record variables of specific value to the spine section when planning the surgical programme. 50 patients were randomly chosen from the waiting list. The OMR sheets were filled in and read by the OMR reader. After OMR registration the resulting ASCII file was imported into a custom made PC based database (Paradox). This database can sort the waiting list according to specified criteria and supply relevant waiting list statistics and graphics. The OMR statistics were tested after the the participating surgeons had been given both verbal and written instructions. Faulty OMR sheets were recorded. OMR user satisfaction was recorded.

Results: 15% of the 50 outpatient records used in the management of the waiting list for surgery did not contain the minimum of necessary information. The percentage of OMR sheets with missing data or unreadable sheets was 4%. The surgeons were satisfied with the OMR registration sheets.

Conclusion: OMR sheets can easily be produced and changed using existing software. Users were satisfied with the OMR sheets, which were easily read by an OMR reader. The database was able to sort the waiting list and produce necessary waiting list statistics and graphics.

Poster

161. Reduced inhibition of fibrinolysis after THR in patients transfused with predonated blood

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The main advantage of blood donation before elective surgical procedures is a reduction of the need for homologous blood transfusions and thus a reduced risk for blood transmitted diseases. A reduced postoperative blood loss after a THR has also been reported after autologous transfusions, postulating that predonation may activate the donor's hemopoietic and coagulation systems (1). The aims of this study were to investigate if, and how, preoperative donation of blood influences blood loss during THR and to analyse the effect of predonation and blood transfusion on hemostatic mechanisms.

Patients and methods: 80 patients with primary coxarthrosis were randomly allocated to preoperative blood donation or not. In the autologous group, two units of blood were collected, one of the units 4 and the other 2 weeks before the scheduled operation. All patients received iron supplementation. Operations were performed under spinal anesthesia in a lateral position using a posterior approach. Blood loss was estimated both by measurement and calculation. The last 10 randomized patients from each group were studied regarding their coagulation and fibrinolysis factors before blood donation i.e., in the morning approximately 6 weeks before operation, in the morning before surgery, 2 hours postoperatively and the following morning.

Results: Measured and calculated blood losses did not differ between the autologous group (1350/1840 mL) and the control group (1260/1980 mL), neither did the total transfusion volumes. 7 patients in the autologous group (7/38) received homologous packed red cells after they had been given their own two predonated units, compared with 29 in the control group (29/40), ($p<0.001$). Predonation of blood resulted in a 4 times reduction of the need for homologous transfusion. The platelet counts, vWF:Ag, PK and antithrombin III decreased during surgery in both groups. FVIII increased after the predonations (p 0.04) while other hemostatic parameters were unchanged. PAI-1 increased postoperatively in the homologous group only ($p<0.01$). No hemostatic parameters or patient factors were identified that could predict total blood loss.

Discussion: We could not confirm the finding that predonation of blood reduces blood loss. In order to reduce over collection and wastage, we recommend that the amount of autologous blood donated before a THR should be two units. In the present study predonation of a third unit would result in a wastage of 32/38 units and it would only reduce the number of patients who received homologous blood from 7 to 5. PAI-1 was significantly higher in the homologous group postoperatively and this may be associated with an increased risk of postoperative venous thromboembolism after THR (2).

References: 1. Elawad A, et al. Predonation autologous blood in hip replacement arthroplasty. Acta Orthop Scand 1991; 62(3): 218-222

2. Eriksson B I, et al. Thrombosis after hip replacement. Acta Orthop Scand 1989; 60(2): 159-163.

Table 1. Descriptive patient data. Mean (SD)

	Autologous group (n38)	Control group (n40)
Men/Women	15/23	6/34
Body weight	77 (14)	72 (14)
Age	71 (5)	71 (5)
Prosthesis		
BiMetric	10	7
Charnley	27	30
Stanmore	1	3
Duration of surgery (min)	107	97