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Revision hip arthroplasty

1. Results of cemented revision hip arthroplasty

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This study evaluated revisions using the second generation cementing technique.

Patients and methods: 125 hips in a consecutive study of cemented revisions operated during 1982 to 1989. Hips revised more than one time and infections were excluded. Repeated clinical and radiographic evaluations were done prospectively for a minimum of 7 years. There were 70 revised cups and 109 stems. The reason for revision was aseptic loosening in 120 hips, 2 dislocations, 2 implant fractures and one cartilage wear. The mean age at the revision was 70 (28–88) years and the average radiographic follow-up 8 (3–13) years. Bone defects were classified according to Gustilo and Pasternak and the Endo-Klinik, osteolyses according to Goetz and the radiographic appearance of the cementing mantle according to Estok and Harris. Cox regression analysis was used.

Results: 5 cups were rerevised and 12 were radiographic failures corresponding to 10-year survival rates of 93±7% (end-point: rerevision) and 77±11% (end-point: rerevision or loosening = total failure), respectively. As regards the later type of failure the Charnley cup performed better (p=0.0008) than the other designs (mainly metal-backed Spectron and polyethylene Christiansen cups). The width of the cement mantle in zon 4 implied increased risk of total cup failure (p=0.0003) and young age at revision (p=0.001). 7 stems were rerevised and further 5 were radiographically loose (10-year survival: revision 92±6%; total failure 87 ±8%). The use of a short stem implied increased risk of revision (p=0.02). Endo-Klinik grade III (p=0.04), postoperative radiolucency region 4 (p=0.04) and 6 (p=0.002), use of a short stem (p=0.008) and young age (p=0.0001) implied increased risk of total stem failure. The hip and pain scores at the latest follow-up were 73±16 and 40±9, respectively.

Conclusion: Correct implant selection and optimum cementing technique are important steps to improve the results of cemented hip revision.

2. Early results using the long-stemmed Wagner prosthesis for aseptic loosening and fractures in THR

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Introduction and methods: The long-stemmed Wagnerrevision prosthesis has been used at the Karolinska hospital since 1993. It is 190–385 mm long and slightly tapered. Its sides are fluted. After reaming the marrow cavity with conical reamers the prosthesis is hammered down to press fit in the midshaft femur. The operation is performed through a transfemoral approach.

Patients: 43 patients out of originally 49 have been followed for more than one year. 2 had died of unrelated causes and 4 were not available at the later controls. Their mean age was 71 (46–93) years. 29 were operated on because of aseptic loosening and 14 because of a fracture beneath a prosthesis.

Results: Pain, joint mobility and walking ability was assessed by use of Charnley's modified Mèrle d'Aubigné Score. At follow-up the average score for pain, mobility and walking was 5.4, 4.3 and 4.2 respectively. There was no difference between patients who had a revision because of mechanical loosening and those who had had a periprosthetic fracture.

All patients showed significant bone regeneration in the proximal femur where there formerly had been resorption. None showed bone resorption at the two year control. Mean subsidence was 0.8 (0–3) cm. 2 patients became infected.

Our most frequent complication was dislocations which have afflicted 11 patients. So far 9 are reoperated; 1 with a thicker stem, 4 with exchange of the cup, 2 with exchange of both stem and cup and finally 2 with a posterior rim attached to the original acetabular component.

Conclusions: The transfemoral approach gives an excellent exposure of the hip and femur and greatly simplifies cement removal. It also induces massive formation of new bone where there previously was resorption. The treatment of perioprosthetic fractures is also facilitated. The dislocation rate, however, is alarmingly high, although it can be managed by reoperation.

3. Early complications in revision hip arthroplasty with impaction grafting technique

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Revision hip arthroplasty with impaction grafting technique has shown promising results. We have used this technique in patients with compromised bone stock in the proximal femur (grade 2 and 3 according to the Endoclassification). We have reviewed our first 50 cases, revised with a collarless polished tapered stem and impaction grafting technique. The follow-up is only six months to three years. The over-all early results are excellent but we have had complications. Three intraoperative femoral fractures, which were not observed and taken care of, occurred during the impaction of the bone graft. In all of these cases, the surgeon had done less than five cases using this technique. In two cases, where revision with impaction grafting was done as the second operation in a two-stage procedure treating an infected total hip replacement, the whole construct subsided early and the graft resorbed. The clinical course in these cases has indicated that the infection had not been eradicated at the time of revision with impaction grafting. In one of the cases the implants have been extracted and the other case is scheduled for a new two-stage revision procedure.

Postoperative dislocation occurred in two cases. One occurred after three weeks and was managed with closed reduction. The other one occurred six months after the revision. This patient has had another two dislocations and she is scheduled for stabilizing surgery. In two cases a fatigue femoral fracture occurred at the tip of the prosthesis, 5 and 8 weeks after revision with impaction grafting technique. One healed after ORIF using a plate and bone graft and the other healed after conservative treatment.

4. Initial stability of two different hip revision concepts—a bionechanical study

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The initial stability of the so called X-Change revision, a standard Exeter stem cemented in a bed of firmly impacted morsellized bonegraft was compared to a uncemented PCA Long Stem implanted with proximal bonegrafting.

Method: Our experimental revision model comprises a synthetic composite femur prepared to a state closely resembling the revision situation. The femur was mounted in a rigid steel fixture inclined 45° and loaded vertically. Stems were implanted under standardized conditions using instrumentation and method as described by the manufacturer. Each stem was implanted and tested three times in each of three identically prepared femora for a total of nine tests of each stem. An Alwetron material testing apparatus was used to push vertically on the prosthetic head at constant downward speed during continuos registration of load and displacement. The average displacement curves for the PCA and Exeter stem was compared at every 100N using paired Students T-test.

Results: Both stems displaced into retroversion with no detectable axial displacement. Displacement was larger with the Exeter stem ($p<0.001$). At a load of 1000N the average vertical displacement of the prosthetic head was 3±2 mm for PCA and 7±2 mm for Exeter.

Conclusion: Considerable displacement occurs at loads less than what would be encountered in activities of daily living. The displacement exceeds what is tolerable to enable bone ingrowth. Thus it seems highly important to protect these stems from excessive torsional loading during the early postoperative period.

5. Increased subsidence of uncemented femoral stems in hip revisions with impaction grafting

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The remodelling of allograft bone in revision hips is dependent on mechanical factors as load, implant stability and fixation principle. The aim of this study was to evaluate and compare the migration and performance of cemented and uncemented stems in impaction grafted femurs.

Patients and methods: 32 consecutive stems revisions were done with impaction grafting. 10 had a type 1, 19 a type 2 and 3 a grade 3 bone loss (Gustillo-Pasternak). The first 20 hips received an uncemented titanium stem with a proximal HA coating (Anatomic, Zimmer) and the last 12 a cemented stem (SP2, Link) within the graft. Migration of the head centre was measured at 6, 12 and 24 months and conventional radiographs and Harris hip score evaluated.

Results: The mean subsidence of the uncemented (UC) stems were 2.6 mm, 2.8 and 3.0 mm (0–16 mm) at 6, 12 and 24 months. The cemented (C) stems subsided 0.37, 0.36 and 0.39 mm at the same time ($p=0.03$). Subsidence between 6 and 24 months were 0.41 and 0.10 mm in the 2 groups respectively (n.s.). Mean head migration reached 1.4/0.5 mm horizontally and 3.2/1.2 mm saggitaly for the UC/C stems at two years. Harris hip score increased from 49/40 to 81/73 (UC/C) (n.s.). At the two year follow up a radiolucent zone was present in 42% of the interface in the uncemented group and in 3% in the cemented (UC vs. C: $p<0.001$). The cortical thickness increased in 14 out of 16 uncemented and in 5 out of 11 cemented stems ($p=0.02$).

Discussion: The increased subsidence in the uncemented group could probably be attributed to both an insufficient impaction technique and a too short area for biologic fixation. A proximal bone ingrowth and a low migration in a few cases indicate that at least some of the stems achieved a stable proximal fixation, despite that the contact against living

bone was very small. Proximal fixation and loading is also supported by the increase in cortical thickness distally. If a fully HA coated stem had been used the fixation might have improved but perhaps at the expense of less cortical remodelling.

Although not being a randomised study the cemented stems displayed a superior fixation and less graft resorbtion, which probably is mandatory to reduce the risk for later clinical loosening. The cemented stem probably loads the grafted bone more evenly and hence better promotes bone remodelling.

6. Early migration of femoral components after revision with impacted cancellous allografts and cement

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The use of impacted morselized cancellous allografts and cement in hip revisions with substantial loss of bone stock is a promising method. The magnitude of early migration of such a composite might influence the long term results. By roentgen stereophotogrammetric analysis (RSA) it is possible to measure the early migration.

Patients and methods: 13 stems were revised for mechanical loosening with impacted cancellous allografts and cement. Standard femoral components were used and the patients were followed with RSA for 1–2 years.

Results: All the components subsided 0.3–13 mm during the observation period. In 12 cases the femoral head were displaced posteriorly also.

Discussion: The migration pattern was about the same as for cemented revisions with high initial migration and the slower. Hopefully formation of new bone may give better long term results than revision with cement only.

7. Stem and socket migration during 3 yers after revision with impacted morsellized allografts—a radiostereometric analysis

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Purpose: To evaluate by radiostereometric analysis (RSA) the prosthetic fixation in cemented hip revisions with contained and impacted morsellized allografts.

Patients and methods: 6 stems and 5 sockets were revised using the Exeter Exchange system in combination with contained and impacted morsellized allografts in four men and three women aged 72–80 (median 76) years. Indication for surgery was infection in one case and mechanical loosening in all other cases. Bone stock deficiency according to Gustilo and Pasternack was classified as Type I in four femurs and Type II in 2. For the acetabulum the classification was Type II in 1 case and Type III in 4. To enable RSA tantalum markers were implanted at surgery in the lesser and greater trochanters, the acetabular roof, the tuber ischii and the socket at surgery. Serial RSA follow-up was performed during three years.

Results: Between 2 and 3 years postoperatively significant migration was still seen in 3 of the six stems as well as in 2 of the 5 sockets:

Stem distal migration (n 6)

(mm)	6 weeks	6 months	1 year	2 yres	3 years
Mean	1.1	1.7	2.2	2.6	2.9
Range	0.6–2.3	0.9–2.7	1.0–3.7	1.4–4.3	1.5–4.9

Socket proximal migration (n 5)

(mm)	6 weeks	6 months	1 year	2 yres	3 years
Mean	0.6	1.0	1.1	1.3	1.4
Range	0.2–1.3	0.3–2.1	0.3–2.5	0.3–2.8	0.4–2.9

Conclusion: In cemented hip revisions with contained and impacted morsellized allografts using the Exeter Exchange system migration was still observed in 3 of the 6 stems and in 2 of the 5 sockets between 2 and 3 years postoperatively. Further follow-up is needed to objectify whether these cases will end in clinical loosening.

8. Acetabular revision using impacted morsellized allograft and cementless HA-coated cup—a preliminary report

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Since 1993 our standard procedure for acetabular revision is impaction of morselized allograft combined with a cementless HA-coated press-fit cup. We report our experience and short term results of 35 consecutive hips operated on during 1993-94.

Patients and methods: 34 patients with 35 hips, follow-up period 2–3 years. The preoperative bone loss was assessed according to Gustillo & Pasternak: 5 hips grad I, 21 grade II and 9 grade III.

We have used the Mallory-Head hemisperical HA-coated press-fit cup with four wings and optional screw fixation. Extensive bonegrafting was performed ensuring that the cups were completely seated in a bed of impacted morselized allograft bone. Standard plevic AP and lateral x-rays were used for radiological evaluation according to methods

described by Wetherell and by Sutherland.

Results: None of these 35 cups has been re-revised. There is one possible infection in a hip reoperated twice due to femoral fracture. The median Harris Hip Score at latest follow-up was 94 (26–100). Radiological cup migration of 2–5 mm was seen in 3 hips. Radiolucencies <1 mm were seen in Zone III in 2 hips.

Conclusion: In a short term perspective acetabular revision with impacted morselized allograft and cementless HA-coated cup seems to give statisfactory clinical and radiological results.

9. Outcome of revision hip arthroplasty in the National Register

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Population registries of hip replacement procedures can be effective sources of information needed for a more scientific choice of implant technology. 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 and re-revisions due to aseptic 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 modern cementing technique.

Material: The result of 160,000 primary THR are presented. The range of follow-up is 1–17 years. The re-revision risk ratios are based on 11,500 revisions and 1,500 re-revisions performed with cement or cementless technique and a wide variation in bone grafting.

Results: Survival curves with revision for septic and aseptic loosening as failure end-point definition are presented. Tables with risk ratios in relation to different "gold standards" with respect to both implant and implantation technique shows up to 600% increased risk for certain implant designs compared to the "baseline" implant. The revision procedure shows a 200% difference in outcome with re-revision as failure end-point. Most important determinant for the outcome is the reason for the first revision, this seems to overcome the effect of primary diagnosis. The highest risk for re-revision are noted among patients re-revised due to infection, bony fracture and recurrent dislocation.

Conclusion: The type of implant and fixation mode proved to be detrimental for success or failure. The type of cement used at the primary procedure also strongly influenced the risk for revision. The risk for re-revision were highest among patients revised due to infection, bony fracture and recurrent dislocation.

Knee arthroplasty

10. The Repicci II prosthesis—a new operative technique with the use of a minor arthrotomy for unicompartmental gonarthrosis

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The standard operative technique for unicompartmental knee replacement is similar to the technique used for total knee replacement. As a consequence the rehabilitation period and hospital stay has been about the same. We now present a method for unicompartmental knee replacement with short hospital stay and rehabilitation time based on a minor arthrotomy and a bone preserving replacement technique.

Material and method: 36 patients (38 knees), 24 women and 12 men with a mean age of 68 (56–86) years) were operated during February to November 1996. All patients had arthrosis limited to the medial compartment and with presence of bone sclerosis. The medial compartment is reached through an 8–10 cm parapatellar incision and with the use of a distraction device. The joint surfaces are replaced by a tibial polyethylene component and a femoral metal component of the Repicci II-system (Biomet). Palacos-Gentamycin cement is used. The preparation of the joint surfaces is made by using a high-speed burr and thereby minimising the bone resection.

Results: All patients were mobilised with full weight-bearing the same day as they were operated. The day after surgery 25 of 36 patients could leave the hospital for their own home. The average hospital stay after surgery was 1.5 days. Two patients were readmitted. There have been no tromboembolic complications, no infections but one serious complication with a fracture of the medial femur condyle 3 days after surgery. All patients are examined with RSA-technique and clinical follow-ups. These data are under evaluation.

Conclusion: The unicompartmental knee replacement can safely be done with one day hospital stay. Further research is needed to evaluate the long-term results. We recently have started a prospective, randomised study comparing the outcome for the Repicci-prosthesis and a traditional prosthesis inserted after saw cutting. The minor arthrotomy is used.

11. Comparison of 3 types of unicompartmental knee arthroplasty—a prospective randomized RSA study

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Unicompartmental knee arthroplasty (UKA) reveals higher revision rate than total knees. This is due to several reasons, one of them being the lack of sophisticated instrumentation leading to insertion of the prosthesis by free-hand technique. Currently two new designs have been introduced into the market which are to be inserted with instrumentation, PFC uni (Johnson&Johnson) and MG uni (Zimmer). We have studied the performance of these and compared the results with the Schlitten UKA (Link), which has a long documentation in the Swedish Knee Arthroplasty Registry.

Patients and methods: 36 consecutive patients (22 women, 14 men) with medial gonarthrosis grade I–III were randomized to PFC (10 Knees), MG (14 knees) and Schlitten (12 knees). The 3 groups did not differ as regards preoperative clinical data. The fixation was measured by RSA postoperative, and at 3, 6 and 12 months. Clinical results were assessed using Knee Society Knee Score.

Results: 1. RSA: At 12 months the PFC uni had migrated 1.1 to 3.2 times as much as the Schlitten uni depending on parameter investigated. Largest differences were noted for rotations about the transverse axis and subsidence. The MG uni, on the other hand, generally migrated less than Schlitten, for varus-valgus tilting, internal-external rotation and subsidence the MG displayed only about half of the migration seen in the Schlitten prosthesis.

2. Clinical results: At 12 months the knee score was 82 (PFC), 93 (Schlitten) and 92 (MG). There were no complications in the MG group. In the PFC group 2 tibial and 2 femoral components were revised due to loosening. In the Schlitten group 1 tibial component was revised due to loosening.

Discussion: The RSA data for the Schlitten prosthesis in this study are compatible with a 8 year revision rate of 8 percent according to the Swedish Knee Arthroplasty Registry. The large migration for the PFC prosthesis indicates a poor prognosis, which indeed is verified in this study with 4/10 knees revised due to loosening. The lower than average migration for the MG prosthesis indicates a favourable long term prognosis as regards fixations problems.

12. How mobile is a mobile meniscal knee prosthesis?

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Loosening and wear have emerged as the two most decisive factors influencing the longevity of knee prostheses. The debate is presently focused on increasing the bone fixation and minimise the wear problem. One way to improve this balance is to improve the stress distribution from the femoral to the tibial component. This has been done using movable meniscal bearing knees. However, a question has been raised as to what degree these inserts move when implanted in a patient. The purpose of this study was to investigate, using radiostereometry (RSA), if this insert really moves as a reaction to external forces.

Patients and methods: Knee arthroplasties using mobile meniscal inserts, the Rotaglide tibial component compared to an identical prosthesis, but with a fixed meniscal insert, the Nuffield knee, were studied. The Rotaglide prostheses allows rotation during extension and gliding and rotation during flexion. The patients were randomised intraoperatively to one of the two concepts. All cases were prepared for RSA. To study migration reference stereoradiograms were obtained postoperatively, at 6 weeks, 3, 6 and 12 months. The RSA examinations for inducible displacement, i. e. cyclic motion representing every-day life, were carried out at the one year follow up. A special part in the stress investigations was to study the movement between the tibial tray and the meniscal polyethylene bearing surface.

Results: For the first 16 patients followed for one year the MTPM for the meniscal part in relation to the tibial tray was 0.3 (0.28–0.32) mm for the fixed meniscal knee and 5.3 (3.81–7.88) mm for the movable meniscal knee. The stress investigation showed inducible displacement of 0.3 ± 0.0 mm for the cemented (n=12) and 0.2 ± 0.0 mm for the non-cemented prosthesis (n=4) in the first part of this study. The prosthetic fixation expressed a migration (micromotion over time) was 0.6 ± 0.2 (mean ± SEM) for the cemented cases during the first year and 1.5 ± 0.3 mm for the first non-cemented cases.

Discussion: The design of the mobile bearing allows 5 mm of A/P glide and 30° of rotation. Our results confirm that during the first year there is a considerable motion of the mobile bearing related to external forces simulating daily life activity in this preliminary report. There does not seems to be any major ingrowth of soft tissue which seriously limit the function of the mobile bearing.

13. Interax vs. AGC total knee prosthesis—a randomized clinical and radiographic short term comparison

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The purpose of this investigation was twofold: 1) a request from a commercial party to clinically evaluate a prosthesis, before a possible introduction on the Swedish market, and 2) to evaluate the information gained from such a study without access to RSA, e.g. the type of study all centers pursuing TKA could accomplish.

Patients and methods: 20 patients with primary osteoarthrosis were matched into pairs according to: gender, age, degree of osteoarthrosis, predominantly involved compartment, and symptoms from other joints. Thereafter they were randomly allocated to either the Interax (IAX) or the AGC prosthesis group. The mean age was 73.3 ±4.0 (IAX) and 71.4 ±5.2 (AGC). In each group there were 8 women and 2 men, 8 patients with the medial compartment predominantly

involved and 2 patients with the lateral. All patients had grad II–IV arthrosis according to Ahlbäck's classification.

The surgical technique was standard, utilizing the respective intramedullary jigs for the femur and extramedullary jigs for the tibia. All components were cemented. Evaluation variables; surgical time, total blood loss, time admitted to hospital, surgical complications, Knee Society Clinical Rating System, ROM, radiographically assessed alignment of the operated leg and the prostheses components. Follow-up was intended at 3 months, but occurred at 4.3 ±0.6 months.

Results: In the AGC group, one patient died before follow-up by reasons unrelated to the TKA, one patient had a superficial wound infection that resolved completely after antibiotics, and one patient had a DVT. In the IAX group, one patient had a DVT and one patient had a total palsy of the peroneal nerve. There was no difference between the groups regarding clinical score, range of motion, or radiographic assessment of leg and component alignment. There was also no difference regarding blood loss or time in hospital. However, there was a difference ($p<0.001$) regarding surgical time, 90 ±5 min for the AGC group and 119 ±4 min for the IAX group.

Discussion: The 30 minutes additional surgery time can be explained by 1) the AGC prosthesis has been our routine procedure since more than a decade, while the Interax prosthesis was completely novel to us apart from a few cases done prior to the start of the study. 2) The instrumentation for the Interax is somewhat more voluminous and involves more surgical steps, which indicates that even with training it will probably be a little more time consuming to put in if the present instrumentation is to be used. The validity of this type of study before introduction of a new total knee can be discussed. Results from this study, in which the follow-up length corresponds to a common sole routine control, indicate that both surgeon and patient would be equally happy with either method in the short term. A power analysis shows that a considerably larger study must be carried out to detect differences it they exist. If loosening rate is the objective, an acceptably long follow-up time is required before introduction of new prostheses, or RSA technique has to be used.

14. Migration of cemented all-poly tibia components in TKA—a prospective RSA study with two years follow-up

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Based on biomechanical studies, metal-backed (MB) tibial components were introduced during the mid-eighties due to inferior performance of all-poly tibias. However, the higher costs for MP implants, and the wish to maximise the polyethylene thickness for a given tibial cut has lead to a renewed interest in all-poly tibial components. The purpose of this study was to analyze the migration of cemented all-poly tibial components using RSA.

Patients and methods: 20 consecutive patients (11 women, 9 men, mean age 74 years), with osteoarthrosis (18) or RA (2) were studied. They were operated with a stemmed all-poly tibial component (Kinemax®), fixed with Palacos® gentamycin bone cement. RSA was performed postoperative and at 4, 12 and 24 months. Clinical outcome was assessed with Knee Society Scoring System, (Insall et al. 1989).

Results: There were no complications. Mean prosthesis score (max 100) at 1 and 2 years was 94 and 96 respectively. Most of the migration (70%–100%) recorded during the 2 years follow up, occurred during the initial 4 months, after which only minor migration could be detected. The majority of the components displayed a combination of subsidence of one part and lift-off of the contralateral part. However, the subsidence was nearly 3 times as large as the lift-off (24 months: 0.66 mm vs. 0.25 mm). In 15 of the cases subsidence occurred at the medial or postero-medial part of the knee. Maximum migration (MTPM) (Ryd) at 4 months was 0.63 mm and 0.75 mm at 2 years. Six components were continuously migrating between 1 and 2 years according to the criteria established by Ryd, whereas 14 components were stable.

Discussion: The pattern of migration seen in the all-poly tibial components were analogous to what has been found for metal-backed tibial components investigated with RSA. However, the magnitude of the migration in the all-poly tibia components was larger than is reported for metal-backed tibial components (Tricon II) inserted during the same period (Nilsson et al. 1995), especially as regard subsidence and varus-valgus rotation. If this is an indication of all-poly tibial components being inferior to metal-backed ones in general or whether this finding is a reflection of that all-poly components in this study had a different articular geometry than the Tricon II prosthesis could not be established.

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15. Gait affects tibial component fixation

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The relative importance of different trigger factors in implant loosening, such as debris particles or mechanical stimuli, have not been established. In a previous prospective study, knee joint flexion moments were increased in patients predicted by radiostereometry (RSA) to develop tibial component loosening[1]. The aim of this study was to corroborate these findings.

Patients and methods: 28 asymptomatic patients (27 knees) operated in Lund with TKA 1988–1991, were selected as matched pairs, according to RSA-findings: continu-

ously migrating versus stable implants, i.e. poor versus good prognosis[2]. Matching criteria were age, gender, implant design and fixation principle. Gait analysis was performed with a three-dimensional system (Vicon®). Kinetic data were collected from 3 steps on a hidden force plate (Kistler®). Knee joint angles, moments and powers, produced by Vicon as curves, were reduced for statistical analysis into peak values and areas under the curves (integrals). The independent T-test, with significance level $p<0.05$, was used to compare the two prognosis groups.

Results: Peak flexion moments were significantly larger in the 14 patients constituing the poor prognosis group, compared to the 14 patients in the good prognosis group ($p=0.005$). The poor prognosis group also showed significantly larger mean value of peak extension moments at heel strike ($p=0.01$) and maximum excursion from peak extension moments to peak flexion moments at loading response ($p=0.03$). The poor prognosis group had 71% of the area under the sagittal plane moment curve on the flexing side of zero, whereas the good prognosis group showed both extending and flexing moments, but only small oscillations around zero ($p=0.05$). Neither peak adduction moments, nor joint powers differed between the prognosis groups.

Discussion: By again finding differences in sagittal plane moments related to prognosis of fixation, we conclude that individual gait patterns and subsequent knee joint loading do play a role in the process of implant loosening. The good prognosis group patients often showed a protective gait pattern, with very small moments in the sagittal plane, resulting in less than normal loading. Normality may seem to be the goal in knee prosthesis surgery, but there may also be a conflict between effective use of muscles and energy, and joint loading. What decide the use of these different gait patterns, and can we intervene?

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16. Reactions to particulate wear debris in the nonreplaced knee compartment

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The role of particulate wear debris, predominantly of UHMWPE, in aseptic loosening of orthopedic implants is under debate. In vitro studies have shown that particulate UHMWPE can activate a macrophage response which may lead to osteolysis directly or indirectly. We have studied the effect on the tissues in the non-replaced compartment in the knee, in order to draw conclusions regarding the susceptibility to UHMWPE particles in the different types of tissue.

Material and methods: 8 unicompartmental knees with OA were revised due to wear of the tibial insert. The replacements had been implanted for 3–11 years with at mean time of 7 years. The resections were made for a total knee replacement. We analysed the synovial fluid, the synovium and the cartilage with underlying bone in the non-replaced compartment. Routine histologic preparations were made of the synovium, the cartilage and the bone after decalcification. The synovial fluid was first centrifuged. In all analyses birefringent particles in polarised light were interpreted as UHMWPE particles.

Results: In synovial fluid an abundance of needleshaped wear particles were found in all cases. In the synovium UHMWPE particles were found in all cases. There was a cellular response to the particulate material with giant cells and foreign body reactions. In the cartilage neither particles nor cellular reactions could be identified in any case. In the bone, reactions like those in the synovium were seen, especially in the fibrous tissue in the bonemarrow.

Discussion: We used the revision uni-knee as a model where the in vivo action of UHMWPE particles on different types of tissue can be studied. These tissues could be extrapolated to represent tissue in the prosthesis bone interface, which is known to range from fibrous tissue to highly differentiated fibrocartilage. We have found PE-particles, and cellular responses from these particles, in synovium and bone. Neither particles nor a cellular response was found in intact cartilage. Since the activation of the tissue by UHMWPE particles requires the recruitment of monocytes from the blood stream, and since there are no vessels in joint cartilage, reactions to PE particles are not likely to be found in this tissue. Such a notion is supported by our findings, which should be relevant whatever the size the studied particle have. These studies could be viewed in the context of prosthetic fixation. The interface between implant and bone consist of a spectrum of fibrous tissue ranging from loose fibrous tissue to fibrocartilaginous tissue. The more cartilaginous the less susceptible it may be to PE particles. Fulfilling this hypothesis it would be better to have a fibrocartilaginous interface than to have bone ingrowth!?

17. Economical aspects of using tricompartmental instead of unicompartmental prostheses for gonarthrosis

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The Official Swedish patient administration system (PAS) contains admission and discharge dates for hospitalised patients. By matching patients from this register with the Swedish National Knee Arthroplasty Register, implant related factors could be compared to length of hospital stay.

6,377 patients with arthrosis (OA) operated 1985–1993 with primary tricompartmental prosthesis (TKA) and 7,433 patients with medial or lateral unicompartmental prosthesis

(Uni) were compared regarding length of hospital stay and cumulative revision rate (CRR). Similarly, 420 revised Uni and 221 revised TKA's were compared regarding length of hospital stay.

The mean age for patients with primary TKA was 72 years and those with a Uni 71 years. CRR according to Kaplan Meier at 10 years was 6.7% for TKA and 11.6% for Uni. At the primary operation the preoperative hospital stay was 1.4 days in both groups while postoperative stay was 13.9 days for TKA's and 11.0 for Uni operated patients. Men stayed half a day shorter than women. The mean hospital stay between 1985 and 1993 reduces at a rate of 0.74 days/year.

The mean age at revision of a Uni prosthesis was 72 and of a TKA 73 years. The mean stay in hospital for revision of a primary TKA was 18.3 days and Uni 13.8 days.

A sample of 42 patients with OA aged 60 or 70 years that were operated in Lund 1994-1994 with a primary Uni or TKA implant were analysed concerning detailed information on hospitalisation and operative cost. We found no significant difference in the cost other than for the length of stay and implant cost.

The cost of a Uni and a TKA implant was estimated as the weighted mean price 1997 for the three most common models in each group, and was 8,382 SEK for a Uni and 15,937 SEK for a TKA implant. These models accounted for more than 2/3 of the total number used. Price information was received through the implant distributor. The cost of hospital stay was the cost used by the Lund University Hospital accounting system, 2,525 SEK a day (1995).

Taking into account the lower risk of revision for a TKA we would expect that using a TKA in the 7,433 patients that received a Uni prosthesis would have resulted in 364 fewer revisions. However it would have increased cost of implants by 26% and cost of hospital stay by 10%, which means an increase of 107 million SEK for the primary operations.

It has been shown that severe complications are more uncommon with patients operated with Uni prostheses, and our data indicate that revision of a Uni is likely to cost less than a TKA revision.

We thus find that using Uni prostheses instead of tricompartmental prostheses in selected patients may save considerable money, more that the extra cost to be expected for the increased frequency of revisions. Further, revisions for Uni's are more benign than TKA revisions, as measured by hospital stay.

Anterior cruciate ligament

18. Analgesic effect of intra-articular morphine after arthroscopic anterior cruciate ligament reconstruction

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Opioids may produce potent antinociceptive effects by interacting with local opioid receptors in inflamed peripheral tissue. The aim of this study was to assess the analgesic effects of intraarticular as compared with intravenous administration of morphine after arthroscopic anterior cruciate ligament reconstruction.

Patients and methods: In a double-blind, placebo-controlled randomized study 40 patients who received one of four injections at the end of surgery were studied. There were 10 patients in each group. The patients in Group I received 1 mg morphine intraarticularly and saline intravenously; Group II 5 mg morphine intraarticulary and saline intravenously; Group III received saline intraarticulary and 5 mg morphine intravenously and Group IV served as a control group with saline intraarticularly and intravenously. The postoperative pain was assessed using a visual analogue scale at 2, 4, 6, 25, 48 and 176 hours. The need for supplemental analgesic agents, vital signs and the occurrence of side effects were monitored. Furthermore we measured the plasma concentrations of morphine metabolites during the postoperative period.

Results: The pain scores were lower in groups I and II throughout the whole postoperative period, as compared with groups III and IV. There was no difference in pain scores between groups I and II nor between groups III and IV. The measurements of plasma concentration of morphine-6-glucuronate correlated with the pain scores in groups I and II.

Conclusion: Low-dose intraarticular morphine can reduce postoperative pain after arthroscopic cruciate ligament surgery. This action is probably specific to local opioid receptors and can be explained by direct action of these receptors. There was no difference in pain scores between the lower and the higher morphine doses. No side-effects or complications from the intraarticular therapy were seen.

19. Are there any correlation between functional scores and objective test results after cruciate ligament surgery?

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How to assess objective and subjective results after knee ligament surgery? The aim of this study was to compare objective stability tests and subjective functional and activity scores and analyse if there is any correlation between these variables.

Patients and methods: 96 patients (66 men and 30 women) with acute or chronic anterior cruciate ligament ruptures were operated on by one surgeon. The "all-inside" arthroscopic technique with interference screw fixation at both ends and patellar tendon autograft was used in all cases. All patients were reexamined by two independent observers 24 (22-26) months postoperatively. KT-1000, Lachmn test, one-leg-hop test, Lysholm score, Lysholm pain subscore, Lysholm stability subscore and Tegner activity score were used. A linear correlation analysis was performed.

Results: The KT-1000 side-to-side anterior laxity (AL), the KT-1000 side-to-side total laxity (TL) and the Lachman test were correlated with the Lysholm instability subscore. No significant correlation was found between these parameters. The one-leg-hop test showed a significant correlation with the total Lysholm score, the Lysholm pain score and the Tegner activity level. The R factors were 0.30, 0.39 and 0.37 ($p<0.001$) respectively. The Lysholm pain score showed a significant correlation with the Tegner activity level ($R=0.43$; $p<0.001$), however, the Lysholm stability subscore showed no significant correlation with the Tegner activity level. The highest correlation was found between the total Lysholm score and the Tegner activity level ($R=0.48$; $p<0.001$).

Conclusion: The KT-1000 tests and the Lachman test were not correlated to the Lysholm score and the Tegner activity score. Thus, the KT-1000 and the Lachman test appear to have a limited value in the assessment of the functional status of the patient. The one-leg-hop test appeared to give important information about the functional status. Furthermore, evaluation of pain was important when predicting the activity level of the patient.

20. Factors affecting donor site morbidity after anterior cruciate ligament reconstruction using patellar tendon autograft

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The main objective of this study was to analyse etiological factors of residual donor site problems after anterior cruciate ligament (ACL) reconstruction. Knee function and the ability to knee-walk were especially evaluated.

Patients and methods: 83 consecutive patients with unilateral chronic ACL instability were operated on by one surgeon using standardized "all-inside" technique with patellar tendon autograft and interference screw fixation. The graft was harvested through a single 7–8 cm vertical incision, the patellar tendon defect was left open and the paratenon was carefully sutured. The patients were re-examined by one independent observer at the two-year follow-up. The following tests were used; KT 1000, knee-walking ability, measurement of the loss of anterior knee sensibility, palpation of the donor site area, subjective patella-femoral pain score, the Lysholm and Tegner scores and MRI of the donor site in randomly chosen patients.

Results: The patients were divided into two groups depending on the ability to knee-walk. Group A consisted of 41 patients who had none or minor problems while walking on their knees and Group B consisted of 42 patients who had major problems or were unable to perform the test. The median total KT-1000 side-to-side difference was 3 (-7–11) mm in Group A and 2 (-6.5–10) mm in Group B ($p=0.03$). The median Lysholm score was 88 (56–100) points in Group A and 77 (37–100) in Group B ($p=0.006$). The median Tegner activity level was 6 (3–9) in Group A and 6 (1-9) in Group B (n.s). In Group A 4/41 (10 %) and in Group B 12/42 (29 %) of the patients experienced subjective patello-femoral pain ($p<0.05$). In Group A 19/41 (46%) and in Group B 35/42 (83%) patients had palpatory donor site tenderness ($p<0.05$). The median loss of anterior knee sensibility was 12 (0–120) cm^2 and 28.5 (0–200) cm^2 in Group A and Group B respectively ($p=0.0002$). In Group A 7/41 (17 %) and in Group B 19/42 (45 %) of the patients needed additional surgery (due to pain near the metal implant, meniscal symtoms or range of motion problems) during the follow-up period ($p=0.0006$). MRI showed no difference in terms of the size of the donor site gap, or thickness and width of the residual patellar tendon between patients in Group A and B.

Conclusion: It appears that donor site morbidity after ACL reconstruction is multifactorial and at least dependent on problems requiring additional surgery during the follow-up period as well as loss of anterior knee sensibility.

21. Proprioception after an acute knee injury—a prospective longitudinal study

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A defect proprioception in patients with an ACL injury has been found in several studies at later time periods after the original injury in selected populations. Whether these findings represent a consequence of the primary injury, repeated injuries or intervention with surgery need longitudinal studies to investigate the time perspective for the development of the defects.

Materials and methods: Measurements were performed at repeated timeintervals after an acute knee injury in 16 consecutive patients. There were 11 males and 5 females with a mean age of 26 (16–36) years. The threshold to detect a passive motion from a 20° starting position towards both exten-

sion and flexion was measured at an angular velocity of 0.5° /sec. Care was taken to eliminate any external cues to limb motion except those from the knee joint and surrounding structures. The positioning did not allow visual control of the leg and auditory impulses were prevented by earphones. The injured limb was compared with the uninjured and with an age matched controlgroup of healthy individuals.

Results: There were no differences between the patients and the reference group in age, sex distribution or activity level. The median threshold to detect a passive motion after 1 month towards extension was 1.0 (0.5–12.0) on the injured side and 0.5 (0.5–7.0) on the uninjured (P=0.05). Compared with the reference group with a median of 0.75 (0.5–2.25) a trend towards higher thresholds were found on the injured side (P=0.06). No differences were found between the two limbs of the patients or when these were compared with the reference group in threshold towards flexion.

At 2 months the median threshold from 20° towards extension on the injured side was 1.0 (0.5–8.0) compared with the uninjured, 0.5 (0.5–4.0) (P=0.03). The median threshold from 20° towards flexion was 1.0 (0.5–19.0) on the injured side compared with 0.5 (0.5–7.0) on the uninjured (P=0.03). After 4 and 8 months there were still some individuals with high recordings but no differences were found in the group comparisons.

Conclusion: An impaired sensitivity to detect a passive motion was found in the immediate postinjury period in an important flexion range for weightbearing activities. In some patients the deficits were persisting more than 8 months but whether these individuals represent a subgroup with a bad prognosis or not need further studies.

22. Bone mineral areal mass in the ipsilateral calcaneus after anterior cruciate ligament injury

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The main objective of this study was to analyse the bone mineral areal mass (BMA) in the calcaneus in patients with anterior cruciate ligament (ACL) injury before reconstruction and two years after reconstruction or revision surgery. Furthermore to assess which other factors such as activity level, associated injuries and the time period between the injury and reconstruction were correlated with the BMA.

Patients and methods: 88 male patients with unilateral ACL injury were included in the study. Group A (n=32) were analysed before the reconstruction, Group B (n=48) two years after the reconstruction and Group C (n=8) two years after the revision surgery. At the time of reconstruction 5/32 patients in Group A, 7/48 in Group B and 2/8 in Group C had no associated injuries. The median age of the patients was 26 (15–41) years in Group A, 29 (18–49) in Group B and 30 (25–41) in Group C. The median preoperative Tegner activity level was 4 in all three groups. The median postoperative Tegner activity level was 7 (3–9) in both Group B and Group C. At the time of the BMA assessment 1/32 patients in Group A, 24/28 in Group B and 4/8 in Group C had a Tegner activity level $\geq$7 (competitive sports).

Results: The median BMA in the calcaneus compared with the uninjured side was 95 (85–105)% in Group A, 96 (86–118)% in Group B and 94 (83–111)% in Group C. In none of the groups did the time period between the injury and the reconstruction affect the BMA. In Group A the patients with associated injuries had a median BMA of 95 (85–105)% compared with 98 (93–100)% in those without associated injuries. In Group B there was no difference in the BMA between the patients with or without associated injuries. Furthermore there was no difference between the patients who had a Tegner activity level $\geq$ 7 or not. In Group C the patients that had a Tegner activity level $\geq$7 had median BMA of 96 (90–111)% and those who did not had 91 (83–97)%.

Conclusion: Male patients with unilateral ACL injury had 4–6% lower BMA in the calcaneus of the injured side before the primary reconstruction, two years after the primary reconstruction and after revision surgery. The time period between the injury and the reconstruction did not appear to affect the BMA. Associated injuries at the time of the reconstruction and low level of performance (Tegner < 7) did not appear to affect the BMA in Group B.

23. Three-dimensional motion of the knee joint in patients before and after an anterior cruciate ligament injury

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Since 1985 we have examined about two hundred patients with unilateral ACL injuries with roentgen stereophotogrammetric analysis (RSA) using an instrumented AP laxity test. Both the injured and the intact knee has been examined. Ten of these patients have after this RSA examination sustained an ACL injury in the previous uninjured contralateral knee. The objective of this study was to evaluate the changes in knee motion performing an instrumented AP laxity test before and after an ACL injury.

Patients and methods: 10 patients (8 men) with a mean age of 29 years were examined before and 6 months to 4 years after the new ACL injury. Eight of them had had their first injured knee ACL reconstructed. The diagnosis was established through clinical examination and arthroscopy or MRI.

The patients were in the supine position and the knees were examined in extended position, 30° knee flexion, 150 N anterior and 80 N posterior drawer.

Results: After the ACL injury, in the extended position, tibia was anterior displaced (mean 2.5 mm, range 5.3--0.8,

p=0.01). All knees were more externally rotated (mean 6.5°, range 12.5–1.2, p<0.01) when flexed 30°. The tibias remained more externally rotated (p<0.01), were more abducted (mean 2.3°, range 15.6--2.3, p=0.05), displaced proximally (mean 1.3 mm, range 0–3.4 mm, p<0.01) and anteriorly (mean 8.2 mm, range 2.6–14.7, p<0.01) after the injury when performing an anterior drawer. No major changes was observed during the posterior drawer.

Conclusion: This study is consistent with previous studies displaying that a multiplanar instability occurs with an insufficient ACL. Even without any load (extended position or 30° of knee flexion) there is a difference and this can significantly influence the results of instrumented laxity tests or when comparing the kinematics of the knees in unilateral injured patients. None of the patients had less than 2.6 mm difference performing an anterior drawer indicating that a side to side difference of 2–3 mm or more is a sign of an insufficient ACL.

24. Strap tensile forces at knee brace application affect tibio-femoral displacement

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We have studied how different strap tensile forces used at knee brace application affect the magnitude of tibio-femoral displacement in an experimental model and in patients with knee joint laxity due to anterior cruciate ligament injury.

Methods: Anterior and valgus displacement were tested on an electronic knee joint. Tension in the quadriceps and hamstring muscles, as well as in all the knee ligaments were controlled. Displacement, load and tensile forces on the straps of a DonJoy knee brace (Gold Point) were all measured during the testing. Sagittal translation in 7 patients with knee joint laxity due to anterior cruciate ligament injury was studied with a KT-1000. The leg and thigh straps of the brace in each experiment were applied by 0, 25 and 50 N.

Results: In the electronic knee, tibio-femoral anterior displacement decreased from 100% without a brace to 52% when the straps were applied by 25 N, and to 42% when 50 N was used. Corresponding values at valgus testing were 94% and 86%. In the patients total displacement was 8.8 (SD=2.2) mm with no brace, 5.6 (SD=0.6) mm when the straps were tightened by 25 N and 5.1 (SD=0.8) mm when 50 N was used.

Discussion: External compression by a knee brace increases muscle relaxation pressure during exercise and may induce premature fatigue in leg muscles. Therefore, excessive compression by a brace should be avoided. This study shows that excessive tightening of the straps does not significantly decrease tibio-femoral displacement.

Shoulder

25. Arthroscopic subacromial decompression for chronic impingement

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The impingement syndrome and the role of rotator cuff lesions was described by Neer in 1972. Arthroscopic subacromial decompression (ASD) was reported by Ellman in 1985. In this prospective study we want to report the 6 weeks and the one-year results of ASD.

Patients and methods: From January 1995 to October 1995, 45 shoulders (42 patients) with impingement syndrome were operated with ASD. There were 30 male shoulders and the dominant shoulder was involved in 35 cases. Indication for surgery was impingement syndrome at least half a year, positive impingement sign and test, positive pour out of a pot test (POP-test). Physiotherapy, subacromial steroids and antiinflammatory drugs were without significant effect. At surgery stability test was performed as antero-posterior drawer test and test for sulcus sign. Patients with instability were not operated on more than arthroscopy and are not included in this study. ASD was done as described by Ellman. Postoperatively the patients mobilised their shoulders without load during a three-month period. A UCLA shoulder rating score was obtained preoperatively and at follow-up six weeks postoperatively by the surgeon and at 11 (4–23) months postoperatively by an independent observer (IH).

Results: Preoperative UCLA score was 15 (9–20), at six weeks postoperatively 28 (11–35) and at 11 months 30 (15—35). The score was good-excellent in 62% six weeks postoperatively and in 70% at 11 months. Total rotator cuff lesion was recorded in 2, partial in 8, degenerative changes in 10 while in the rest no obvious lesion was recorded. At follow-up 27/42 patients had an unchanged occupation, 15 were on sick leave, were unemployed or had disability pension.

Conclusion: All patients reported improval of their shoulders. Excellent and good results of ASD for chronic impingement were recorded in 70% after 11 months. No difference was recorded between men and women,or dominant and nondominant hand. Patients with a partial rupture of the rotator cuff didn't have inferior results. Of the two patients with total rotator cuff rupture one had a good result, one a fair.

26. The influence of cuff pathology on shoulder function after arthroscopic subacromial decompression

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The operative treatment of total rotator cuff defects in the shoulder differs in the literature to be, either a repair or a débridement of the cuff lesion combined with a arthroscopic subacromial decompression (ASD). This study was made to an investigate if patients with intact rotator cuff or rotator cuff tears differed in functional outcome after ASD.

We clinically reviewed 39 patients with subacromial impingement who all underwent ASD, no other surgery was performed. 13 patients with intact cuff, 13 patients with partial thickness cuff tears and 13 patients with full thickness cuff rupture less than 2 cm. Selection was based solely on the status of the supraspinatus tendon. Patients with other pathology were excluded. Median follow-up time was 2.9 (1–4) years and 5.9 (4–7) years. The clinical evaluation was performed by an independent observer using the Constant score and the visual analogue pain score (VAS). A nonparametric (Kruskal-Wallis H) test for multiple comparisons was used to determine whether there were any differences between the groups regarding the Constant shoulder function scores and the VAS scores.

There were no significant difference between the groups regarding age or male/female ratio. Both at the 3- and 6-years follow-up there were no significant differences between the groups regarding the Constant scores and the VAS scores.

We conclude that result and functional outcome after ASD are not obviously related to the degree of cuff pathology.

27. Arthroscopic stabilization of traumatic recurrent dislocation of the shoulder using multiple transglenoid sutures

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A number of arthroscopic Bankart procedures have been reported. The present study reports the result of 24 patients with recurrent dislocation of the shoulder treated with an arthroscopic Bankart technique with multiple transglenoid sutures a.m. Caspari.

Patients and methods: 24 patients, 5 women and 19 men, mean age of 26 (16–46) years, with an average follow-up of two years were clinically evaluated using Constant and modified Rowe score by an independent observer. All of them had been operated on with an arthroscopic Bankart technique using multiple transglenoid resorbable sutures that were tied over the infraspinatus fascia as described by Caspari. All patients used a protective brace for 5–6 weeks, but physiotherapy was started the first day after surgery.

Results: A careful clinical evaluation was performed after an average follow-up two years. There were three recurrencies (12 %). Two of these patients were reoperated using an open Bankart technique and both recurred again. The remaining patients had an average Constant score of 87 and a modified Rowe score of 87. On a 0–10 visual analogue scale (0=no pain, maximum stability or normal shoulder function) the patients subjectively evaluated their pain (mean 0.6), stability (mean 1,0), overall function of the shoulder (mean 1.2). No serious complications were recorded.

Conclusion: Arthroscopic Bankart procedures have been reported to have a higher recurrence rate compared to open procedures. The present study represents the first 24 patients operated on with the Caspari technique at the authors institution, which means there is a learning curve involved. Therefore the overall results are encouraging. An interesting finding was that both patients that were reoperated after failure of the arthroscopic procedure had recurrencies even after an open Bankart procedure.

28. Humeral head resurfacing arthroplasty in rheumatoid patients—a clinical and radiographic follow-up study

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Reports on resurfacing arthroplasty of the shoulder are few (Jónsson et al. 1986, Rydholm & Sjögren 1993). They found satisfying pain relief and improved motion range up to 4.2 years although a considerable degree of radiographic loosening was encountered. There seemed to be a need for a further follow-up study, relating clinical and radiographic findings to age, duration of disease and local shoulder symptoms as well as follow-up time.

Material and methods: 51 consecutive cup hemiarthroplasties (Scan Shoulder) were performed in 44 patients. 39 shoulders in 33 rheumatoid patients were assessed clinically and evaluated with the Constant score system at an average of 4.4 years. Of these, 35 shoulders in 30 patients were evaluated radiographically.

Results: We found a high degree of patient satisfaction with significantly increased motion range ($p<0.05$) and significantly reduced pain ($p<0.001$) although overall shoulder function was poor. There was an age-related decrease of the Constant score value at follow-up, due to an increased pain degree ($p<0.05$) as well as diminished shoulder power ($p<0.05$). Motion range did not correlate with age. The duration of the rheumatoid disease appeared to correlate with increased glenoid wear at follow-up ($p<0.05$), but was of no significance for the clinical outcome. Neither the duration of local shoulder symptoms, the length of follow-up time nor the degree of preoperative shoulder pain appeared to be of any significance for the clinical or radiographic outcome.

Conclusion: There was a high degree of radiographic deterioration. This correlates with the study by Rydholm & Sjögren (1993). However, we could not find any correlation between proximal humeral head migration, glenoid wear or signs of radiographic loosening and the length of follow-up time. During the observation period shoulder function did not seem to deteriorate with time.

29. Functional outcome after shoulder replacement in fracture patients

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Complex fractures of the proximal humerus remains difficult to treat. In order to examine the results of shoulder replacement following fracture of the proximal humerus, we examined the 45 shoulder arthroplasties that were performed at Huddinge Hospital 1981–1995.

Patients and methods: A full examination by an independent observer, and radiological examination was done a mean 3 (1–12) years postop. The patients also completed a questionnaire. 10 patients were dead, 2 patients were excluded due to senile confusion and 4 patients were unwilling to participate, leaving 24 women and 5 men for follow-up. Their mean age at operation was 71 (47–87) years. 14 Global, 14 Neer and 1 Scan shoulder prosthesis were used.

Results: Constant score at follow-up was 37 (16–69). Only 3 patients could abduct or flex the shoulder over the horizontal plane. All patients could reach their mouth and ear. 10 patients could comb their hair with the operated arm. Pain vas none to mild at night or at rest in most patients, but nearly half had moderate to intense pain during elevation or lifting.

Conclusion: Fracture treatment with shoulder prosthesis often gives pain relief at rest but the shoulder remains stiff with a marked reduction of performance and active movements are painful in some patients.

30. Revision of unstable shoulder arthroplasties with the inverted Delta-III prosthesis

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Arthroplasty of the shoulder for rotator cuff arthropathy or for malunited fractures has been reported to result in pain relief and a modest gain in active range of motion. Instability of the arthroplasty after surgery has been reported and it is a difficult problem to treat and there are few reports in the literature concerning the treatment of this complication. The present study reports on 8 patients with unstable arthroplasties of the shoulder that were revised using the inverted Delta-3 prosthesis.

Patients and methods: 8 patients, 5 men and 3 women, with a mean age of 73 (42–88) with severe disability due to unstable shoulder arthroplasties (7 hemiarthroplasty and 1 total shoulder arthroplasty) were revised using an inverted Delta-3 prosthesis. The indications for the previously performed arthroplasties had been malunited fractures with poor rotator cuff function in five patients and rotator cuff arthropathy in three patients. All patients developed instability of the arthroplasty resulting in very poor shoulder function with no or almost no active range of motion. They were revised using the inverted prosthesis as a salvage procedure. The inverted prosthesis has the head of the prosthesis on the glenoid side and the polyethylene cup on the humeral side. This principle creates better stability and function using the deltoid muscle alone.

Results: One patient had an epileptic seizure two weeks after his cementless revision and his humeral component rotated 180°.. At revision the stem was cemented in the correct position. No other early complication was recorded. The follow-up time is still limited (maximum two years) but stability of the shoulder arthroplasty was achieved in all patients with improved active range of motion. One patient died of an heart attack 6 months after surgery.

Conclusion: Instability of shoulder arthroplasties is a very difficult complication to treat, particularly if the coracoacromial arch is deficient due to previous surgery. Arthrodesis, resection arthroplasty or stabilization procedures using artificial material has been used with various success. Early results with the Delta-3 prosthesis used in the present study show promising results with restored stability and improved function in all patients.

Varia, part 1

31. Rehabilitaion of leg amputees—good results with a small prosthetic team and roll on silicone socket

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Amputation of the lower extremity is often the result of a chronic, progressive disease. The patients are elderly and have small reserves from their long period of illness. Rehabilitation of these patients is a hard task and a multidisciplinary team is a good approach.

Patients: 103 patients had amputations of the lower extremity performed during 1995–1996 (28/100 000 inhabitants). 80 were tibia, 6 knee and 37 femur. 28% died within three months from surgery. The diagnosis was in 55% atherosclerosis and in 43% diabetes.

Methods: The surgery was performed only by orthopaedic surgeons. To their aid a special PM exists. On day 5–7 after surgery the postoperative plaster is removed and a silicone roll on socket is applied unless specific contraindications exist. After this a training prosthesis (non-end bearing) is used. When walking is re-established the patients continue the training in an outpatient group. The prosthetic team is the same through the whole rehabilitation process.

Results: Of the 74 patients that survive the first three months 62% are fitted with a prosthesis. 80% of these patients return to their previous living. The average time from surgery to the first definite prosthesis is 54 days and the average time at hospital is 75 days.

Conclusions: The silicone socket helps taking away the oedema, diminishes pain and makes femoral prosthesis possible even with additional function deficiencies. The team approach is essential for the good results that are presented.

32. Rehabilitation of patients with artificial limbs—target oriented health care process using database communication

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Introduction and results: A retrospective study was performed on lower limp amputated patients in 1992–1996. During this time 341 patients underwent 420 amputations. The survival rate among these patients was after six months 70%, after one year 62%, after two years 54% and after four years 48%. Totally 48% of the primary amputees got a prosthesis. In patients surviving more than six months the prosthesis application rate increases to 69%.

Method: The Capod system is used to make the model to make the prosthesis. Every week outdoor patients are seen and usually the whole team is present. After decision of making a prosthesis the patient is taken to hospital and about 10 days is sufficient to get enough training for a transtibial amputee. Measurement with Capod is done in the morning the day of arrival and already in the afternoon the same day the prosthesis is ready to be tested by the patient. After being sent home the amputee is trained by a special home-rehabilitation team. Database documentation is used in order to achieve easier follow up. The Wong-scale for measuring the patients satisfaction is a way to get proper rehabilitation goal.

33. A new model of rehabilitaion for healthy, transfemoral amputees

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Many above-knee amputees feel that their normal movements, such as walking, have been dramatically restricted. They also suffer from secondary problems such as pain and a sense of fatigue in their lowback and healthy leg with loss of identity, self-confidence and self-esteem. A training program with focus on psychological attitude and realistic environments was applied with repeated functional evaluations.

Subjects: So far 9 above-knee amputees, mean age 37 (17–52) years have participated. Their amputations were caused by trauma or tumour and they have walked with their prosthesis for at least 18 months.

Method: Before and after rehabilitation walking ability is analysed visually (with video) and using a VICON-system. Physical fitness regarding energy consumption and endurance is analysed with indirect calorimetry. Participants are also tested with psychological tests and are interviewed on several occasions to cover their reactions, coping-strategies and aspects of quality of life. They have been training 1 1/2 h weekly for about 10 months with special focus on postural control, balance and symmetry in walking, incorporating the prosthesis in their natural movements and body-awareness.

Results: All subjects have shown an highly improved walking-skill with a normalised gait-pattern and a decreased energy consumption. Comfortable walking speed is now equivalent to healthy individuals of the same age. Moving freely has led to an improved self-esteem. They feel more self-confident, can rely on their own capacity and experience an improved quality of life.

34. Swanson vs APL tendon arthroplasty in the treatment of osteoarthritis of the first carpometacarpal joint—a prospective randomized study

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Trapezectomy in combination with a gap-filling stabilising arthroplasty is the common surgical treatment for osteoarthritis of the first carpometacarpal joint. We report the 6 months results of a prospective, randomized study between the Swanson arthroplasty and the Abductor Pollicis Longus tendon arthroplasty (APL).

Methods and patients: 28 patients, mean age 64 years, were included in the study receiving either a Swanson silicone interposition endoprosthesis (n=15) or an arthroplasty using a slip of the APL (n=13). Preoperative range of motion and grip strengths were measured and the patients had to judge their disability and register pain on a Visual Analogue Scale. The same measurements were done 6 months postoperatively by an independent observer. At this time also radiograms of the thumb in a stressed pulp to pulp position were taken in order to measure the amount of functional decrease of the trapezial space i.e. the distance between the basis of the first metacarpal and the distal pole of the scaphoid.

Results: 2 endoprostheses dislocated during the follow up time. No clinical nor radiographic silicone synovitis was seen. 12/15 patients in the Swanson group and 11/13 in the APL group rated themselves as satisfied with the arthroplasty. 26 out of 28 patients complained of pain on light household work preoperatively and after operation 20 out of 28 were painfree. For heavier work, which for all patients was painful preoperatively, only 5 considered themselves painfree at the six months control. The preoperative pain as mea-

sured on a VAS decreased from 6.6 in both groups to 2.3 and 2.4 postoperatively in the Swanson and APL group respectively. No statistically significant differences were found regarding grip strength nor thumb abduction. The trapezial space measured on radiograms averaged 11 mm preoperatively and 9 and 5 mm postoperatively in the Swanson and APL group (p=0.01). In this stress test the distance decreased by 15% for both groups. There was no correlation between pain and the trapezial space.

Conclusion: Both operative methods gave a good but not complete pain relief. No major clinical advantages were seen with either operative method in this short perspective.

35. Risks and complications in 100 endoscopic carpal tunnel releases

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The aim of this study was to describe the risks and complications of 100 consecutive endoscopic carpal tunnel releases (ECTR) after one year by an unbiased observer (TvS).

Patients and methods: Between 1993 and 1995, 113 ECTR in 93 patients were performed in the hospital of Ängelholm (population 90.000). 11 of these patients (13 ECTR) were lost to follow-up leaving 100 consecutive operations in 88 patients. 60 women and 22 men were included. The mean age was 52 (27–83) years. All operations were performed by one surgeon (TL). The modified two-portal ECTR described by Chow was used with local anesthesia in all patients. Conversions from ECTR to open surgery were performed in two patients, in both due to pain at the introduction of the troachar.

Results: The overall result showed 94% symptom-free or improved cases. No major complications such as cut nerves, vessels or tendons were seen. Early complications were seen in 6 cases, of which 4 were transient numbness in the third and fourth web space, 1 was wound problem and 1 was numbness in the ulnar nerve distribution from Guyon's canal. Due to persisting numbness five cases needed secondary procedures. Three cases had open surgery in the carpal tunnel (CT) with findings of tenosynovitis (2) and fibrosis at the proximal border of the CT (1). One case had open surgery both at the wrist and at the elbow with later diagnosis of polyneuropathy and one case had open neurolysis of the median nerve at the pronator muscle. Two late complications were seen.

Case number 9: A 49-year-old woman was operated on in her right dominant hand. At the introduction of the troachar she had pain. Conversion to open surgery showed no injury to the nerve itself, but a discoloured median nerve with an hour glass deformity, indicating a severe CTS. She developed a minor RSD, slowly resolving over the year. At the follow-up she rated herself to have an overall improved result.

Case number 13: A 46-year-old female hairdresser was operated on in her right dominant hand. At positioning of the hyperextended wrist and fingers she noticed radiating pain into the third and fourth web space. After leveling the fingers and wrist the pain resolved and the ECTR was performed. Her CTS symptoms disappeared. Due to persisting symptoms in the third and fourth web space an explorative operation was performed after one year without finding any external derangement of the median nerve or the communis branches. At the follow-up she rated herself to have an overall worse result.

Conclusion: We recommend ECTR to be performed in local anaesthetics to be able to react upon the patients distress and immediately convert to open surgery. Secondly we recommend the peroperative hyperextension to be minimised.

Bone fragility

36. Aluminium, Alzheimer's disease and bone fragility

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The age-specific incidence of fragility fractures has increased epidemically. Especially patients with senile dementia (including Alzheimer's disease) have a highly increased risk of fragility fractures. As aluminium does inhibit bone mineralization and may be an etiologic factor in Alzheimer's disease, aluminium might be a common denominator.

Patients and methods: Bone biopsies were taken at operation in 120 patients for hip fracture. 13 patients (4 men and 9 women) had Alzheimer's disease. From the remaining patients an individually age- and gender-matched non-demented control group of 13 patients was selected. The 26 bone samples were measured for their content of aluminium using an inductively coupled plasma mass-spectrometer.

Results: All specimens contained aluminium: the aluminium content varied between 66–4080 ng/g wet bone. There was a higher aluminium content in the patients with Alzheimer's disease ($P = 0.005$; Wilcoxon signed rank test) and in the younger hip-fracture-patients ($P = 0.02$; Spearman rank correlation).

Conclusion: A chronic low-grade aluminium intoxication may play a role not only in the development of Alzheimer's disease but also of bone fragility: the greater the aluminium exposure, the higher the risk for an early fracture. This hypothesis may explain the increased risk of fragility fractures in patients with Alzheimer's disease as well as the higher aluminium content in the younger hip-fracture-patients in our study. The epidemic of fragility fractures may be a con-

sequence of an increased aluminium exposure due to the use of aluminium cooking pots or the acidification of our environment.

37. The ability to predict hip fracture risk—a comparison between DXA of the hip, Heel ultrasound, finger ultrasound and radiographic absorptionetry of phalanxes

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We applied four different techniques to quantify bone mass at three different anatomical sites and compared their ability to predict hip fracture risk.

Materials and methods: Consecutively all non-institutionalised patients living in Uppsala, both men and women, between 50 and 85 years of age were included in the study, if they had a first hip fracture and a measurable contra lateral hip. Sex-matched and sequentially age-matched controls living in Uppsala were selected randomly from the population register. The controls had unbroken hips and no hip prosthesis. There were no significant difference in age between patients vs. controls among the women, n=50 and n=159 resp. (75.4 ±8 resp. 74.5 ±4) or men, n=19 and n=26 resp. (74 ±9 resp. 73 ±4). Bone densitometry was performed within five days after operation for hip fracture and consisted of DXA of the contra lateral hip (DPX-L™), heel ultrasound (Achilles™), finger ultrasound (DMB Sonic 1200™) and radiographic absorptiometry, RA of the fingers (Osteogram™). Data for RA still being analysed. A modified WHO definition for osteoporosis, i.e. values less than -2.5 standard deviation of a young sex-specific population was applied in order to classify the participants as osteoporotic/non osteoporotic.

Results: The values for the patients, compared with the controls, were significantly lower for BMD (25% women and 22% men), stiffness (23% and 14% resp.), SOS (2% and 2% resp.) and BUA (6% and 11% resp.). Finger ultrasound SOS was insignificantly lower (3% women and 1% men). Among the fractured women DXA of the hip defined 72% as osteoporotic vs. 19% among the controls and heel ultrasound 98% vs. 76%. For men a similar pattern was found, 59% vs. 15% for DXA and 58% vs. 27% for heel ultrasound.

Conclusion: Both DXA of the hip and heel ultrasound have a capacity to identify the majority of the patients with hip fractures whereas finger ultrasound was unable to significantly differentiate the patients from the controls. An overwhelming majority of the hip fracture patients were osteoporotic according to the WHO definition when measured by DXA of the hip and heel ultrasound. Heel ultrasound was extremely sensitive to identify patients at risk for hip fracture but the specificity was poorer. DXA of the hip was not as good to identify patients at risk but had a much higher specificity.

38. Almost all instutionalized elderly are osteoporotic—results from ultrasound measurements of heel and fingers

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The aim of this study was to investigate bone status with two different portable ultrasound equipment at two different anatomical sites in an institutionalised elderly population.

Material and methods: Participants were recruited from and investigated at four nursing homes in Uppsala. Participants were selected randomly and 236 women (age 84.8 ±9) and 84 men (81.1 ±9) accepted to take part. The heel was investigated by an Achilles™ ultrasound bone densitometer which gives results for speed of sound (SOS) and broad band ultrasound attenuation (BUA) as well as a combination of these called stiffness index. The distal metaphysis of the proximal phalanxes were measured by DBM Sonic 1200 and reported as SOS. The WHO definition for osteoporosis, i.e. values less than -2.5 standard deviation of a young female population, generally called T-score was applied in order to classify the participants as osteoporotic/non osteoporotic. We used the same WHO definition for osteoporosis also for men, i.e. less than -2.5 standard deviation of a young male population, although there is no official definition for osteoporosis among men. A comparison in standard deviations between an age- and sex-matched population was performed, i.e. Z-scores.

Results: 73% was measured by heel ultrasound, 66% by finger ultrasound and 40% with both devices. All dropouts from finger ultrasound measurements were due to the method while for heel ultrasound 57% of the dropouts were related to the method. 95% of the women measured with heel ultrasound were osteoporotic, mean T-score = -4.8 and 92% had Z-scores less than 0, i.e. below "normal" for age, p=0.001, mean Z-scores = -1,6. Sixty percent of the men were osteoporotic, mean T-score = -2.6 and 80% had Z-scores less than 0, mean Z-score = -1.3. T- and Z-scores for finger ultrasound is being analysed.

Conclusion: The institutionalised elderly women all have osteoporosis as defined by WHO criteria when applied for heel ultrasound and they also have low bone mass in comparison to age.

39. Vertebral deformity in patients with hip ftacture

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The purpose of this study was to compare the frequency of vertebral deformity, as a sign of vertebral osteoporosis, between hip fracture patients and a control population.

Material and methods: Lateral radiographs of the thoracic and lumbar spine were obtained in 197 patients with hip fracture. 62 were men and 135 women, mean age 80 (44-95). The prevalence of roentgenologic vertebral deformity was estimated using a digitising method. The shape of each vertebra Th4-L4 was described using three ratios; anterior/posterior heights, midvertebral/posterior heights and posterior height/posterior height of the adjacent vertebra. Several criteria for vertebral deformity were used; 3SD, 4SD or 5SD reduction of any ratio. The result was compared with the prevalence in age and sex matched controls from the normal population measured with the same technique.

Results: The prevalence of vertebral deformity was significantly higher among the hip fracture patients as compared with the normal population. Using 3SD reduction of any ratio as deformity criteria the prevalence was 72% in the hip fracture group as compared with 51% in the controls ($p<0.001$). The difference was more pronounced in lower age, among women and if more restrictive criteria for vertebral deformity were used.

Conclusion: The hip fracture patients have more vertebral osteoporosis as compared with the normal population.

40. Decrease in hip fracture incidence due to increasing immigration?

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After a steady increase in the incidence of hip fractures in Malmö during recent decades, the increasing trend was broken during the first half of the 1990's. A significant lower incidence than predicted was noted 1992–1995, in all groups except trochanteric fractures in men. Comparisons of incidence studies world wide show that Scandinavians have higher incidence of osteoporotic fractures, i.e. hip fractures, than other nationalities. Could the increasing group of non-Scandinavian immigrants in Malmö lead to a decrease in incidence of hip fracture?

Material: Malmö has the highest quotient of immigrants in Sweden, more than 20% of the city's population are born in another country. Among the 2779 cases of hip fracture treated at Malmö General Hospital during 1991–1995, 88 were of non-Scandinavian origin.

Results: The incidence of hip fractures in the population of non-Scandinavian origin is significantly lower than the one of the Scandinavian group (se table). If the entire population of Malmö would have been of Scandinavian origin we would have had approximately 4% more hip fractures. Thus the lesser risk of hip fractures in a growing non-Scandinavian population in Malmö is a contributory cause, but cannot alone explain the decrease in incidence.

Yearly incidence of hip fractures in Malmö 1991–1995

		non-Scand.	Scand.	p-value
Men	50–64 yr	0.04 %	0.08 %	p=0.041
	≥65 yr	0.36 %	0.65 %	p=0.004
Women	50–64 yr	0.03 %	0.10 %	p=0.016
	≥65 yr	0.49 %	1.38 %	p<0.001

41. IGF-1 levels are low in patients with hip fractures

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Deficiency of endogenous growth hormone (GH) is associated with osteopenia and reduced muscle mass. The aim of the study was to investigate if GH secretion was low in patients with pertrochanteric and cervical hip fractures i.e. fragility fractures by measuring serum insulin-like growth factor 1 (IGF-1), IGF binding protein 1 (IGFBP-1) and IGFBP-3 as an indirect parameter of GH secretion. We also examined if the levels of circulating IGF-1 and IGF-1 binding proteins correlated with bone mineral mass.

Patients and methods: 43 patients were chosen consecutively, 23 with hip fractures and as a reference group served 20 patients with primary coxarthrosis who were to undergo a THR. Bone mineral mass (total body scan) and body composition were determined by dual energy X-ray absorptiometery (DPX-L, Lunar) 2–5 days after surgery and after 6 months. Serum IGF-1, IGFBP-1 and IGFBP-3 concentrations were measured by specific radio immuno assay technique four times; on admission for the hip fracture patients and in the morning before surgery for the arthrosis patients, 7 days postoperatively, after 6 weeks and after 6 months.

Results: Serum levels of IGF-1 were lower in patients with hip fractures than in patients with coxarthrosis. The patients with hip fractures had significantly lower total bone mineral mass than the arthrosis group.

Conclusion: Serum IGF-1 levels were low in patients with a low bone mineral mass, i.e. in the hip fracture group. It is unclear whether these findings are of importance in the pathogenesis of senile osteoporosis and hip fractures.

42. *In situ* microdialysis in human bone tissue—stimulation of prostaglandin E_2 release by mechanical loading

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Prostaglandins are considered potent regulators of bone formation as well as bone degradation. They are likely to play a

central role in the ability of the skeleton to respond to mechanical loading. In this study we describe, to our knowledge, the first experiment using the microdialysis technique for studying the release of prostaglandin E_2 (PGE_2) in the proximal tibia metaphysis secondary to mechanical loading.

Material and methods: 9 healthy women, 6 in the loading group and 3 controls, mean age 34±2 (years ± SEM), participated. A standard microdialysis catheter was inserted into the tibia metaphyseal bone under local anaesthesia. Samplings were done every 15 minute under a 2 hour equilibration period. Thereafter, heel-drops (one per second) with as hard impact of the heels into the floor as possible, were done for 5 minutes by the subjects in the loading group. The control group performed no exercise. Sampling continued after this for another 2 hour period. PGE_2 was analysed using a modified du Pont Prostaglandin E_2 RIA-kit.

Results: Basal levels of PGE_2 in the proximal tibial metaphysis was determined to a mean of 45 ±10 pg/ml (mean ± SEM, n=6). The major finding was a 2.5-3.5 fold increase in the release of PGE_2 following mechanical loading. The increase was statistically significant ($p<0.05$ compared to basal levels) one hour after the mechanical loading and persisted for the rest of the experimental period. No major alterations were observed in the control group.

Conclusion: In situ microdialysis is a useful method for studying the PGE_2 production in human bone. A rapid and significant increase in PGE_2 levels was noticed in response to dynamic mechanical loading.

43. Acetabular fractures in elderly patients treated with acute total hip arthroplasty

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Although dislocated acetabular fractures in good bone are considered to benefit from surgery with open reduction and internal fixation, the treatment of these fractures in elderly people remains controversial. We present a surgical procedure which promotes early rehabilitation and an acceptable hip function for these patients.

Patients: 8 patients, mean age 73 (60–89) years with a dislocated low-energy acute acetabular fracture were included in the study.

Operative procedure: In a lateral position the femoral head was resected. Without any major attempts of reducing the fracture, the roof of the acetabulum was, if necessary, stabilised with a few screws. Bone autografts from the femoral head filled the fractured acetabulum and a Bursch-Schneider reinforcement ring was positioned on the posterior column secured with screws proximally to the joint. A cup was cemented into the ring. A Charnley femoral prosthesis was finally cemented in a standard fashion into the femur. Postoperatively immediate weight bearing was allowed.

Results: The patients have been followed for 26 (12–39) months. No patients are deceased. There were no postoperative complications in any of the patients except for in one senile patient where recurrent dislocations of the prosthesis occurred shortly after the operation. The remaining 7 patients were able to return to their preoperative walking status. At follow-up, there were no radiographic signs of loosening of either the acetabular or the femoral component. The bone auto-grafts in all sockets show signs of incorporation.

Discussion: In order to avoid general and fracture complications, it is well accepted that patients with hip fractures should have immediate operative treatment. We believe the same principle should be applied to elderly patients with dislocated acetabular fractures. The described procedure have enabled these elderly patients to a quick rehabilitation and good social function.

44. Intramedullary nailing of proximal and diaphyseal fractures of the humerus using the True-flex nail

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Functional treatment of diaphyseal and proximal humeral fractures are usually recommended. A number of intramedullary nails for humerus are now available and the purpose of this study was to evaluate the results after intramedullary nailing of diaphyseal and proximal acute fractures of the humerus using the True-Flex nail.

Patients and methods: 25 patients, 16 female and 9 male with a mean age of 75 (49–87) years were included. There were 13 diaphyseal and 12 proximal fractures. The indication for surgery was fracture dislocation despite attempts to reduce the fracture by closed means. The True-Flex nail is an unreamed nail without traditional interlocking with screws. Proximal stability is created by screwing a cap on the proximal end of the nail and rotational stability is said to be created by the wings of the nail. A clinical and radiological evaluation was performed by an independent observer. The average follow up time was 13 months.

Results: 2 patients died during the early postoperative period and are therefore excluded. 4 of 11 proximal fractures healed and 9 of 12 diaphyseal fractures healed. Complications such as infection, nail migration and transient radial palsy were recorded. In 2 patients longitudinal instability of the fracture resulted in failures. Subjectively 9 of 13 patients with healed fractures rated their functional results as good or very good. Objectively the patients with healed fractures had an average forward elevation of 100° and abduction of 86°.

Conclusion: When nonoperative treatment fails, True-Flex nailing is a simple intramedullary nailing technique that yields good results in 75% of diaphyseal fractures. However, the technique has a high failure rate in proximal humeral fractures, such as dislocated two part fractures of the surgical neck. Therefore the technique is recommended only in diaphyseal fractures.

Fractures

45. Communication and referrals of hip fracture patients

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Many elderly people sustain a hip fracture today. A rehabilitation program for patients with hip fracture involving mobilisation immediately postoperatively, discharge directly to their own homes and continued rehabilitation is of a great importance for the individual and the society. The aim of the study was to improve the communication between the personnel at the Orthopedic Department in Lund and the personnel in the community at the discharge from the hospital. The aim was also to study whereto the patients were discharged and the factors involved in the decision making.

Patients and methods: The hip fracture patients living in Lund and Orup health care districts who were admitted to the Orthopedic Department for treatment were monitored during five months in 1994, 1995 and 1996, respectively. Data concerning contacts during admittance and at discharge, and whereto the patients were discharged were collected from the patients' files. Contacts with the physiotherapists in the community were taken. Between the surveys education was given to the rehabilitation staff, nurses and social workers in the community/primary health care.

Results: Discharge directly to the patients' own homes did not change between the years. Less patients were discharged to the geriatric clinic, instead they were discharged to short term care within the community. Factors of importance in the decision making of discharge were identified to be health and function, patients' own wish whereto be discharged, social factors and the communities' possibility to provide service.

Conclusion: It is important to focus on the factors involved in the decision making of whereto the patient is discharged to assure the right level of care and to create a positive environment for rehabilitation of hip fracture patients.

46. MRI examination in patients with suspected hip fracture—a study of 30 patients admitted to hospital after acute moderate trauma and normal plain radiographs

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The purpose was to study the value of MRI in patients admitted to hosptial because of a painful hip after a moderate trauma and with normal plain radiographs, thus avoiding days in hospital waiting for additional examinations such as a bone scan 3–5 days later and/or new radiographs after a week.

Material and method: 4 men and 25 women, mean age 77 and 80 years, were finally included in this prospective study. The patients were admitted to the Department of Orthopedics in Malmö with a clinically suspected hip fracture after a moderate acute trauma and normal plain radiographs. The MRI examination was performed within 3 days in 29 patients who had a follow-up with a clinical examination 6 weeks after the trauma, including radiographs in 18 patients. The 10 patients classified as having sustained a hip fracture according to the MRI examination were operated on with internal fixation. They were clinically examined at 4 months and with radiographs of the hip after 1 week and 4 months postoperatively.

Results: Of the 29 MRI examinations, 10 were diagnosed as hip fractures: 5 cervical and 5 trochanteric. All these 10 hips were operated on with internal fixation. 11 patients were classified as other types of fractures (8 pelvic fractures and 3 undisplaced fractures of the greater trochanter) and were mobilized with full weight bearing as well as the remaining 8 patients who had no fracture or only a hemathoma around the greater trochanter. The mean total number of days in hospital was 11 days for the whole group and 7 days for those without any hip fracture. The original diagnosis after the MRI examination remained unchanged in all 29 cases also after the follow-up.

Conclusions: According to this study, we believe that the MRI examination can provide a rapid and precise diagnosis in patients with a suspected hip fracture after a moderate trauma and normal plain radiographs. MRI examiniation is a sensitive technique and its interpretations may need an experienced examinator.

47. Unstable per/subtrochanteric fractures treated with dynamic compression screw and indirect reduction technique

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The choice of implant for treating unstable per/subtrochanteric fractures in the elderly remains controversial. Previous studies have reported high complication rates for unstable trochanteric fractures treated with plate-technique.

Patients and method: 25 patients, mean age 82 (66–97) with unstable per- or subtrochanteric fractures were surgically treated with a dynamic compression screw (DCS). Care was taken to limit the surgical exposure and to minimize soft tissue damage. In order not to jeopardize the vascular bone supply, separate fragments were not fixed with interfragmentary compression. According to the indirect reduction technique, the plate acted as a bridge plate tensioned by a separate pull-screw positioned distally to the plate. Postoperative weight bearing was allowed immediately.

Results: There were no major postoperative complications. Mean blood loss was 500 (50–2000) mL. Mean opera-

tive time was 75 (40–180) min. 6 patients were diceased within 1 year. Of the remaining 19 patients, 4 patients were operated because of fracture collapse (2) or plate breakage (2). In 2 patients the fracture healed in varus of the femoral neck with considerable shortening of the leg. 13 fractures were radiologically healed.

Discussion: Modern technique of plate-fixation of meta- and diaphyseal fractures emphasizes minimal invasive surgery, long plates an few screws. Good results have been reported in complex fractures of the distal femur and tibia. This technique applied in elderly patients with unstable proximal femur fractures was not successful.

48. Dynamization in subtrochanteric fractures with the Medoff sliding plate

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The purpose of this study was to compare dynamic patterns of the Medoff Sliding Plate (MSP) with uniaxial sliding along the shaft versus biaxial sliding along both the shaft and the neck of the femur in various fracture types.

Patients and methods: The MSP is an alternative concept for treatment of high subtrochanteric fractures. The device offers sliding along the femoral shaft and optional sliding along the neck of the femur. Bedsides the uni- and biaxial dynamization options, the MSP has the unique possibility of staged dynamization, i.e. initial plate sliding followed by later dynamization along the lag screw. The rationale of this procedure is to minimize the medialisation of the femoral shaft by vertical impaction at fracture site and to reduce the risk of lag screw penetration or cut-out by unlocking of the lag screw. 32 consecutive elderly patients (mean age 77 years) with subtrochanteric fractures were treated with the MSP, 17 with uniaxial and 15 with biaxial dynamization. Prospectively, the patients were followed clinically and radiographically for at least one year.

Results: Uniaxial dynamization along the femoral shaft provided impaction at fracture site and prevented medialisation of the shaft. However, two lag screw penetrations were observed in this group but both fractures healed uneventfully. Biaxial dynamization also resulted in vertical impaction but sometimes in increased medialisation of the shaft especially in combined intertrochanteric and subtrochanteric fractures. One nonunion occurred but all other fractures healed. Staged dynamization was done in three cases with a comminuted lateral wall and lag screw migration, which stopped after unlocking of the lag screw.

Conclusion: This small series with several fracture types could not give a clear answer, if uni- or biaxial dynamization should be used. However, from a theoretical and biomechanical view we prefer uniaxial dynamization in all subtrochanteric fractures, especially in transverse or reverse oblique fractures, and staged dynamization in combined inter- and subtrochanteric fractures with a comminuted lateral wall.

49. The Medoff sliding plate versus standard dynamic screw systems in unstable intertrochanteric and subtrochanteric hip fractures—a preliminary report of a prospective randomized multicenter trial

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The purpose of this study was to compare the efficacy of the 6-hole Medoff sliding plate (MSP) with standard dynamic hip screw systems in unstable extracapsular hip fractures.

Patients and methods: The MSP offers sliding along the femoral shaft and optional sliding along the neck of the femur. Its biaxial mode was used in intertrochanteric fractures and its uniaxial mode in subtrochanteric fractures. At present, 563 elderly patients with a hip fracture have been randomized to be treated with either the MSP or with the standard hip screw, and prospectively followed for a minimum of one year.

Results: In the intertrochanteric fractures, 12 technical failures were found in the standard group (n=252) and 13 in the MSP group (n=221). However, in the latter group 8 failures were probably a consequence of the deviation from the recommendation of biaxial dynamization. In the subtrochanteric fractures, 4 failures were observed in the standard group (n=43) an 0 in the MSP group (n=47). In total, 14 reoperations were done in the standard group and 5 in the MSP group.

Conclusion: The MSP has more options than the dynamic hip screw in the treatment of extracapsular hip fractures. Since it offers different sliding modes, it is important to know how to use the right alternative to avoid unnecessary technical failures in intertrochanteric and subtrochanteric fractures.

50. Ankle fractures—a prospective study comparing outcome measures

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This study aimed to compare an established scoring system, Olerud-Molander Ankle Score (OMA Score), to SF-36 Health Survey, to Visual Analogue Scale (VAS), to five simple questions regarding limitations in everyday life, and to clinical signs for evaluation symptoms after an ankle fracture.

Patients and methods: 55 patients, aged 16 to 65 years (median 41), operatively treated for a B-type ankle fracture

were included. 12 patients were lost to follow up at 2 years. There was no difference between the study population (n=43) and the dropouts regarding sociodemographic or fracture characteristics. All patients were interviewed during the initial hospitalization concerning background factors and asked to assess their injury-related health state by using the VAS. The patients were followed up at 24 months: OMA Score, SF-36, VAS and a questionnarie with 5 questions regarding limitations in every day life were used and the patients were also clinically examined.

Results: Two years after the fracture the median OMA Score was 90 (mean 83.7, SD=22.2). More than half of the patients reported some disability related to the ankle fracture, even though none of the patients was sick-listed; most of the subjective symptoms were related to leisure time activities and sports. A good correlation was found between the OMA Score and most of the SF-36 subscores. The former was also associated to Visual Analogue Scale and to the simple questionnaire concerning limitations in everyday life. However, the clinical measurements used, showed only a weak association to the OMA and SF-36 subscores.

Discussion: Disability, i.e, self-perceived limitations in everyday life, is common after an ankle fracture; in this study more than half of the patients reported some disability 2 years after the injury. The results imply that SF-36 Health Survey can be useful measuring outcome after an ankle fracture.

51. Complications and functional results after treatment of 100 tibial fractures with intramedullary nailing

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Interamedullary nailing of tibial fractures has been recommended as it facilitates early weight-bearing, eliminates risk for shortening and leads to union in most cases. Serious complications does however occur. We report the results after intramedullary nailing from a small hospital whiteout a special trauma unit.

Patients: 100 patients were operated on with a Grosse-Kempf intramedullary nail. In 78 cases as a primary operation and in 22 cases as a secondary operation after failure of other primary treatment. 17 of the primary cases were open fractures. All patients were followed until union or reoperation.

Results: 2 of the primary cases died before union occurred, one patient with severe trauma after 27 days, the other because of a tumour 6 months postoperatively. 4 of the primary cases were reoperated; 2 with external fixation, one with a longer nail and one because of infection. The other 72 primary cases healed, 2 with severe disability due to compartment syndrome.

Conclusion: Intramedullary nailing as a standard procedure can be recommended also at the small hospital. Our complication rat was not higher than what has been reported from special trauma units.

52. The effect of screw omission on bone-plate interface mechanics

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Minimizing surgical exposure and the amount of hardware implanted has become the aim in promoting the biological healing of fractures. Modification of the spacing and number of bone screws has been shown to increase the mechanical strength of fracture fixation without jeopardizing the stability of the construction. The omission of selective screws has also been shown to increase bone strain and has been suggested as a means of treating bone plate induced osteoporosis.

Materials and methods: Using Fuji prescale pressure sensitive film we have evaluated the effect of selective screw omission on the plate-bone interface mechanics. Testing was performed using a 10-hole, 4.5 mm DCP applied to equine cadaveric third metacarpal bones. Film was interposed between the bone and the bone plate which was applied to a constant level of screw torque. The resultant digitized bone plate patterns enabled computation of the interface contact area (%), the average force at the interface and the pattern of pressure distribution.

Results: The symmetrical omission of 40% of the total screw number resulted in significant differences between the control (10 screws) and each treatment for both interface contact area ($p<0.05$) and average force ($p<0.02$). In one instance, there was no difference between the control and treatment interface contact area ($p=0.052$). The pattern of pressure distribution was the same for both control and treatments.

Discussion: The results suggest that a dramatic reduction in the number of screws applied to a given plate (40%) does not bring about the expected major changes in the interface mechanics; the implication being that the frictional coefficient between the plate and bone will not be dramatically altered and as such the ability of the fixation, using fewer screws, to maintain fragment reduction and stability will not be impaired.

53. Long-term results after fractures of the olecranon in children

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The purpose of the study was to describe the long-term results after a fracture of the olecranon in children.

Material and methods: We identified 2,965 individuals treated for an elbow fracture at Malmö University Hospital between 1969 and 1979. 315 (11%) had an olecranon fracture. 98 of these patients were still alive and city residents in 1993. 22 of the 98 patients were 16 years of age or less at the time of the fracture, with a mean age of 11.2 (5–16) years. All 22 patients participated in a follow-up examination and answered a questionnaire. 15 patients also attended a clinical and radiographic examination of both elbows. Mean follow-up time was 19 (14-26) years.

Results: 2 patients described mild discomfort in the fractured elbow as compared with the nonfractured. Their complaints were tenderness and pain when using the elbow. The other 20 patients had no complaints regarding their elbows. We found no difference in either range of motion or strength between the injured and uninjured elbow. Radiogaphically, we found a significant elongation of the olecranon in the earlier fractured elbows (29.7±3.4 vs 28.1±2.9 mm, $p<0.01$). We found no nonunion. 2 patients had degenerative changes including cysts or osteophytes in the fractured elbow. None had reduced joint space.

Conclusion: The long-term results after an olecranon fracture in children are good. Radiographically there is an elongation of the olecranon, though not associated with reduced range of motion and usually without subjective complaints.

Spine

54. Cervical spine surgery in rheumatoid arthritis—a nation-wide registration

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A national registration of cervical spine surgery in patients with rheumatoid arthritis (RA) during 1993 showed 86 operations in 83 patients having been performed at eleven hospitals. Seventy-four of the operations were primary and 12 were reoperations. We report on pre- and postoperative clinical and radiographic findings, types of instability, indications for surgery, surgical methods, reoperations, postoperative treatment and early complications.

C1-C2 instability or dislocation was present in 69/82 cases, subaxial dislocations in 30/82 and cranial settling in 10/82. The average C1-C2 instability/dislocation was 9 mm on plain radiographs.Posterior fusion was performed in 76 operations. Wiring of C1 to C2 with bone grafting, followed by immobilization in a semi-rigid collar for two months was the treatment of choice, and commonly without complications. Nineteen patients had an occipito-cervical fusion done with wires and bone cement. One unit performed subaxial cervical decompression (laminectomy) without fusion, one unit performed posterior fusions with onlay grafts only, and another unit used carbon fiber grafts for fixation. In all, however, the indications for surgery, preoperative investigations, surgical methods and postoperative treatment were found to be reasonably uniform in Sweden.

Three patients died within 1 month. 16 patients showed recurrent dislocation due to nonunion at follow-up after 7 (1–17) months.

The majority of patients showed a good improvement of pain and neurologic status and were satisfied with the procedure.

55. Cervical spine fractures in the elderly—factors influencing survival

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Cervical spin fractures affect the elderly proportionally more often than the rest of the population. A clinical observation is that some of the patients perish quite soon after they have sustained their injury. The aim of the present study was to identify parameters predicting the survival after cervical spine fractures in patients over 65 years of age.

Patients and methods: The series consisted of 67 consecutive patients, 26 women and 41 men, with a mean age of 77 (65–99) years between 1988and 1994. Data was available for 66 patients. High energy trauma caused the injury in 36 patients. C1-C2 level was injures in 38 patients and subaxial cervical spine in 28. Neurological injured was present in 25 patients, 6 of whom were non-ambulatory due to the injury. 39 displayed normal neurology. The neurological status was not determined for two patients. 49 of the patients were operated and 17 treated conservatively.

Information if the patient was still alive or the date of death was obtained from the county administrations official population statistics at 53 (24–105) months after the injury. The following parameters were collected from the patients notes: Year of injury, age, gender, high vs. low energy trauma, neurological status, operative vs. conservative treatment, anterior vs. posterior approach, operation time, blood loss, complication or not, reoperation or not, and time in hospital. A multiregression lifetable analysis was performed using a statistical software package (StatView 4.5, Abacus Concepts Inc., Berkeley, California) for PC.

Results: At follow-up 40 patients were still alive whereas 26 patients had died. The 50% survival time was 5 years and 10 month. Neurological status and age were significant factors for survival. Not being able to walk increased the relative risk to die 5 times, and a 10-year age increase doubled the relative risk.

Conclusion: Neurological injury and old age are significant negative factors for both short- and long-term survival in cervical spine fracture patients over 65 years of age. Operative vs. conservative treatment did not influence survival.

56. Cervical spine fractures in the elderly—clinical outcome

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The aim of the investigation was to evaluate the clinical an radiographic results of cervical spine fractures in patients over 65 years of age.

Patients and methods: The series consisted of 67 consecutive patients (data available for 66), 26 women and 41 men with a mean age of 77 (65–99) years treated between 1988 and 1994. High energy trauma caused the injury in 36 patients. C1-C2 level was injured in 38 patients and the subaxial cervical spine in 28. Neurological injury was present in 25 patients, 6 of which were non-ambulatory. 49 patients were treated operatively.

Follow-up 53 (24–105) months after the injury consisted of a review of notes and radiographs, a questionnaire answered by 31 of the 40 still alive patients, and a clinical examination. A neck score summarising the results of neck symptoms, rhizopathy, myelopathy, and global functional performance was developed.

Results: 3 operated patients died within 10 days of the injury, 2 from myocardial infarction and one from stroke. Complications from the respiratory-, and cardiovascular systems and from the kidneys, were common. The majority of patients healed their fractures with a good alignment. The overall recovery was good. However, all but 3 patients suffered some residual symptoms. The most common complaint was neck stiffness (2/3 of the patients). Frankel grade at injury, and time between injury and follow-up correlated with the clinical results. Anterior vs. posterior surgical approach, or surgery vs. conservative treatment did not significantly affect the clinical outcome.

Discussion: Cervical spine fractures in the elderly offer special difficulties because the patients usually suffer from other medical conditions which leads to an increased number of complications. With increasing age, osteoporosis becomes more pronounced which, however, does not seem to be a problem for internal fixation. Old patients with unstable cervical spine fractures tolerated surgical treatment well and surgery offers a good alternative in treating these patients.

57. Surgery is cost effective in treating progressive paraparesis caused by metastases of the thoracic spine

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The objective of this study was to compare the cost for surgical treatment of thoracic spine cancer metastases with the hypothesised cost that would have been generated if surgery had not been performed.

Patients and methods: The study is based on individual data from 24 patients, 8 women and 16 men with a mean age of 67 years, operated for progressive paraparesis due to thoracic spine metastases. The cost was calculated for each patient by adding the cost for the preoperative investigations (plain radiographs and at least one neuroradiological investigation, usually MRI), anaesthesia, surgery, implants (pedicle screw spine fixation), postoperative intensive care, and postoperative care, as well as other costs generated during and after the treatment. These cost were compared to the hypothesised cost generated if the patient had developed paraplegia.

Results: The total cost for treating these 24 patients with paraparesis SEK 2.6 million giving an average cost for each patient of SEK 109,000. During the study the average daily cost for institutional care of a paraplegic patient was SEK 1,500 and for hosptial based home care was SEK 509. Thus, the cost for surgical treatment according to our protocol equals the cost for 10 weeks of institution care or 30 weeks of hospital based home care.

Conclusion: Surgery is cost effective because the preserved walking ability in the majority of patients allows independent living in the own home an makes institution care dispensable.

58. Predictive factors in lumbar disc surgery

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In a prospective 2-year follow-up study of 160 consecutive patients undergoing primary surgery for suspected lumbar disc herniation we studied the diagnostic and prognostic factors with stepwise logistic regression analysis.

When the different factors were entered in the same order as presented clinically, history and pain analysis contained most of the predictive information available, physical examination and radiography added nothing, and pathologic anatomy only little further.

When all factors were entered simultaneously in the computations, the following factors (in order of relative importance) predicted relief of sciatica after 2 years; rupture of the annulus (as opposed to bulging disc/negative exploration), no preoperative comorbidity, and male gender. A patient with all favourable factors obtained an odds of 0.19 for having leg pain at 2 years; a patient with all negative factors 2.92. The following factors predicted return to work at 2 years: no preoperative comorbidity, duration of sciatica < 7 months, education/vocational training in addition to compulsory school, age < 41 years, male gender and no previous surgery. A patient with all favourable factors obtained an odds of 37.02 for working 2 years postoperatively, a patient with all factors negative 0.002. Since the pathologic anatomy had no direct impact on return to work, it may be questioned whether return to work is a relevant outcome parame-

ter in lumbar disc surgery.

Many people have asymptotic herniations, and today hypersensitive diagnostic imaging is widely available. Therefore, the importance of clinical evaluation has increased, and most of the relevant information can actually be obtained just by listening to the patient. Currently patients with lumbar disc herniation are often routinely treated conservatively for prolonged periods, and disability, neurological signs, and diagnostic imaging per se are given a high impact in surgical decision marking. Our data suggest a more differentiated approach: patients with severe leg pain along with anamnesis, signs, and radiographic picture suggestive of annulus rupture often merit early surgery, while patients with unfavourable background factors together with a discrepancy between disability and impairment rarely benefit form surgery. Also, failure to improve on conservative treatment does per se not justify surgery.

59. Symptoms, signs and functional disability in patients with adult spondylolisthesis

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The symptoms and signs was determined in patients with adult spondylolisthesis (AS) and the functional disability was compared to that of patients with chronic low-back pain (CLBP) of degenerative origin.

Patients and methods: 110 patients, 53 women and 57 men with a mean age of 39 (18–56) years, with AS before randomisation to operative or conservative treatment were included and compared to the preoperative findings of 38 patients with non-specific degenerative CLBP. The functional disability was assessed by the Disability Rating Index (DRI) which is the mean of 12 functional VAS, and by pain VAS index which is the mean of present pain and worst pain last week.

Results: Sleeping disturbances, back stiffness, worsening of pain at walking and sitting were each reported by over 80% and sciatica in 67% of the AS patients. Lumbosacral tenderness (67%, reduced lateral bending (46%) and hamstring tightness (22%) were the only signs that occurred in over 20%. A sensory disturbance of L5 was seen in 13% and a positive SKR in 12%. The mean DRI was 48 and the mean pain index was 64 in the AS group. The mean DRI was 58 in patients with CLBP ($p<0.0003$). The functional profile was, however, strikingly similar in both groups.

Conclusion: The analysis showed similar symptoms, signs and functional disability in adult spondylolisthesis as commonly observed in patients with chronic LBP. Thus, patients with a diagnosis most likely affecting the mechanical properties of the spine exhibit the same clinical pattern as patients with low-back pain of nonspecific origin.

60. A prospective and consecutive study of surgically treated lumbar spinal stenosis—clinical appearance related to radiographic findings

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The degree of narrowing of the spinal canal necessary to cause symptoms of spinal stenosis is not clear. The aim of this study was to evaluate symptoms and signs in patients operated on for central spinal stenosis and to correlate the findings to age, preoperative duration and radiographic narrowing.

Patients and methods: 105 consecutive patients scheduled for decompressive surgery were included in a prospective study. All patients were interviewed and examined using a defined protocol including data on age, sex, preoperative duration of symptoms, walking ability and occurrence of pain at rest and at night. Included were also data regarding SLR-test, reflex disturbance and EHL-weakness. All myelograms were scrutinised by a neuroradiologist. The AP-diameters at each level from L1-L2 to L5-S1 were recorded. The level of and width at narrowest level was registered as well as number of levels with an AP diameter of less than 10 mm. Statistical analysis was performed including logistic regression.

Results: Symptoms and signs. Younger patients more often had a positive SLR-test ($p=0.03$, ANOVA). Reflex disturbances correlated to patient age; older patients more often had reflex disturbances. There was no correlation between preoperative duration and pain or neurological disturbances; patients with longer preoperative duration did not demonstrate more severe symptoms. Reflex disturbances were significantly associated with high patient age.

Radiographic findings: There was a total block in 13 patients. The mean value of the AP-diameter in the other patients was 6.8 (4–11) mm. In patients younger than 70 years the L4-L5 level was the commonest lever for most pronounced narrowing while the L3-L4 level was the narrowest in the older patients. Patients with degenerative spondylostesis had a more pronounced narrowing of the spinal canal. There was a tendency towards more walking disturbances in patients with a narrower spinal canal. There was no correlation between reflex disturbances or EHL-weakness and myelographic narrowing.

Conclusion: Pain was more intense and a positive SLR-test was more common in younger patients while reflex disturbances were commoner in the elderly. The vertebral level for the lowest AP-value was higher with higher age. Preoperative duration did not afflict the severity of symptoms or signs.

61. A prospective and consecutive study of surgically treated lumbar spinal stenosis—outcome at serial follow-up investigations

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We have evaluated the results after decompression for lumbar spinal stenosis at regular intervals postoperatively and correlated these results to the degree of narrowing of the spinal canal.

Patients and methods: In a prospective study, 105 consecutive patients who underwent decompressive surgery were evaluated at serial follow-up examinations. At the follow-up examinations the patients opinion on the surgical result was registered. The occurrence of pain at rest and at night was registered as well as

walking ability. The surgical results were related to patient age, sex, preoperative duration and radiographic narrowing as described in part I.

Results: The result regarding leg symptoms deteriorated with time; excellent result was reported by 62 to 66 percent between 4 month to 2-year follow-up compared to 50 percent at 5-years follow-up. There was a correlation between the AP-diameter and excellent outcome at all intervals:

	4 months	1 year	2 years	5 years
AP<6mm	81%	72%	77%	62%
AP>7mm	45%	47%	51%	35%
p-value	0.002	0.04	0.04	0.06

The logistic regression analysis also demonstrated a significant correlation between a severe reduction of the AP-diameter and excellent results at 4 and 12 months follow-up and also to preoperative symptom duration. Improvement of walking ability also was associated with a pronounced narrowing of the spinal canal. There was no correlation to age. A tendency towards better results in men was noted. During the follow-up period 17 patients were reoperated.

Conclusion: The results after decompressive surgery of central spinal stenosis deteriorated with time. There was a significant correlation between good result and pronounced narrowing of the spinal canal. The results were also influenced by preoperative duration but not by age of sex. When surgery for spinal stenosis is contemplated, these prognostic factors should be taken into consideration.

62. A long-term (4–12-year) follow-up study of surgical treatment of lumbar spinal stenosis

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There are sparse data available regarding the long-term results of surgery for lumbar spinal stenosis. The aim of this study was to evaluate the long-term clinical outcome and possible complications of decompressive surgery of spinal stenosis, with special reference to possible differences between patients undergoing fusion, with our without instrumentation, or decompression alone.

Patients and methods: All patients who underwent decompressive surgery for central and/or lateral spinal stenosis at the Sahlgrenska University Hospital, Göteborg, Sweden, between 1982 and 1991 were included in the study. The records of all the 124 included patients were reviewed, including an evaluation of preoperative symptoms, indications för surgery, previous history of lumbar surgery, surgical procedure and possible postoperative complications. 6 patients were deceased at the time of follow-up and 22 lost to follow-up for other reasons. 96, i.e. 81% of the patients were reexamined by an independent investigator and assessed with a questionnaire evaluating subjective outcome, remaining symptoms and disability. The mean follow-up time was 7.1 (4.0-12.2) years and the mean age at follow-up 64.4 (29-87) years.

Results: 42% of all patients underwent decompression only and 58% decompression and fusion. 67% of the fusions were instrumented. Four patients had wound infections (2 instrumented fusions, 1 uninstrumented fusion and 1 without fusion). In 18% of the patients with instrumented fusions the instrument had been removed. At follow-up, 65% of all patients were subjectively satisfied, 25% dissatisfied and 10% uncertain. Subjective low back pain and leg pain, evaluated with VAS 0-100, was 33.9 (SD±34.4) and 35.8 (SD±32.0) respectively. At follow-up, 44% of the patients had a walking capacity of more than 5 km, compared to 4% preoperatively. 18% reported a walking capacity of less than 200 m at follow-up, compared to 67% preoperatively. At follow-up, 25% of all patients used analgesics daily, 35% occasionally and 39% never. 30% of the patients with a fusion used daily analgesics compared to 14% who were decompressed only. Remaining sensory deficit at the operated level was detected in 50% of all patients and 56% of the patients had a remaining motor deficit or reflex abnormality involving the operated level. 3% had impairment of anal sphincter function.

Discussion: The percentage of patients with satisfactory results were concordant with the results of the few earlier long-term follow-up studies of surgery for lumbar spinal stenosis, incl. one meta-analysis of the litterature. Considerable improvement of walking distance at follow-up was found in most patients. There were no obvious differences in the clinical outcome between patients who were fused and those who were not. However, the limitation of the study is the retrospective design and there is a need for prospective studies on the long-term effects of lumbar spinal stenosis surgery.

63. The Karolinska study on conservative treatment of acute low-back pain—outcome at 1, 3 and 12 months

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Study design: A prospective randomised clinical trial comparing three conservative treatment methods for the acute low-back patient.

Summary of background data: Treatment of the acute low-back patient is controversial partly because of poor study design and lack of long term follow-up unbiased observers.

Methods: 180 patients, 19–64 years old with a history of low-back pain with or without sciatica, and a sickleave less than 2 weeks, were randomly assigned to one of three treatments: manual therapy (60 patients), physiotherapy with a low-back training program (60 patients) and treatment by general practitioners according to current low-back pain programs in Sweden (60 patients). The third group served as the control group. Outcomes were assessed by unbiased observers at 1, 3 and 12 months.

Results: At 1, 3 and 12 months' follow-ups no differences were revealed between the three groups regarding objective outcomes (sickleave, change of occupation, mobility of the lumbar spine) and some subjective outcomes (pain experience variables, Oswestry). After one month a significant improvement was noted in the majority of parameters compared with the values on entry to the study for all groups, although this was slower in the control group. In all follow-ups the manual therapy and training group patients were more satisfied with the treatment than the control group. Study limitations were the relative wide inclusion criteria and the drop out rate (i.e. 6% at 1 month, 14% at 3 months and 22% at 12 months)

Conclusions: Patients with acute low-back pain, with or without sciatica, should be handled by a general practitioner. These patients do not require specific manual treatment, nor an intensive training program and they will also improve significantly after one month with care from a general practitioner.

64. Preliminary data on 3-D lumbar motions *in vivo*

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RSA has since long been the method of choice for 3D assessment of skeletal motions. The main draw backs were radiation and a static or quasistatic assessments. We present preliminary data on 3-D lumbar motion measured with a opto-electronic in vivo method MacReflex (R), sampling frequency 50 Hz, allowing more dynamic assessments.

Subjects and methods: One healthy subject volunteered to participate. Hoffman-pins were inserted in the L4, L5 and S1 spinal processes. Pin location was checked with fluoroscopy. At the end of each pin a tripode with three reflectors was placed. Infrared cameras illuminated the markers and 3-D co-ordinates were registrated and processed and motions expressed as rotation and translations along perpendicular x, y and z axes at the L4-L5 and L5-S1 levels. Subject performed trunk flexion -extension, rotation and lateral flexion during the recordings.

Results and preliminary conclusion: Flexion-extension: Rotation up to 18° occurred at L4-L5 level with coupled motions, i.e. rotation anticlockwise and lateral flexion. A translation in the sagittal plane was noted. *Rotation*: The rotation was less that 3° at both levels. No coupled motions. *Lateral flexion*: Rotation up to 10° was noted during left flexion and 5° during right flexion. Coupled motions occurred.

The opto-electronic system seems to produce 3-D data on lumber motion in vivo allowing an accurate analysis of dynamic trunk motions. It is invasive but up till now we have assessed (but not analysed) 10 subjects with only one minor complication.

65. Mobility provocation of the lumbar spine evaluated by RSA

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Three-dimensional radiostereometric analysis (RSA) can detect lumbar intervertebral mobility induced by change in position from supine to erect with high accuracy (1). In the present study, RSA was used to determine whether more powerful spinal loading can supply additional information on the intervertebral mobility in the umbar spine.

Patients: Four patients with no prior open spinal surgery and with possible segmental pain on degenerative basis in the lower lumbar spine had an external fixation test using the Magerl frame as a prognostic measure for lumbar fusion. Following percutaneous insertion of transpedicular Schantz screws in one or two lumbosacral segments under general anesthesia, metallic indicators enabling RSA were implanted percutaneously in the vertebrae L3, L4, L5 and S1. One month after the completion of the external fixation test RSA was performed.

Methods: The three marked segments were examined by RSA with the patients in the standardised positions: 1) supine, 2) normal standing, 3) standing with sandbags weighing in total 20 kilograms on the shoulders and 4) sitting. The translatory and rotatory movements in the segments were calculated.

Results: Neither normal standing, standing with sandbags nor sitting had any significant effect on intervertebral trans-

lations along the transverse (x) axis, or on intervertebral rotations around the vertical (y) or sagittal (z) axes. Normal standing could induce translations along the vertical (y) and sagittal (z) axes as well as rotations around the transverse (x) axis which were slightly enhanced by standing with sandbags. Sitting, however, yielded in all cases translations up to 6 mm along the vertical (y) and sagittal (z) axes as well as rotations up to 12° around the transverse (x) axis in all three segments. In general, the amount of vertical (y) translation was similar in the three segments and the amount of sagittal (z) translation as well as transverse (x) rotation increased in distal direction.

Conclusions: Change in position from supine to sitting induces more pronounced intervertebral translations along the vertical (y) and sagittal (z) axes as well as more pronounced intervertebral rotation around the transverse (x) axis in the distal lumbar spine, than change in position from supine to normal standing or standing with sandbags weighing in total 20 kilograms on the shoulders.

Reference: 1. Johnsson R, Selvik G, Strömqvist B, Sundén G. Mobility of the lower lumbar spine after posterolateral fusion determined by RSA. Spine 1990; 15: 347.

66. Manipulation does not alter the position of the sacroiliac joint—a radiostereometric analysis

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Study design: A radiostereometric analysis (RSA) study of patients with sacroiliac joint (SIJ) dysfunction.

Objectives: To investigate whether or not manipulation can influence the position between the ilium and the sacrum, and if positional tests for the SIJ are valid.

Summary of background data: SIJ dysfunction is a subject of controversy. The validity of different SIJ tests is unknown. There is a massive therapeutic tradition to manipulate supposed dysfunction of the SIJ. Many manual therapists claim that their good clinical results are a consequence of reduction of a subluxation.

Methods: 10 patients with symptoms and SIJ tests indicating unilateral SIJ dysfunction were recruited 12 SIJ tests were chosen. The majority of these tests had to be positive before and normalised directly after manipulation. RSA was performed in the standing position before and after treatment.

Results: In none of the 10 cases did manipulation alter the position between the sacrum and the ilium. Positional tests changed from positive before manipulation to normal after.

Conclusions: Manipulation of the SIJ normalised different types of clinical tests but this was not accompanied by altered position of the SIJ as defined by RSA. Thus, the positional tests were not valid. However, the present results neither disprove nor prove possible beneficial clinical effects achieved by manipulation of the SIJ. Since the supposed positive effects are not a result of reduction of a subluxation, further studies of the effects of manipulation should focus on the soft tissue response.

67. *In vivo* behavior of rods and plates with transpedicular screw fixation in posterolateral lumbar fixation

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Aim of the study: To explore any differences in vivo stability of rods versus plates in lumbar spine fusion using transpedicular screw fixation.

Patients and methods: 14 patients, 7 operated on with transpedicular screws and rods (Diapason) and 7 operated on with screws and plates (VSP), matched according to number of levels fused, had peroperative metal markers inserted in the vertebrae for radiostereometric analysis (RSA). Mean patient age was 45 (33–56) years. In each group, 2 fusions were performed between L4 and L5, 3 between L5 and S1, and 2 from L4 to S1. In some cases a concomitant nerve root decompression was performed with facet joint preserving technique.

RSA was performed 4 weeks after surgery. This time was chosen with consideration to soft tissue healing but before fusion healing occurred; thus, stability of the lumbar spine depended mainly on the implant at this time. RSA was performed in standing and supine position without any mobility provocation, in line with the postoperative instructions to the patient. Movements between the outermost vertebrae of the fusion were calculated along the transverse, vertical and sagittal axes. The accuracy of the method along these axes has previously been determined to 0.3, 0.6 and 0.7 mm, respectively.

Results: In one patient with fusion between L5 and S1, stabilised with rods and screws, the sagittal translation was 1.01 mm. This patient had no significant mobility along the transverse and vertical axes. None of the remaining 13 patients displayed mobility from supine to erect position exceeding the accuracy of the method.

Conclusion: With the limited provocation described above, in line with the postoperative regimen for lumbar fusion patients, screws and rods, as well as screws and plates seem to give adequate stability for the lumbar spine segments. One patient with screw and rod fixation showed 1 mm mobility along the sagittal axis, in the remaining patients no movements between the vertebrae were seen.

68. Nucleus pulposus applied epidurally on spinal nerve roots induces increased endoneural capillary permeability

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It is now well established that spinal nerve roots will be subjected to both functional and histological injury after epidural exposure to autologous nucleus pulposus. The pathophysiology for these injuries are however not known. The aim of the present study was to assess changes in endoneural capillary permeability after short term epidural exposure to nucleus pulposus. Such changes might precede functional and histological nerve tissue injury.

Material and methods: 10 pigs were subjected to laminectomy and epidural application of autologous nucleus pulposus (NP group; n=5) or retroperitoneal fat (control, group C; n=5) around S2 and S3 nerve roots. After 90 minutes Evans blue albumin (EBA) in saline was injected i.v. 30 minutes later nerve root specimens were collected, fixed and longitudinally sectioned. The EBA complex emits a red fluorescence and it's distribution was evaluated by fluorescense microscopy.

Results: The increase in permeability was measured on a three degree scale as the amount of extravascular fluorescense, indicating leakage of albumin through the capillary wall. A total of 33 nerve root specimens were evaluated: 0 = EBA mainly inside capillaries: *Found in 8 NP and 13 C specimens.* + = EBA also focally among the axons: *Found in 3 NP and 4 C specimens.* ++ = EBA among all axons: *Found in 5 NP and 0 C specimens.*

Marked extravasion (++) was thus found in nerve roots from four nucleus pulposus exposed animals but in none of the control animals.

Discussion: Only nerve roots from the nucleus pulposus exposed group showed a marked extravasation and periaxonal spread of Evans blue labelled albumin. This might reflect an increased endoneural capillary permeability caused by bioactive substances derived from the nucleus pulposus. In conclusion, these results demonstrate that application of autologous nucleus pulposus epidurally around the pig spinal nerve roots, induces increased endoneural capillary permeability within two hours. Such mechanisms may be of significance in the pathophysiology of lumbar disc herniation and sciatica.

69. Temperature increase in cadaver discs by high intensity focused ultrasound

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Surgical treatment of disc herniation has been performed since the 1930ies and the evolution has gone from laminectomy via focused fenestration to microdiscectomy, and today further less invasive treatment modalities exist such as percutaneous nucleotomy and chymopapain injections. Next step should be a noninvasive method. It would at best be painfree, abolish risk of infection and be possible to perform as an out-patient procedure. The purpose of this preliminary study is to show the ability of high intensity focused ultrasound (HIFU) to induce temperature increase in spinal discs.

Materials and methods: Cadaveric bovine spines were divided into segments, consisting of a disc and its adjacent vertebral bodies. The posterior elements were removed to gain a dorsal access. A thermocouple was inserted in the nucleus pulposus by means of a lead cannula, which was redrawn before the treatment started. The disc segment was placed above a focused ultrasound transducer in a bath containing degassed water. Focus of the transducer was inside the nucleus pulposus. The discs were treated with sequential ultrasound, each sequence lasted ten seconds and consisted of a shorter burst of a few seconds and a longer part where no ultrasound was sent. In total, 18 discs were exposed to HIFU.

Results: All discs except one disclosed a significant temperature increase. Incorrect positioning of the preparation probably explained this case. Temperature increased within few minutes from initiation of exposure and maximum mean temperature varied between 50 °C and 100 °C. Level and duration of mean temperature did not correlate to time of exposure, power or burst sequence.

Conclusion: High intensity focused ultrasound may be used to heat the nucleus pulposus in cadaveric bovine discs. Further trials in anesthetised experiment animals are planned regarding effect and safety margins.

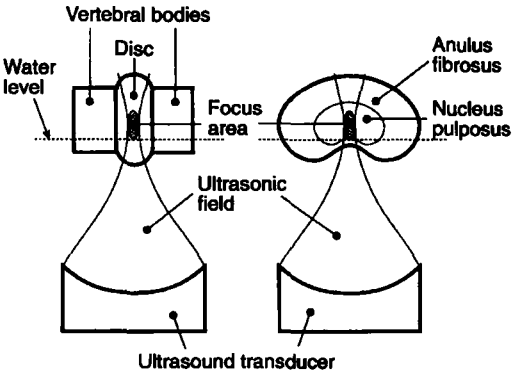

Figure 1. Ultrasound transducer and disc segment

Varia, part 2

70. Ilizarov technique for treatment of bone defects

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Defects of the long bones associated with fracture, nonunion, osteomyelitis, or tumour is often a challenge to the orthopaedic surgeon. Treatment should aim at healing without shortening. We have in these cases used bone segment transportation technique with the Ilizarov frame.

Patients: 8 patients have been treated. The defects were located in tibia (4), femur (3), and radius (1). Three of the cases were infected. The aetiology was traumatic (5), congenital pseudartrosis of tibia (1), tumorresection (2). The segmental defect was 8 (2–15) cm.

Technique: After subperiosteal corticotomy the bone segment was transported over the defect, usually at the velocity of 1 mm/day. The patients were allowed full weight-bearing from the first day postoperatively. When the segment approached the distal fragment, continuous compression was applied on the docking site, until union. Cancellous autografting to the docking site was performed in 3 cases.

Results: All defects healed. The treatment time in frame was 10 (2–16) months, or 1.2 months/cm defect.

Conclusion: Distraction histiogenesis with the Ilizarov technique has the capability to bridge over long bone defects, also in osteomyelitis and in fibrous dysplasia. The technique allows full weight bearing during the often very long treatment period. We consider bone transportation as the method of choice in most cases with segmental defects of long bones.

71. Hemicallotasis osteotomy for gonarthrosis—is it any good?

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Valgus osteotomy is a well established method in treating gonarthrosis. Though there are few reports describing the outcome following hemicallotasis osteotomy using an external fixator the method is now frequently employed. The purpose is therefore to present the short-term results as well as complications following this procedure.

Patients and methods: In this prospective study, 15 men and 6 women are evaluated at least 1 year (12–27 months) following osteotomy in 22 knees. Mean age at the time of operation was 52 (39–62) years. All patients had medial gonarthrosis classified according to Ahlbäck. Hip-knee-ankle angle (HKA) was measured prior to the operation, at the end of distraction, after 3 months when the fixator was removed and at the follow-up. Hospital for Special Surgery scores (HSS) were also obtained prior to the operation and at the follow-up.

Results: HSS increased significantly from 71 preoperatively to 83 points at the follow-up. The mean HKA was 178 after 3 months but 181 at the time of follow-up. Complications occurred frequently; in 6 patients only the treatment was uneventful. In 13 cases pin-tract problems occurred. There were one thrombosis and 2 reoperations due to technical errors and one patient acquired a septic arthritis of the knee 6 months after the operation. In another two patients the fixator had to be removed due to pain.

Conclusion: Hemicallotasis osteotomy is a cumbersome operation for the patient as well as the orthopedic surgeon but as it has its advantages compared with wedge osteotomy we believe that the method may still be used after careful patient selection.

72. Wear in uncemented, porous sockets versus full-polyethylene sockets—a randomized radiostereometric (RSA) study

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The use of an uncemented porous acetabular socket and a cemented stem has been recommended for primary hip replacement. However, in recent reports such sockets have been associated with an increased rate of polyethylene wear. With the use of RSA, we studied wear rates in a series of 102 hip replacements randomised to have either a cemented full-polyethylene Charnley (CH) socket or a porous, uncemented Harris-Galante type I (HG) socket. All hips had a cemented, mono-bloc Charnley stem.

Patients and methods: Wear could be assessed in 95 of the 102 hips included in the study; 47 CH and 48 HG. RSA was performed at regular intervals, standard radiographs were obtained simultaneously; mean follow-up 63 months (range, 24-90). Wear was analysed as the 3-dimensional penetration of the femoral head into the polyethylene, and is presented as the vectorial length of penetration. A regression of wear over time was made for the individual case, and the regression coefficients were entered into a covariance analysis.

Results: The mean annual wear rates were 0.09 and 0.10 mm for the CH and HG, respectively, $p=0.14$ (Mann-Whitney test). The wear rates during the initial 3 months were in both groups higher than from 3 months and onwards, whithout any correlation between these two events, $p=0.08$, $r^2=0.06$. In the covariance analysis, demographic factors and thickness of the polyethylene did not influence the results. There were no signs of osteolysis around the HG sockets. One CH socket had migrated 5 mm proximally and is scheduled for revision. There was no difference in migration between the two designs.

Conclusion: The HG sockets have wear characteristics similar to the CH sockets at a mean of 5 years. These data

suggest that an uncemented, porous acetabular component of the Harris-Galante type I can safely be used in conjunction with a cemented Charnley femoral component.

73. Interface porosity and shrinkage in cemented implants—effect of different mixing procedures

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The strength of the bond between bone and bone cement, and bone cement and metal is crucial to the long-term stability of cemented femoral components in total hip replacements. Porosity on cement-stem interface is thought to decrease the static strength on the interface. Porosity formation on interface is usually produced during bone cement preparation and implantation. Therefore, an understanding of initial interface change after implantation is essential to identify later prosthesis loosening. The study analysed the interface contact in cemented implant and the difference of the interfaces in different mixing procedures of bone cement.

Material and methods: Five paired pig femora were used in the experiment. The marrow cavity was prepared by using modern cementing technique. Prechilled Palacos R bone cement (4 °C) was mixed with a vacuum mixing system (MITAB, Sjöbo, Sweden). One of the paired femora was filled with bone cement mixed under vacuum, the other was filled with bone cement that had not been mixed under vacuum A stem was inserted into the femoral canal. The femur was sectioned transversely from the level of the minor trochanter and distally at six levels, each at a distance of 10 mm, using a high-pressure water cutter. The interfaces between the bone and cement and the stem and cement were examined under a microscope with a computerised video digital table system. The length and width of the gaps between the interfaces as well as the number of pores were measured. The gap % = gap length/total interface length x 100. The number of pores per 100 mm = number of pores/ total interface length x 100. The sections were examined in a scanning electron microscope (SEM).

Results: Vacuum-mixing significantly reduced the pores at the interfaces. Porosity at the stem-cement interfaces was always found to be higher than at the bone-cement interfaces. In the total material of 60 specimens, there was an 85–90% complete contact of interfaces without any gaps. However, small gaps on the interfaces were detected in some areas. There was no increase in the length of gaps ($p>0.05$) in the group with vacuum-mixed cement, compared to the group without vacuum-mixed cement.

Conclusion: Pores and gaps have not previously been quantified in cemented implants using different mixing procedures. In this experiment, we studied the interfaces without any other influence, such as bleeding or the effect of loading the implants. In all our specimens, there was intimate contact in about 90% of the circumference of the interfaces. The small gaps we observed may have been due to diametral cement shrinkage. Vacuum mixing did not lead to an increase in the gap but significantly reduced the interface porosity.

74. Two mixing systems, tensile strength and porosity for Simplex P

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That porosity is linked to the mechanical properties of bone cement is well known, and the efficiency of mixing systems varies. The aim of this study was to compare the efficiency of two mixing systems, the Simplex Enhancement Mixer and an experimental system (PrePack). The Pre-Pack-system is designed to producing high quality cement, i.e. pore-free cement, and to reduce the amount of monomer fumes in the operating theatre.

Material and methods: The experiments were carried out at 20±1° C and all components stored at this temperature at least 24 hr's prior to the experiment. A double dose of cement was used for the preparation of Tensile and porosity measurement specimens. A single dose of cement was used for the Macroporosity measurements. In the Enhancement mixer the cement was mixed according to manufacturers instructions. In the PrePack system vacuum was applied and the pre-packaged cement components brought together, mixing was conducted for 30 sec after which the cement was collected under vacuum. The tensile specimens were moulded and cured in saline solution at 37 °C. The tensile testing was performed at a rate of 5 mm/min. Tensile strength, strain at failure, and E-modulus were calculated. Microporosity was measured by cutting and staining disc of bone cement. Macroporosity was calculated from radiographs of cement rods.

Results: The PrePack system yielded significantly higher tensile strength (45.2 MPa vs. 40.5 MPa) and strain at failure (1.8% vs. 1.6 %), the modulus was not significantly different (2579 MPa vs. 2586 MPa). The microporosity was higher with the Enhancement mixer but not statistically significant. Macroporosity was significantly higher in the Enhancement mixer (2.49 % vs. PrePack 0.23 %).

Conclusion: The PrePack system produced significant improvements in cement strength and porosity when compared to the Enhancement mixer. Also the exposure of operating staff to monomer is reduced by integrating the cement components in the PrePack.

Posters

75. A council on the management and treatment of hip and knee arthroplasty in southern Sweden

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Purpose and Objectives:
– To create and maintain joy and satisfaction in work with friendship and a good spirit.
– Through co-operation, co-ordination, concordance, development and unification, locally and in the region, create a high and even standard including the care of the patients as well as the results of operations and follow-up while maintaining a high cost-effectiveness.
– To co-ordinate the routines in the care of patients including the routine treatment before, during and after the operation, the medical records, indications for surgery, patient information, blood tests, transfusions, thrombosisprophylaxis, antibiotics and bonebanks. Furthermore, to come to an understanding with regard to surgical technique, implants, postoperative regimes, mobilisation, rehabilitation and follow-up schedules including roentgen examinations.
– Collaboration and development in research and continuous education of staff, to increase our knowledge and to facilitate, modify and improve the quality of the patient's care including delegation to project groups of specific problems and through auscultation and public information, making development and interchange of experience possible for the benefit of our patients.
– Quality work with long-term strategic planning in networks and decisions based on facts as well as customer and process orientation. Constant improvement and capability development through education, co-operation, research, effectiveness improvement and result analysis.

76. Code of practice—a total quality management concept for orthopedic technical workshops

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The quality system CODE OF PRACTICE (CoP) covers all the main functions within the company Aktiv Ortopedteknik i Malmö AB. CoP is a Total Quality Management (TQM) system which has been developed for the field of technical orthopaedics. Each quality manual is therefore a handbook showing how each branch efficiently can provide quality assurance for their entire operation. Quality (Q) can, according to the ISO 8402 quality, be defined as: the collected properties of a product which provide it with the ability to satisfy stated or implied requirements. The aim of the Q system requirements is first and foremost to satisfy the customer. This is achieved by preventing non-conformity during all stages from production to service.

SS-EN ISO 9001 is one of a series of three international standards dealing with requirements of Q systems and can be used for external Q assurance purposes. SS-EN ISO 9001 is a general Standard. SS-EN ISO 46001 states particular requirements pertaining to medical devices.

The CoP manual has just recently been approved by BSI (British Standard Institute) according to SS-EN ISO 9001 and SS-EN ISO 46001 which are included as an integral part of CoP. CoP also comprises procedures not directly affected by the SS-EN ISO standard.

The Q system is divided into 15 CoP blocks: Business/Q policy, Q assurance, Management/customer contact, Organisation, Flow chart/process control, Logistic/purchasing material administration, Product range, Technology/clinical, Process control, Warranty service, Calculation/price structure, Health and safety, Personnel, Economy/administration and Suggestion scheme. Each block is documented in a number of Q system documents. The documents can be of various types such as: policy documents, procedure descriptions, detailed instructions or handbooks, externally produced technical manuals, approved by management, and appendices as forms, measurements charts, medical records, etc.

A record of work carried out must be made every time the patient visits the clinic. A patient's medical record must contain: anamnes, present condition, examination of the patient, daily notes and a summery with final judgement or final notes. CoP also includes forms and rules for evaluation of new products and materials, customer complaints and non-conformity report.

CoP can be an efficient tool in the Q work of technical orthopaedic services and CoP can serve as an inspiration and a model to the departments of orthopedics.

78. Routines for hip fracture treatment in southern Sweden

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The aim of this study was to map the routines for hip fracture treatment in Southern Sweden.

Materials and methods: A telephone questionnaire concerning pre-, postoperative and operative routines was used. Orthopaedic departments in 12 hospitals answered.

Results: Differences were found concerning preoperative washing and the amount of blood samples taken. Two hospitals treated patients with oxygen before the operation. The operative procedure was usually done during the first 24 hours after admittance in all hospitals. All but one hospital used the LIH nail for cervical fractures. Trochanteric frac-

tures were treated with glide screw and plate in all hospitals. Weight bearing was allowed immediately postoperative in all departments. Differences were seen in radiographic and follow-up regimes.

Conclusion: The operative treatment of hip fractures in southern Sweden does not differ very much. Differences in pre- and postoperative care exists in some extent.

79. Rehabilitation after a hip fracture—a video presentation

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Many elderly people sustain a hip fracture today. More than every fifth woman at the age of 80 has sustained or will sustain a hip fracture. At present 18,000 hip fractures are yearly undergoing operations in Sweden. Due to osteoporosis, less muscle mass and problems with balance and dizziness the risk of falling is increased. Most of the people who fall and sustain a hip fracture live in their own homes. By being active, doing the house work and taking daily walks, muscles and balance get trained and osteoporosis is prevented.

A rehabilitation programme for patients with hip fracture started in the mid seventies at the Orthopedic Department in Lund. This means mobilisation immediately postoperatively, gait training at the hospital, discharge directly to their own homes and continued rehabilitation there.

The contacts between the Orthopedic Department and the Primary Health Service changed when a new health reform (Ädelreformen) was implemented in 1992. The communities became responsible for health service and rehabilitation for elderly people. Education for the social workers in the community was needed to increase knowledge about patients with hip fracture and to increase understanding for the possibilities to rehabilitate these patients in their own homes.

Physiotherapists and occupational therapists are important resources in the rehabilitation after a hip fracture. By exercising the elderly and providing them with technical aids the elderly will be able to continue their activities of daily living directly after the hip fracture. Supervision and guidance to social workers helping them to take part in the rehabilitation are also important tasks for the rehabilitation staff.

A videofilm was produced to be used in education for social workers in the community.

80. A new method for cutting metal implants with a high-pressure water cutter

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For interface analysis of implants in hard tissues, we used a new cutting technique with a high-pressure water cutter.

Material and methods: A femur with cemented stem was sectioned transversely using a high-pressure water cut (Water Jet Cutter, NC 3000, Water Service AB, Ronneby, Sweden). The machine produced a water pressure of 3500 bar through a nozzle (inside diameter 1.0 mm), with addition of sand (120 mesh). The cutting produces a maximum heat of 60 °C on the cutting surface. In the study, the moving speed of the nozzle and the distance of sections and cutting direction were measured. As comparison we used a high speed diamond cutter. One femur was also cut by a high-speed, water-cooled, circular saw with a diamond blade. The cutting time was recorded. The interface of the sections was analysed, using a microscope with direct light. The usefulness of the method was tested in a comparison of cemented implants using different mixing procedures. Palacos R bone cement was mixed with vacuum (6 cases) and without vacuum mixing (6 cases), and was injected into 50 mL syringes (2.5 cm diameter). A femoral stem was implanted into the model. The specimens were cut transversely with high-pressure water into 4 sections with a thickness of 10 mm each. The number of pores of the interface between the cement and the stem was counted under a microscope.

Results: The best surface was obtained with a speed cut between 5 and 20 mm/min. The cutting time for one section took about 10 to 15 minutes with the water pressure cutter and 3 hours with the diamond saw cutter. A section thickness of 5–10 mm is optimal. The cement porosity were seen clearly without artefacts. A intact interface between the materials was shown in all specimens using both cutters. However, small gaps on the interfaces were detected in some areas. Such gaps were not affected by the direction of the cutting. The mean numbers of pores around the interface of specimens with of without vacuum mixing were 1±1 and 25±3, respectively.

Conclusion: The method with a high-pressure water cutter used for industrial purpose resulted in a cutting surface comparable to a high-speed, water-cooled, circular saw with a diamond blade, however, with minimal heat generation. The cutting speed was much faster with water cutter. To investigate larger series of metal implants in hard tissue experimentally or for retrieval studies, the cutting technique could be used with minimal artefact.

81. Cervical rod spine system (CROSS)—a multioption cervical spine fixator

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There are several obvious drawbacks with plates for posterior fixation of the cervical spine. The stability of the construct relies on the plate being pinched between the screw head and the underlying bone. Any minimal backing out of the screw will render the plate loose at that point. The holes of the plate

are lined up in a straight line and at a fixed distance from each other which not always coincides with local anatomy. Thus, the placement of screws may be at a less desirable position and some screws may have to be left out all together. Screws placed through a hole in a plate can only deviate at a certain angle which exclude the usage of for instance transfacet joint screws. Also, laminar hooks can not be used together with a plate.

The CROSS fixation system has been developed to allow combinations of bone screws, laminar hooks, and cerclage wire as bone anchors. The various bone anchors can be independently placed in accordance with the demands of local anatomy. The longitudinal members of the construct, the rods, are placed after the screws have been positioned. Additional screws and hooks can be mounted at a later stage without disassembling the construct. The components of the construct is rigidly locked together to form a mechanical unit. The system is manufactured from titanium alloy.

In a biomechanical test CROSS was compared to: rods and stainless steel wire, stainless steel- or titanium cable, or polyethylene bands; anterior plate (AO/CSLP); and posterior plates. Stiffness and range of motion were evaluated in axial compression, torsion, lateral bending, and flexion- and extension. Before cyclic loading the CROSS system was as stiff and decreased range of motion as effective as posterior plates. After cyclic loading the CROSS system kept its stability better than posterior plates. The wire/cable systems and the anterior plate all provided less stability both before and after cyclic loading.

We have used the system in 36 patients. Early experience is promising. The fixator can be adopted to cover most cervical spine pathologies suited for posterior stabilisation. Operation time has been decreased and fewer reoperations have been performed compared to when plates were our standard implant.

82. Cervical disc herniation after whiplash trauma

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It has been claimed that whiplashtrauma may contribute to and cause disc herniation within the cervical spine. However, to our knowledge, there are few previously reported prospective studies where such patients have been followed with consecutive magnetic resonance tomography (MRT) investigations.

Methods: Patients admitted to the Traffic Injury Register in Göteborg were prospectively investigated clinically, with questionnaires and radiographically with MRT within the first two weeks after a rear end collision trauma. They were followed frequently within the first year and after 3 years a new thorough neurological investigation and a MRT was performed. Changes within the disc between the 3rd and the 7th cervical vertebrae (4 discs) were especially evaluated in each patient and any difference between the two MRT investigations noted and correlated to the clinical symptoms. The changes of the discs were graded according to Jónsson and Rauschning from grade 0 to grade 4.

Patients: 18 consecutive patients were included in the study. 1 patient was operated within the first year with disc excision due to a symptomatic disc herniation grade 3. 3 patients refused to come to the follow-up at 3 years. Thus, 14 patients remained with a total of 56 discs that were evaluated.

Results: 7 of the 56 discs had protrusions grade 3 or 4, i.e. protrusions that impinged on the dura or the cord. 7 discs displayed protrusions grade 1 or 2 i.e. a bulge or a slight protrusion. At the 3 year follow-up, 10 discs had deteriorated. 2 discs deteriorated from grade 3 to 4 and 2 discs from grade 2 to 3. 6 other discs without previous changes deteriorated, 3 from 0 to grade 3 and 3 from 0 to grade 1/2. 4 of the 7 patients with grade 3/4 changes of the disc have neurological symptoms whereas 2 of the 7 patients without any disc changes had any neurological symptoms.

Conclusion: It seems as if the whiplash trauma may contribute to disc deterioration and herniation within 3 years. However, the number of patients is small and the study is not controlled.

83. Mechanical load and primary guinea pig osteoarthrosis

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By surgically altering load distribution it was possible to affect the development of OA in Hartley guinea pigs, which spontaneously develop knee arthropathy, mimicking primary human OA.

Materials and methods: Male 9-month-old Hartley guinea pigs were randomised into 4 groups. The 1:st group was killed immediately. The 2:nd group had a mid-femoral 30°-valgus osteotomy, internally fixed with a miniplate. The 3:rd group had a unilateral transtibial amputation. The contralateral sides served as internal controls. The 4:th group had a soft tissue sham operation. The animals were housed separately and allowed unrestricted activity in their cages. Groups 2–4 were killed after 3 months. Proximal tibia was processed for light microscopy and each condyle step-sectioned with a constant interval of 250 mm. In the central (non-meniscus covered) part of the condyle the following parameters were calculated by stereologic methods: heights of articular cartilage and subchondral bone, fibrillation (ratio between the true, rough articular surface and its tangent) and horizontal splitting.

Results: Force measurements showed that the amputated animals overloaded their remaining leg, whereas the osteotomized bore fairly equal load on their hindlegs. In compari-

son to sham operated animals there were less fibrillation and horizontal splitting medially after osteotomy, and also a lower subchondral bone thickness. The calcified cartilage height did not change. Laterally fibrillation increased. Non-weight bearing gave an obvious bone atrophy and also reduced the subchondral bone changes compared to those in sham operated animals.

Discussion: The changes of subchondral bone heights indicate that surgery actually redistributed load. Osteotomy equalised bone heights between the condyles, and therefore presumably also compressive load. The effect on cartilage fibrillation and bone height show the relationship between load and OA.

Although clinical fibrillation may precede OA, it does not always progress. In guinea pigs fibrillation is predominantly found at the central medial condyle, a site that invariably develops advanced OA.

Calcified cartilage was remarkably constant during the experimental period, and since it did not change upon intervention and since it was also always thicker on the lateral side it seems unlikely that tidemark advancement is a prominent early pathogenic factor in guinea pig OA.

Bone changes were seen simultaneously with the cartilage changes and were even more pronounced in the amputated animals. This further implies the importance of stiffness gradients in the pathogenesis of OA. Our data show a consistent pattern confirming a close relationship between load and the development of OA.

84. 5-year follow-up of the Romanus combination cup in primary total hip arthroplasty

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Uncemented THA is still a procedure under development and all cases should be followed in prospective studies. Since the introduction in April 1988 the RCC (Romanus Combination Cup) has been one of the most frequently inserted uncemented acetabular implants in Sweden. All operating surgeons has been offered the opportunity to report their patients to a common database and to follow them according to a specific protocol. So far 1303 cases are reported and followed prospectively. Satisfactory 2-year results were presented at the SOF in Trollhättan 1991.

Material: All cases that were operated during one year, between July 1, 1990 and June 30, 1991 were selected for this 5-year follow-up report. During this period 225 cups were implanted in 13 departments. They were used in combination with various stems, cemented as well as uncemented. Primary THR were performed in 1977 hips.

Method: The 225 patients were radiographically examined at the local hospital according to a standard protocol and sent for evaluation by an independent observer (HL). The evaluation was focused on such findings as migration, change in orientation, wear, reaction around the implant. The clinical result was evaluated from the prospective protocol or by a questionnary.

Results: 140 cases of 197 operated in 11 departments have been reviewed so far. Revisions have been performed of one cup, six femurs, and two of both components. Radiolucent lines (≥2 mm) were seen in one case and granulomas in four cases. None of the cups had migrated. Excentricity (abnormal wear?) of ≥ 5 mm/2 were seen in three hips.

Conclusion: The RCC performed well in a 5-year perspective in this multicenter study. No major problems have been encountered so far.

85. Does the tapered shaped Exeter stem migrate at the stem–cement interface or/and at the cement–bone interface

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Purpose: To elaborate the RSA method in the quest to objectify whether prosthetic migration in cemented femoral arthroplasties occurs at the stem-cement or/and the cement-bone interface.

Patients and methods: In 5 consecutive hip arthroplasties with the double tapered, collarless and polished Exeter stem prosthesis, tantalum markers were implanted in the greater and lesser trochanters as well as in the medioproximal aspect of the cement mantle. In three of the cases the markers in the cement could not be adequately imaged for planned RSA. In the remaining two cases the configuration of the markers allowed RSA (segment motion) follow-up from immediately postoperatively until one year after surgery. Subsidence and radiolucent zones on conventional radiographs was assessed.

Results: In the two cases followed by RSA subsidence of the stem occurred within the cement, but the cement did not subside in relation to the femur:

Subsidence (mm)

Case	6 wks	3 mo	6 mo	1 yr
Stem versus cement (mm)				
1	0.7	1.1	1.5	1.8
2	0.7	0.9	0.9	1.0
Stem versus femur (mm)				
1	0.7	1.0	1.4	1.7
2	0.7	0.9	0.9	1.1
Cement versus femur (mm)				
1	0	0	0	0
2	0	0	0	0

Radiography revealed in case 1 a 1-mm radiolucent line between the cement and the neck of the prosthesis. No other radiolucent line was seen in the cement mantles. No discontinuity was seen in the cement mantles. The distance between the tip of the stem and the distal end of the radiolucent

centralizer diminished 1-2 mm on the radiographs during the observation period.

Conclusion: In 2 of 5 hip arthroplasties the position of the tantalum markers in the cement allowed RSA. In these cases all subsidence of the stem occurred within the cement as suggested by the Exeter group. Further refinement of the method and more cases will give a more reliable answer to the interesting question whether the stem prosthesis subsides within or/and together with the cement mantle.