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## Anterior cruciate ligament injury

### Early training after acute anterior cruciate ligament rupture

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*Introduction:* A major problem in the treatment of anterior cruciate ligament injuries is to define the subgroup of patients who are at risk of re-injury and/or repeated giving-way. The aim of this study was to evaluate the effect of immediate neuromuscular rehabilitation and also to attempt to early identify patients in whom this treatment would not provide a satisfactory functional result.

*Patients and methods:* During a 3-year period, all the patients with clinical suspicion of, or confirmed, acute anterior cruciate lesion, both isolated and in association with meniscus and collateral ligament injuries, have been evaluated under general anesthesia using arthroscopy and stability tests. All the patients with a low to moderate activity level were treated with immediate training after randomization into one of two groups. Group 1 were given instructions by a physiotherapist after the injury and were told to continue the training on their own regularly. Group 2 went through a supervised neuromuscular rehabilitation program. The permitted level of activity was successively raised in both groups. All the patients were told to avoid contact sports. A small brace was used during other sporting activities. Fifty-eight patients have been followed for more than 1 year.

*Results:* At 6 weeks post injury, 12 patients had to change from group 1 to the supervised training because of insufficient improvement in knee function. Seven patients were admitted for a ligament reconstruction during the first year. The activity level according to Tegner was a mean of 6.7 (3–9) before injury, 2.8 (0–6) at 6 weeks, 4.5 (1–9) at 3 months and 5.6 (3–9) at 1 year. The functional knee score of Lysholm and a one-leg-hop test used as a performance evaluation were also successively improved.

*Conclusions:* In a consecutive group of patients with a low to moderate activity level and an acute anterior cruciate liga-

ment rupture, with or without associated injuries, supervised physiotherapy was of importance during the early period of rehabilitation. Totally, 7/58 patients needed a ligament reconstruction during the first year after injury because of symptoms of instability or re-injuries despite the rehabilitation program. A gradual increase in activity and neuromuscular rehabilitation resulted in a good knee function in most of the remaining 51 patients.

## The stabilizing effect of the knee braces after anterior cruciate ligament rupture

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*Introduction:* Knee braces are frequently used to treat patients with instability due to a tear of the anterior cruciate ligament (ACL). We have examined the effects of three different knee braces on rotatory and translatory instability.

*Material:* Fifteen orthoses (5 SKB, 5 ECKO, 5 Lenox-Hill type) individually modeled for 14 patients with arthroscopically verified ACL tears. The uninjured knees (15) were examined with and without orthoses and the intact knees (13) without orthoses.

*Methods:* The anterior-posterior and rotatory laxities were recorded using tractions (150 and 80 N) and torques (8 Nm), or a combination of traction and torque, at 30° and 20° of flexion. During the testing procedure, tibial and femoral movements were measured using roentgen stereophotogrammetric analysis.

*Results:* The three types of orthoses reduced ( $P = 0.005$ ), but did not normalize ( $P = 0.005$ ) the anterior laxity, when compared with the intact knees. The external rotatory laxity was slightly reduced by the orthoses ( $P = 0.005$ ) whereas the internal rotatory laxity did not change. When the tibia was pulled anteriorly and rotated, the orthoses neither altered internal or external rotatory laxity.

*Conclusion:* Knee braces may reduce anterior and external rotatory laxity in the anterior cruciate insufficient knee.

## Strength training in old anterior cruciate ligament injuries: A 5-year follow-up study

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**Introduction:** The role of strength training in the treatment of ACL injuries has been discussed over the years. Few long-term studies have been published.

**Material and methods:** Sixty-one patients (46 men and 15 women, mean age  $26 \pm 7$  years) with ACL injuries participated in a strength-training program. Before, after training, and at a late follow-up 5 years after training, knee function was assessed with a knee score, Cybex measurements, activity grading, and a performance test. Before training, all the patients underwent diagnostic arthroscopy. All the meniscus injuries were treated at this session.

**Results:** Immediately after the training period, 13 patients had a ligament reconstruction. During the follow-up period another 13 patients underwent reconstruction owing to increasing symptoms of instability. Four patients had an arthroscopic meniscectomy. All the patients except those who had a ligament reconstruction were followed up 5 years. The functional score was high ( $90 \pm 9$ ). The activity had increased one level. The muscle strength remained unchanged. In the functional test, they performed almost normally.

**Discussion:** Although 40 percent of the patients underwent ligament reconstruction, the rest of the patients showed an almost normal knee function even 5 years after they finished regular strength training. There were few new meniscus injuries.

**Conclusion:** Muscle-strength rehabilitation alone in patients with an anterior cruciate ligament injury leads to sustained improvement of knee function in the majority of patients.

## Anterior cruciate ligament tear—a complex injury

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**Introduction:** Tears of the anterior cruciate ligament are seldom isolated. In the literature, tears of capsular and collateral ligaments are referred to as medial or lateral ligament-complex injuries, but the complexity is shallowly discussed. A study has been performed to reveal the complexity.

**Patients and methods:** Forty-six knees with verified tears of the anterior cruciate ligament have been carefully surgically explored. Every tear, partial or total, of ligaments, menisci, retinaculas, muscles, and also minor condylar fractures and their location, has been recorded. The different patterns of each knee have been analyzed.

**Results:** Forty-two different combinations of isolated tears were found, all factors considered. Up to 10 different associated tears were found. The most frequent associated injury was tears of the medial capsular and collateral ligaments in 33 knees. The tears of the anterior cruciate ligament were found to be "isolated" in 6 knees. The site of rupture of the anterior cruciate ligament was at, or close to, the femoral attachment in 30 knees; in midsubstance in five knees; oblique in substance in six knees; and at, or close to, the tibial attachment in five knees (three tibial spine fractures).

**Conclusion:** Anterior cruciate ligament tears are often complex knee injuries. This complexity must be considered when different treatments of anterior cruciate ligament tears are compared.

## Patient selection for nonoperative treatment in acute cruciate ligament injuries

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**Material:** Twenty patients, median age 24 years at injury, with isolated anterior cruciate injuries, diagnosed by arthroscopy and stability examination under anesthesia and who were not selected for surgery were reexamined after a median of 32 months. Selection of patients for conservative treatment was performed after careful patient information and evaluation of motivation for rehabilitation, muscular fitness, interest in sports, and physical activities at work according to the principles of Noyes et al.

Two reference groups were evaluated: 1) Nineteen patients, median age 20 years at injury, with acute isolated anterior cruciate ligament injuries underwent primary augmentation-reconstruction after initial diagnosis with arthroscopy and examination under anesthesia. they were reexamined after a median of 25 months. 2) Twenty-three knee-healthy medical students, median age 26 years.

**Methods:** Examination was made using the Lysholm and Tegner scores. Arthrometer (KT-1000) was used for objective stability evaluation. Degree of positive Lachman and pivot shift was also recorded.

**Results:** Nonoperated on patients were pleased with high Lysholm scores (median 89). Nine of 20 nonoperated on knees had a clearly positive pivot shift sign. Fifteen knees in the nonoperated on group had an injured-uninjured difference of 3 mm or more. Nonoperated on knees had lower scores and increased arthrometric values, those with a pivot shift showing highest anterior displacement. No case of clearly positive pivot shift was seen in the operated on group. An injured-uninjured difference of 3 mm or more was seen in 3 patients in the operated on reference group. There was no arthrometric difference between students' knees and operated on knees.

**Conclusions:** Patients with physical demands will do well without surgery, but they will have deteriorated sagittal stability.

## Knee function after surgical and nonsurgical treatment of acute rupture of the anterior cruciate ligament

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**Introduction:** The necessity of restoring stability after total rupture of the anterior cruciate ligament (ACL) is controversial, because both surgical and nonsurgical treatment have been shown to result in satisfactory knee function. The aim of the present study was to compare surgical and nonsurgical treatment after a minimum of 4 years' follow-up.

**Patients and methods:** Totally, 167 consecutive patients, 119 men and 48 women, 13–59 (mean 26 ± 9) years with an acute rupture of the ACL, diagnosed with arthroscopy, were randomized to one of three treatment groups: 1) repair and augmentation of the ACL (Group SA); 2) simple repair (Group S); and 3) nonsurgical treatment (Group C). Associated meniscal injuries and injuries to other ligaments were treated in the same way for all the patients.

In all, 156 patients (93 percent) have been reexamined 55 ± 8 months after the injury. Nineteen patients (16 patients in Group C and 3 in Group S) had developed a symptomatic instability resulting in a reconstruction of the ACL. Sixty-three percent of the patient in Group SA had returned to competitive sports compared with 27 percent in Group C ( $P < 0.001$ ). Group SA ( $7 \pm 3$  mm) had less instability than Group C ( $10 \pm 4$  mm;  $P < 0.001$ ). Group SA ( $92 \pm 7$ ) had a higher Lysholm score than Group C ( $86 \pm 11$ ;  $P < 0.01$ ). Group SA (jump ratio  $1.00 \pm 0.1$ ) had better jumping ability than Group C ( $0.93 \pm 0.10$ ;  $P < 0.01$ ), whereas running showed the best correlation with the level of activity. Muscle strength was similar for the groups.

**Conclusion:** Repair and augmentation of acute ACL rupture results in superior stability and knee function that makes return to competitive sports possible.

## Stereophotogrammetric (RSA) evaluation of anterior cruciate ligament reconstruction

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**Introduction:** A problem after anterior cruciate ligament reconstruction is a successive stretching of the graft with recurrent instability problems. Isometric positioning will probably improve the results, but the possibility of insufficient fixation or graft lengthening still exists. The RSA technique has been shown to be of value in evaluating micromotion down to fractions of millimeters in several studies. Our aim was to measure the sagittal laxity before and after an anterior cruciate ligament reconstruction in an attempt to localize the site of recurrent instability.

**Patients and methods:** Five consecutive patients were operated on with a reconstruction using the central one third of

ligamentum patellae including bone blocks from the tuberosity and the patella as a free graft. A measured isometric positioning and tension was used. The bone blocks were secured by heavy sutures of nonresorbable material tied over steel buttons. The femur and the tibia were marked with tantalum balls during a preoperative arthroscopy. Postoperative plaster treatment for 4 weeks was used. During the operation the bony ends of the graft were marked. Measurements were made before reconstruction and 1 year postoperatively using passive standardized sagittal provocation. A reference examination of the position of the graft was made postoperatively. Motion between the femur and tibia, as well as the fixation of the bone blocks, was measured.

**Results:** The mean preoperative and postoperative total sagittal laxity, as defined by motion between the femur and the tibial eminence, was  $7.2/5.7$  mm at 50 N,  $11.6/6.7$  mm at 100 N, and  $14.1/6.8$  mm ( $P < 0.03$ ) at 150 N, respectively. No significant motion occurred between the bony ends of the graft and the tibia or femur, respectively, during the first year. All the patients were clinically stable after 1 year.

**Conclusions:** RSA provides an accurate technique to measure the true sagittal instability between the femur and the tibia without interference of soft tissues. The reconstructive procedure used resulted in a physiological laxity with a distinct end point resistance after one year. The technique to anchor the graft was found to be sufficient when using postoperative plaster treatment.

## Late results after reconstruction of the anterior cruciate ligament by using a meniscal graft

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Between 1950 and 1972, 21 persons were operated on with cruciate ligament repair using a meniscal graft at a local hospital (Hämösand). We have reinvestigated 19 of these (2 persons were dead and 1 was not relocated). In 16 cases the medial meniscus was used, in the others the lateral meniscus. Postoperatively, all were treated with immobilization in a plaster cast for 4–6 weeks.

Most data were received by telephone interview; only 7 patients were able to come to the hospital for an examination.

The median age at operation was 31 (20–63) years. There were 18 men and 1 woman. Six patients were reoperated on: 1 arthroplasty, 1 arthrodesis, 1 raphi of the graft, 1 reconstruction with the other meniscus after 10 years, 1 extraarticular stabilization, and 1 lateral TAM.

The interviews were based on Lysholm's score. The median score for the whole group, excluding 3 patients (1 arthroplasty, 1 arthrodesis, and 1 with sequelae after a CVL) was 67 (26–100). Most of the patients described some problems with the knee from instability and/or arthrosis; only 5 patients could use the knee in unrestricted activity.

## A concept for reconstruction of the anterior cruciate ligament in athletes by using a bio-logic material

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**Materials and methods:** Eighty-four competitive athletes with a symptomatic chronic ACL-deficient knee underwent intraarticular reconstruction of the ACL. A distally attached strip of fascia lata was used as a graft. The operative technique included notch plasty, as well as isometric positioning and secure fixation of the graft. The extensor mechanism was not compromised. Postoperative rehabilitation included continuous epidural anesthesia, immediate exercise, and protected, gradually increasing stress of the graft. The aim of the sports-oriented rehabilitation was to return the patient to his preinjury level after 6 months. Subjective and objective evaluation including functional tests were performed preoperatively and postoperatively at 6, 8, 10, 12, 24, and 36 months. The follow-up period varied between 6 and 43 months.

**Results:** Stability measurements showed a mean decrease from 5.9 preoperatively to 1.0 mm at 6 months and 0.9 mm at 24 months, respectively. All the test results were improved. Muscle strength, jumping ability, and cutting ability returned to preinjury levels within 6 months of surgery in most cases. Eighty-two percent of the athletes returned to their own sport at a mean of 6 months after surgery. Seventy-six percent of the patients returned to competition at preinjury level in their sport at a mean of 6 months postoperatively. Minor complications were noticed in 9 patients. Three (4 percent) graft ruptures occurred.

**Conclusion:** This concept provides the possibility of a rapid return to competitive sports, involving cutting. A long-term follow-up will show whether or not the stability and improved function are permanent.

## Reconstruction of the anterior cruciate ligament using the patellar tendon: A 5-year follow-up

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**Introduction:** A great number of reconstructive procedures for the anterior cruciate ligament (ACL) have been described. Grafts from the patellar tendon have a strength similar to that of the ACL. There are indications that the patellar tendon regenerates after graft removal. We have used the patellar tendon in reconstructive surgery of the chronic ACL-deficient knees.

**Patients:** From 1982 through 1984, 39 patients were operated on with a reconstruction of the ACL using the patellar tendon according to Clancy. Most of the patients also had a

lateral capsular reinforcement with fascia lata. The indication for surgery was a disabling anterior instability of the knee with positive Lachman and pivot shift tests. Physiotherapy and a knee brace were tried preoperatively in most cases. Arthroscopy with meniscal surgery, when indicated, was performed in all the cases. The mean preinjury activity score (Tegner) was 6.9. After the injury, most patients were unable to participate in any kind of sport. The mean preoperative knee score (Lysholm) was 67. Thirty-six patients were followed-up after 5 (4–7) years. Two patients were dead and 1 was interviewed by telephone. At follow-up, a clinical evaluation including stability testing with Stryker knee-laxity tester and a Cybex test was performed.

**Results:** One patient was reoperated on with a synthetic graft and thus was a failure. The mean postoperative knee score was 90. The mean activity score was 5.0, and had thus dropped 2.5 levels from the preinjury level in 28 patients (2 patients had an improved level, 5 an unchanged one). Lachman's test was negative in 14 patients, slightly positive in 16 patients (9 had a hard end point, 7 had a soft end point). The pivot shift was negative in 28 patients. The mean anterior laxity measured with Stryker knee laxity tester was 5.7 ( $\pm 2.3$ ) mm, which as 2.1 ( $\pm 1.0$ ) mm more than the uninjured knee. Twenty-three transplanted tendons seemed to be intact, five were ruptured, and seven could not be assessed.

**Conclusion:** Most patients had a considerable reduction in disability as measured with the knee score, but only 4 patients were completely asymptomatic. Knee stability was assessed to be normal in only 14/36 patients.

## Anterior cruciate ligament reconstruction with a Dacron prosthesis

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**Patients and methods:** Sixteen patients (13 men, 3 women; mean age 28 [20–36] years) were evaluated 24 (8–53) months after an operation with Dacron prosthesis reinforcement of the anterior cruciate ligament. Eleven patients had sustained trauma from playing football and 2 suffered a downhill skiing injury. Three patients had been operated on earlier with suturing of the anterior cruciate ligament without reinforcement. One of these patients had also undergone a pes anserinus reconstruction. Before the Dacron prosthesis procedure was performed, 4 patients had been submitted for removal of a meniscus and 2 patients had undergone meniscus suturing.

Preoperatively, the patients were trained extensively. An intensity test with an Orthotron test machine was performed. Lysholm's and Tegner's scores were assessed, the latter also for the patient's status before the injury.

Postoperatively, these examinations were repeated. A test with Stryker's laxity tester was also performed, evaluating the operated on knee, as well as the contralateral knee.

**Results:** Mean Tegner score was: before the injury 8.8, preoperatively 3.3, and postoperatively 5.9. Mean Lysholm score was: preoperatively 63 and postoperatively 79. Mean Stryker value was 9 mm on the operated and 7 mm on the contralateral knee. The average sick leave was 4 months. The quadriceps strength of all the patients increased after the operation. Subjectively, 15 of the 16 patients considered the operation beneficial.

## Goretex versus Kennedy LAD in anterior cruciate ligament reconstruction: A preliminary report

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**Introduction:** During the last few years different techniques for artificial substitution of the anterior cruciate ligament have been developed. There are few, if any, prospective randomized studies where different methods are compared.

**Methods:** Forty patients with old anterior cruciate injuries were randomized to either Goretex substitution (N = 18) or Kennedy LAD augmentation (N = 23). The surgical approach has been identical using a modified over-the-top technique. Notch plasty has been performed in every case. Goretex patients were treated 2 weeks and LAD patients 4–5 weeks with a knee cast. Otherwise, similar rehabilitation programs were used.

**Evaluation:** All the patients are checked yearly using Lysholm and Tegner scores, arthrometry (KT-1000), degree of positive Lachman and occurrence of pivot shift. The median follow-up time was 3 (2–4) years.

**Results:** There have been no wound complications and no grafts have been removed. In the Goretex group, 7 patients have had recurring aseptic effusions and 3 of these are dissatisfied with their knees, and are considered to have insufficient grafts. In the LAD group, there have been no signs of synovitis or effusion, and all the patients are satisfied with their knees.

**Conclusion:** Most of the knees in both groups are stable. But because the Goretex method has been associated with effusions, it cannot be recommended in its present form.

## Knee

### Therapeutic laser treatment in gonarthrosis

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A randomized double-blind study was performed to evaluate the effect of therapeutic Ga-As Laser (1500 Hz) on the sub-

jective symptoms from medial gonarthrosis (radiographic Grades 2–4).

**Method:** Laser treatment for 20 minutes was given to 13 patients once a week for 6 weeks. The placebo group (n 13) received simulated laser treatment for identical lengths of time and intervals. Follow-up was performed 1 and 4 weeks after the end of treatment. The subjective opinions of reduction in pain at rest, pain on weight bearing, and walking ability were recorded on analogue scales. The opinions regarding improvement of pain at rest, pain on weight bearing, start pain, walking ability, stiffness, sleep disturbances, analgetic medication, and total evaluation of effect were recorded as none, moderate, and definite.

**Results:** One week after treatment the analogous scales revealed a significant reduction of all the symptoms ( $P = 0.05-0.007$ ) after laser treatment. The differences between the groups were not significant after 4 weeks. However, at that time the evaluation of the 3-grade scale regarding improvement revealed significant improvement after laser treatment of all the parameters except for stiffness ( $P = 0.05-0.007$ ).

**Conclusion:** Treatment of medial gonarthrosis with Ga-As laser had a positive effect on the subjective symptoms from the knee at least up to 4 weeks after treatment.

### Physiotherapy in medial gonarthrosis

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**Patients:** Forty-nine patients scheduled for surgery with moderate medial gonarthrosis and no symptoms from other joints of the lower extremities formed the group of the present study. Twenty-five patients were randomized to physiotherapy three times a week for 5 weeks to increase the strength of the quadriceps and hamstring muscles of the affected leg. Twenty-four patients were randomized to a control group with no physiotherapy. The aim was to see if physiotherapy had any measurable effect at this stage of arthrosis.

**Method:** A clinical examination focusing on pain and stability as well as a gait analysis of self-selected walking speed, single-stance phase, weight-acceptance time, and stance-knee flexion were made upon entry to the study and after 3 months.

**Results:** After 3 months, 16/25 patients in the physiotherapy group stated that the knee felt better as compared with none in the control group. In the treatment group, knee pain decreased, free-walking speed increased from 99 to 107 cm/s, and weight-acceptance time decreased from 15.4 to 14.7 percent of the gait cycle. No significant changes were seen in the control group between the first and second examination. There were no significant differences between the group means.

**Conclusions:** Walking capacity increased after physiotherapy in patients with moderate medial gonarthrosis and knee pain.

## Does a stem on the tibial component improve fixation of uncemented Freeman-Samuelson knee prosthesis?

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**Introduction:** To improve the fixation of the tibial component to bone, Freeman added a central intramedullary stem. We investigated the micromovements of metal-backed tibial components (Freeman-Samuelson MkII) with and without a stem.

**Patients and methods:** Twenty-one consecutive patients with a mean age of 68 (56–78) years at the operation were randomized to a metal-backed tibial component *with* (7 arthrosis, 4 RA) or *without* (3 arthrosis, 7 RA) a central intramedullary stem. All the operations were performed without bone cement. The patients were examined with roentgen stereophotogrammetry at 1 week and 6 and 12 months postoperatively. We recorded distal translation of the prosthetic center, maximum "lift-off," and total point motion (Ryd 1986) at a standardized point on the tibial plateau and the rotations of the prosthesis.

**Results:** At 6 months the average distal migration was 1 mm in both groups, and at 12 months the sinking was 1.1 mm in the group without a stem and 1.6 mm in the group with a stem (NS). Five of 10 tibial components without a stem displayed a proximal movement of one edge of the tibial plate from the underlying bone (mean 0.6 mm), as did three of 11 prostheses with a stem (mean 0.3 mm). The MTPM at 6 months was 2.2 mm in the group without a stem and 2.4 mm in the stemmed group. At 12 months, the MTPM in the unstemmed group was 2.6 mm and in the stemmed group 3.6 mm (NS). The mean rotations in the sagittal and frontal planes were about equal in the two groups (1°). The stemmed prostheses tended to display increased rotatory movements in the horizontal plane (internal/external rotation), without a stem 1.4°, with a stem 2.7° ( $P < 0.05$ ).

**Conclusion:** When two pegs and no cement was used, significant movements occurred during the first postoperative year in our patients. Adding a cylindrical stem to the metallic metal plate did not seem to stabilize the prosthesis.

**Reference:** Ryd, L. *Acta Orthop Scand* 1986;Suppl. 220.

## Irrigation systems for arthroscopic surgery

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**Introduction:** Due to the development of suction instruments, there is a need for better control of pressure and flow during arthroscopic surgery.

**Methods:** In a knee model, we studied flow and pressure during simulated arthroscopy and motorized surgery using various pumps (Sarns 5500, Crafon AP 10, Arthroautomat, Orthoconcept, and the 3M) or different types of gravity irrigation. Inflow took place through the arthroscope and outflow from the model through a Stille cannula. Two simultaneous pressures were recorded from the model with tip and dome transducers.

**Results:** The pressure/volume curves indicate differences between the pumps. Either volume (i.e., Sarns) or pressure (i.e., the Arthroautomat) will prevail, and only the 3M pump can combine these to a true automatic pump. This function, however, needs a separate pressure-monitoring cannula and special tubing. There are adequate safety systems if pressure rises due to blocking of the outflow in all the pumps, except the Sarns pump, for which we designed the elevated outflow. Suction outflow easily overcomes the pump capacity, and has to be balanced with reduction of suction pressure. In our own system, we use combined inflow and an elevated position of the outflow.

**Conclusions:** Both simple and sophisticated systems are available today that give better control of pressure and flow during arthroscopic surgery.

## High- and low-vacuum drains in total knee arthroplasty

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Deep-suction drains, used by most surgeons for preventing hemarthrosis and wound hematoma after total knee arthroplasty (TKA), are of two main types: high prevacuum (HV) and low vacuum (LV). HV drains are efficient and might overcome occlusion by blood clots, which could occlude LV drains. However, HV drains could increase venous bleeding, and there is also a higher risk of occlusion by soft tissue and also soft-tissue damage.

We have compared a high, prevacuum bottle system (Medinorm) with a system where a low vacuum is achieved by manually compressible bellows (Devac). In a prospective series of 82 patients (16 operated on bilaterally), the 98 TKAs were allocated at random to a HV or LV drain group. The tourniquet was not released until after the closure of the wound.

The bleeding in the HV groups averaged 862 (80–2,190) mL and in the LV groups 761 (120–1,760) mL. Thirty-eight units of blood were given in 18 of 35 unilaterally operated on patients in the HV group, compared with 25 units in 14 of 31 patients in the LV group. These differences are not statistically significant. There was one superficial infection in each group and one hematoma in the HV group.

**Conclusion:** There was a tendency towards less bleeding and less need for blood transfusion in the low-vacuum drain group.

## Hip arthroplasty

### Total hip arthroplasty in patients with CDH

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**Introduction:** THA in adults with a congenital and complete dislocation of the hip presents many challenging technical problems due to the distorted anatomy around the hip joint.

**Patients:** Fifteen THAs in 12 patients with CHD >100 percent according to Crowe were followed for 5 (1–7) years. The average age was 64 (36–80) years. Ten hips had been operated on with various types of osteotomy previously. Resection osteotomy of the femur and reimplantation of the trochanter was made in all the hips in order to place the acetabular cup at the site of the original acetabulum. Three patients had acetabular bone grafts.

**Results:** All the patients had preoperative walking pain that disappeared in 9/15 hips, improved in four, and was unchanged in two. Walking capacity was improved in 5 patients and was unchanged in the rest. The use of walking aids was unchanged. Seven out of 8 patients with preoperative low back pain improved dramatically. Four hips dislocated postoperatively; two of these had closed and two open reduction. One of these contracted a deep gram-negative infection that responded to conservative therapy. No clinical or radiographic signs of loosening have been noted.

**Summary:** THA in complete CDH is a technically difficult operation that in combination with the frequency of complications stresses the importance of patient selection, preoperative planning, and detailed information to the patient concerning expectations and postoperative improvement.

### Prophylactic treatment of heterotopic bone formation after hip arthroplasty

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**Introduction:** Prophylactic treatment with NSAID's has been effective in preventing heterotopic bone formation (HBF) after total hip arthroplasty (THA). Reduced range of motion, impairment of function, and failure due to HBF has been reported in 3–10 percent after THA. This study was performed to examine the effect of prophylactic treatment with diclofenac (Voltaren®) on the occurrence of HBF and the clinical importance of HBF after hip arthroplasty.

**Patients and methods:** Totally, 100 hip in 98 patients (59 males and 39 females) with coxarthrosis were operated on with a Lubinus-SP total hip prosthesis. The study was double-

blind with 50 diclofenac/50 placebo. Diclofenac was given 75 mg i.m. preoperatively and postoperatively on the operation day and 50 mg per os three times daily for 6 weeks postoperatively. Radiographic examination was performed postoperatively and 3 months after the operation, and all newly formed calcifications were measured. A clinical examination, a Harris hip score, and radiography were performed 1–2 years after the operation.

**Results:** (the clinical follow-up involves 92 patients):

Pain	HBF 0	HBF <20 mm	HBF >20 mm	Harris score	Pain
Placebo (%)	24	10	66	84	8
Diclofenac	96	4	0	86	0

The treatment with diclofenac prevented heterotopic bone formation in a significant way. Three patients with four hips had serious problems with pain; these patients had developed HBF, and they had not been treated prophylactically with diclofenac. The difference between the groups was not statistically significant, but in our opinion a general prophylaxis should be considered for patients with arthrosis of the hip.

### Migration of cemented acetabular prosthesis: A roentgen stereophotogrammetric analysis

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**Introduction:** Because of variations in bone quality, the preconditions for fixation of the hip prostheses may differ in patients with primary coxarthrosis and secondary degenerative joint disease. To evaluate the significance of the preoperative diagnosis for the primary fixation of a cemented acetabular prosthesis, we recorded the micromovements in a group of patients operated on because of arthrosis (A), rheumatoid arthritis (RA), or sequelae after fracture of the femoral neck (SFFN).

**Patients and methods:** Fifty patients (51 hips: A 20, RA 15, and SFFN 16 hips) were operated on using cemented Lubinus SP prosthesis. Roentgen stereophotogrammetric examinations were performed 1–3 weeks, 6, 12, and 24 months postoperatively.

**Results:** Thirty-one of 51 acetabular cups displayed micromovements during the observation period. Eight of 20 (A), 11 of 15 (RA), and 12 of 16 (SFFN) cups migrated in the three groups, respectively. Most of the migrating cups moved in the proximal direction, and the migration was most pronounced during the first 6 months. The mean proximal displacement during that period was 0.3, 0.4, and 0.5 mm for the three groups.

## Postoperative stability of press-fit acetabular prostheses

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Biocompatibility, close-contact prosthesis-bone, and a stable fixation during the postoperative course are important prerequisites to obtain bony ingrowth into porous-coated implants. Stable fixation of cemented acetabular cups is possible to achieve, but seems more difficult concerning noncemented threaded acetabular prostheses. This study aimed to investigate the micromovements of noncemented press-fit cups.

*Patients and methods:* Fifteen men and 6 women (22 hips) operated on with a THA because of coxarthrosis were studied. The acetabulum was replaced with a titanium wire-mesh-coated hemispheric component (Harris-Galante). The prosthesis was fixed to the bone using a press-fit design and 2-4 titanium screws. Tantalum markers were inserted into the pelvic bone and the acetabular polyethylene insert. Roentgen stereophotogrammetric examinations were performed 2-14 days, 6 weeks, 3, 6, and 12 months postoperatively.

*Results:* Nineteen prostheses were stable during the first 6 postoperative months. One cup displayed a progressive tilting that was detected 6 weeks postoperatively. Two implants displayed significant migration 6 months after the operation. Further 6 cups, which seemed to be stable during the first postoperative 6 months, exhibited migration during the later part of the observation period.

*Conclusions:* Stable primary fixation of the prostheses suggests the presence of bony ingrowth in some of the implants. Late occurrence of measurable micromovements may be caused by poor bone quality, inadequate acetabular preparation, and too small contact-area prosthesis-bone and/or minimum postoperative movements not detectable until 6-12 months postoperatively.

## Integrity of the gluteus medius muscle after the transgluteal approach in total hip replacement

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The postoperative integrity of the conjoined aponeurosis of the gluteus medius and vastus lateralis was studied in 97 consecutive total hip replacements (95 patients), performed via a transgluteal approach. Following implantation the gluteal/vastus aponeurosis was sutured with interrupted sutures of 0.4 mm polydioxanon (PDS<sup>TM</sup>), and the repair was reinforced by an osteosuture using a mersilene band. During closure, metal sutures were placed in the gluteal/vastus aponeu-

rosis, on both sides of the suture line, and the integrity of the repair was assessed on radiographs taken immediately postoperatively, after 2 weeks, 2 months, and 1 year after the operation. Separation between the markers occurred in about half of the patients, but gross separations were rare. Because most separations showed a progressive increment, elongation of the sutured aponeurosis might be a more common mechanism than perioperative injury to the neurovascular pedicle. Moreover, the degree of separation did not correlate with pain, and Trendelenburg gait was significantly increased only in the group of patients having a separation exceeding 2 cm, indicating that a moderate gluteal elongation may be readily compensated for.

## Bipolar prosthesis in revision after cervical hip fractures: A 2-6-year follow-up

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*Material:* Ninety-nine bipolar hip prostheses (Charnley stem and metal-backed socket) were used in revision of previously nailed cervical hip fractures in 97 patients aged 63-96 years (median 83 ± 6 years) from 1983 through 1986. The indications were old age, impaired general health, or decreased mobility. For other patients, total hip replacement was the usual procedure.

*Results:* Forty-seven patients were dead at the last follow-up. Eight patients died within the first 3 months, 23 within 1 year, and 9 within 2 years postoperatively. Two hips dislocated, both within the first 2 weeks postoperatively. One had closed, whereas the other had an open reduction. No revision for other reasons was made. Of all the patients at the latest follow-up, 15 had pain in the operated on hip requiring analgetics, 50 had a flexion in the operated on hip of 90° or more, and 31 had an ADL activity equal or better than before the prosthesis operation.

We conclude that bipolar hip surgery is a safe and satisfactory alternative when revising a failed cervical hip fracture in the elderly or inactive patient.

## Revision of Lubinus THR during 10 years

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*Introduction:* In spite of few published reports, the Lubinus THR comprised 40 percent of the hip implants in Sweden during the previous 10 years. Reoperations during the first 10 years after primary THR are presented with reference to the 5-year radiographic follow-up and cause for reoperation.

*Material and methods:* Totally, 189 Lubinus THRs were included in the study. Follow-up, including radiographs, was

performed 5 years postoperatively. Twenty patients had died and 131 attended. The charts of all the patients who underwent revision during the 10-year period up to and including 1988 were studied and cross-matched with the available material from the 5-year follow-up.

**Results:** Three patients (1.5 percent) died. Two patients (1 percent) had an early deep infection, but a successful early revision THR. Three patients (1.5 percent) had dislocations during the first year. Fifteen patients (8 percent) had other complications without sequelae. At 5 years, three implants were obviously loose, seven radiographically at risk—none of the latter has so far needed revision. Two of the three have been exchanged. A total of 10 patients (5 percent) had a revision THR during the 10-year period. Two early and one late infection, 1 case of recurring dislocation, one early and five late loosening (once cup, two stems, three of both). One hip was transformed later into a well-functioning Girdlestone hip. The revisions are evenly spread over the 10 years. No mechanical failures (fractures, wear) leading to revision have been seen with 1,800 Lubinus THRs implanted during the last 10 years.

**Conclusions:** The system is reliable. The revisions are scattered over the whole period. Very little information was gained at the 5-year follow-up. One can expect approximately one revision per 200 primary THRs per year during the first 10 years. There is a risk that the yearly need for revision may increase after 10 years.

## Failure of THR in Sweden: A multicentric study

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Multicenter clinical trials have an important role in the assessment of total joint replacement. The primary reason for these studies is the need to have access to a large number of patients. All the failures after total hip replacement performed in Sweden between 1979 and 1986 have been analyzed in a prospective study. Medical records from every reoperation are documented and analyzed by computer. This multicenter clinical trial has shown that both patient-related, surgical and implant-related parameters are of utmost importance for rate of failure. There is an increasing number of revisions after total hip replacement in Sweden between 1979 and 1986. Male sex and young age increase the risk of revision. The primary diagnosis is very important for type of failure. The risk of deep infection is small, but increases with number of previous operations. Aseptic loosening has emerged as the main problem, and it constitutes 74 percent of all the revisions. Prosthetic design is of utmost importance for rate of failure, and significant differences exist between different types with respect to long-term survival.

## Upper extremity

### Arthroscopic versus open acromioplasty: A preliminary report

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Twenty patients, 27–56 years of age, suffering from shoulder impingement syndrome and without rotator cuff tears were randomized to arthroscopic or open acromioplasty. All the patients were examined radiographically, studying the shape of the acromion and occurrence of osteophytes before and after surgery. All the patients were examined by arthroscopy.

Arthroscopic procedures showed 20 percent shorter surgery time and equally good resection of the acromion and osteophytes as measured on special radiographs. Patient satisfaction was higher in the arthroscopic group due to significantly better immediate postoperative function and lack of immobilization. Routinely, the arthroscopic procedures had fluid leakage producing a prominent subcutaneous edema, which was absorbed during the following day, and caused no problems.

At 3 months' follow-up, the arthroscopic group showed a significantly better active range of motion, fewer residual symptoms, and an earlier return to work.

### Recurrent anterior shoulder dislocation and subluxation: 2 year results of 122 cases treated with transfer of the coracoid process (Bristow-Latarjet)

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**Patients and methods:** During the years 1980–1985, 122/124 patients with recurrent anterior shoulder dislocation and subluxation, operatively treated with the Bristow-Latarjet procedure at our hospital, had a follow-up after 2 years with a clinical and radiographic examination.

**Results:** In 2 cases recurrence of the dislocation occurred (1.6 percent). Subjective assessment of the results were excellent in 107 cases (88 percent), good in 13 (10 percent), fair in 1 (1 percent), and poor in 1 case (1 percent). The objective score according to Rowe was excellent in 107 cases (88 percent), good in 10 (8 percent), fair in 3 (2 percent), and poor in 2 cases (2 percent).

The mean postoperative decrease of motion was (operated on shoulder compared with nonoperated on one) flexion: 0° outward rotation; arm adducted: 8°, arm abducted 8°. Inward rotation (measured as difference in reached spinal processes); 0.9 s.p.

Radiographic examination showed bony healing of the transplant to the scapular neck in 103 cases (84 percent) and nonunion in 17 cases (14 percent). In 1 case the transplant had migrated less than 1 cm from its original position, and in 1 case more than 1 cm. No serious complications occurred. One patient had further surgery due to persisting instability.

*Conclusion:* This is a short-term follow-up with good results. A longer follow-up period revealing the incidence of arthrosis is necessary. Further, this method is technically demanding, and it is nonanatomic. Complications, as well as difficulties at reoperation, have been described.

### Long-term functional results after modified Bristow procedure for recurrent dislocation of the shoulder

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Shoulder function in terms of range of motion, isokinetic muscular performance, subjective rating, and radiographs were analyzed in 43 patients with an average follow-up time of 6 years after a Bristow-Latarjet procedure due to recurrent dislocation of the shoulder. The functional analysis and muscular performance of the injured shoulder was compared with the opposite healthy shoulder in each patient. Ninety-five percent of the patients assessed the overall subjective result after surgery as good or excellent. Totally, 31/43 patients had no pain or discomfort at all, while the remaining 12 patients complained of moderate pain induced by activity. Two patients suffered from recurrent dislocations. Range of motion and isokinetic peak torque at 30° and 90° per second in all directions did not differ significantly between the injured and healthy side. However, 4 patients demonstrated considerable decrease in range of motion and peak torque, and they also complained of pain due to activity. The subjective discomfort in these patients was thought to be caused by a conflict between the implanted screw and the humeral head during motion.

### Osteochondritis dissecans of the elbow: A long-term follow-up study

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Fifteen patients with osteochondritis dissecans of the capitulum of the humerus have been followed up on an average of 20 years. The case histories and radiographs were reviewed. Two patients had signs of minor arthrosis and 1 of major arthrosis. Other radiographic changes, such as regional decalci-

fication, irregular joint surface and/or free bodies or both were often seen. Decreased range of motion, especially in extension, was noted in several patients, but caused only minor disabilities. Osteochondritis dissecans in the elbow seems to differ from the same lesion in the knee, because the knee is a weight-bearing joint.

## Hip

### Long-term results after nailing and after femoral neck osteotomy of a slipped capital femoral epiphysis

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The results of nailing of a slightly slipped capital femoral epiphysis in 25 patients and wedge osteotomy of the femoral neck of a severely slipped capital femoral epiphysis in 22 patients are reported. The average follow-up time is about 35 years in both groups. In both groups the patients were operated on when they were, on an average, 14 years of age. At follow-up, 1 patient in the nailing group has been reoperated on with an osteotomy and 1 with an endoprosthesis. In the osteotomy group, there were early complications of chondrolysis and avascular necrosis in 6 cases. One patient has been operated on with arthrodesis after 3 years and 6 patients with an arthrodesis, reosteotomy, or endoprosthesis after 30 (25–35) years.

## Spine

### Simplified treatment for subacute back pain: Result of a structured treatment program

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*Introduction:* In Spri report No. 188, "Back Pain," good results were reported in Gothenburg with a simple treatment program for patients with low back pain (LBP). A special LBP clinic associated with the orthopedic department was formed with the aim to take care of patients referred by primary care units. The present study, supported by the National Welfare Board, has been able to show that good results with great economic gains can be reached even without a special LBP clinic, provided the patients are taken care of adequately at the primary care units.

*Material and methods:* Twenty physicians at the primary care unit in three communities—Group I—were chosen for the trial period March 1986 to February 1987. Three other communities were selected for comparison—Group II. The

same treatment program as in Gothenburg was used. The main aim was to increase the intensity of work recovery and to evaluate the effect on the duration of sick listing.

**Results:** During the 12 months, 3,368 sick listings (2,624 individuals) with LBP were registered. Thirty-five percent were sick listed more than 1 week and needed a doctor's certificate to obtain compensation. The 1,176 certificates were signed by 245 different physicians, 302 (26 percent) of those by physicians belonging to the study. The results showed shorter sick listing, fewer chronic LBP patients (sick listing more than 3 months), and fewer back invalids (sick listing more than 1 year) in Group I than in Group II.

**Conclusions:** It is most important to increase the knowledge around adequate back care and to increase the cooperation between various instances in order to get people back functioning again. The primary care physician must realize the crucial importance of *time*, and must avoid unnecessary sick listing. An orthopedic surgeon and his team must be available for consultations, for continuous education of physicians, and for quick admission of referrals from primary care units.

### Low back pain after loading with special reference to microfractures

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The aim of the present study was to show whether microfractures are a common cause of low back pain after heavy loading.

**Patients and methods:** The patients were collected over a period of 1 year and the selection criteria were as follows: 1) no earlier known low back pain in healthy patients; 2) age range 20–55 years; 3) the heavy load should be heavy lifting within physiologic limits; 4) the low back pain should arise during actual lifting and should not be more than 5 days old when the patient was first examined.

Ten patients, 7 men and 3 women, with a mean age of 34 (20–54) years, fulfilled the criteria. All of them agreed to take part in the study; they were examined clinically and investigated with radiography and scintimetry using intravenous administration of 440 MBq <sup>99m</sup>Tc-methylene diphosphonate (<sup>99m</sup>Tc-MDP) within 2–4 weeks after the appearance of pain.

The diameter of the spinal canal in the lumbar spine was measured on the plain lateral radiographs.

**Results:** There was no radiographic evidence of fractures. There were no signs of increased uptake on scintimetry.

There was a significant difference (Student's *t*-test) regarding the diameter of the lumbar vertebral canal between the 10 patients with low back pain as compared with a nonpatient group of 10 patients with no history of low back pain.

The available space in the lumbar vertebral canal has been

suggested to be of great importance in the symptomatology of disc lesions and in response to treatment (Porter et al. 1978). Hence, it is more likely that low back pain after heavy loading within physiologic limits may originate from the soft tissues than from microfractures of the lumbar vertebrae.

### Back pain in pregnancy with special reference to the sacroiliac joint

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**Introduction:** During pregnancy the pelvic joints are affected by hormones, and pain is believed to originate from the sacroiliac joints. The purpose of this study was to identify symptoms and signs and especially the pain drawing pattern among pregnant women.

**Material and method:** Totally, 338 pregnant women who visited an antenatal clinic in Malmö during 1 week were interviewed with a structured formula. Women with back pain also completed a pain drawing and were examined by an orthopedist.

**Results:** In all, 171/338 women had back pain at the examination. Pregnant women with sacroiliac pain had a typical pain drawing with lumbosacral stabbing and smoldering pain radiating in one or both buttocks and upper dorsal aspect of the thigh. It was found that women with sacroiliac pain and no other pain had hooking problems in the swing phase when walking.

**Prognosis:** Twenty-seven percent of all the pregnant women had persistent pain 1 year after delivery. The prognosis was not related to symptoms or signs, but to number of pregnancies, heavy work, and former back pain.

### Mobility of the lower lumbar spine after posterolateral fusion determined by roentgen stereophotogrammetric analysis

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**Introduction:** Spinal fusion may yield pain relief in symptomatic spondylolysis, disc disorder, and facet joint arthrosis in the lower lumbar spine. Residual mobility between the fused vertebral segments can be detected by roentgen stereophotogrammetric analysis (RSA) with high accuracy (1). In an attempt to determine when maximal intervertebral stabilization occurs in patients with no prior spinal surgery, RSA was used in this study of posterolateral fusions in the lower lumbar spine.

**Patients:** Eight men and 3 women with a median age of 34 (21–59) years and no prior spinal surgery had a posterolateral fusion, including application of tantalum indicators for the RSA between L5-S1 or L4-S1. A lumbar orthosis was used for 5 months after surgery. Eight patients had spondylolysis-olsthesis and 3 an intervertebral disc disorder with lumbar and/or radiating pain.

**Methods:** All the patients were followed with RSA monthly for 6 months and 21 year postoperatively. At each RSA the patients were examined in the supine and erect positions, and the translation movements of the vertebrae between these positions were calculated. Conventional radiographs were taken 6 months and 1 year after surgery.

**Results:** In the 8 patients with osseous fusion radiographically, the sagittal and vertical translations between the fused vertebral segments began to decrease 3–6 (sagittal: median 5, vertical: median 4) months after surgery. However, the time for rigid fusion seen at RSA varied between 3 months and 1 year, and in 4 patients either a sagittal or a vertical translation of 0.7–1.8 mm persisted at 1 year. The transversal translation was mostly negligible and it could not be correlated with the time of the fusion. In the 3 patients with poor fusion radiographically, no rigid fusion at RSA was obtained, although a reduction of the mobility occurred successively in 1 patient.

**Discussion:** The mobility of the lower lumbar spine decreases within 6 months after a successful posterolateral fusion (1). This seems to be verified by this study in which decreased intervertebral translations could be visualized by RSA 3–6 months after surgery. A radiographically healed posterolateral fusion in patients with no prior spinal surgery may either be rigid or permit a small sagittal or vertical translation, probably exerted through a spring effect.

**Reference:** 1. Olsson et al. *Clin Orthop* 1977;129:181.

## Painful disk disruption

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Thirty-five patients suffering from chronic lumbar radicular syndromes were evaluated with discography and/or CT-discography and with the External Percutaneous Transpedicular Fixation test. Repeated diagnostic tests through the years had not led to precise diagnosis or treatment. CT scans and lumbar myelograms were normal.

All the patients had pain for more than 3 years, and 9 of them for more than 10 years. Organic pathology and reproduction of pain that could explain the patient's symptoms was identified in 32 of the patients. CT discography is valuable to adequately identify abnormal levels in patients considered for fusions. Fixation test of the suspected segments relieved both the back pain and sciatica in 13 of 15 patients. No complications occurred. Fixation test performed under local anesthesia is a safe and reliable tool for predicting the outcome of fusion.

## Discectomy on outpatient basis

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The preliminary results after automated percutaneous discectomy (Nucleotome, Surgical Dynamics) or open microsurgical discectomy performed as an outpatient procedure are presented.

**Material:** Indications for surgery was sciatic pain not responding to conservative treatment during at least 3 months, positive SLR, and neurologic deficit in myotome and/or dermatome. Disc herniations were verified with CT scans combined in some instances with plain or CT discography and MRI in 20 patients.

**Results:** All the patients operated on with open microsurgical technique had excellent results. Failures after percutaneous discectomy were reoperated on with microsurgical technique. The failures were found to depend on entrapment of the extruded disc material. No complications occurred in any of the patients. In both groups all the patients declared that the outpatient procedure was satisfactory, and no one had any difficulties in managing their home situation postoperatively.

**Conclusions:** Outpatient discectomy proved to be a safe procedure performed either percutaneously or with open microsurgical technique. The outcome of open microsurgical discectomy is dependent on advanced technique. Percutaneous discectomy depends on thorough selection of patients to avoid entrapped disc fragments. The selection of method is improved by the use of discography and state-of-the-art MRI.

## Results of reoperations for sciatica: A prospective study

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**Introduction:** The results of reoperations for sciatica are generally considered to be inferior to those after primary surgery. However, as far as we know, there are no previous prospective studies on clinical and radiologic predictors in repeated surgery.

**Patients and methods:** We analyzed the cases of 51 consecutive patients undergoing secondary spinal surgery for sciatica. The mean age at primary surgery was 37 years, the interval between the operations 8 (0.5–33) years, and follow-up 3 (0.1–7) years. The analyses included pain drawing, kyphometry, myelography, and computerized tomography.

**Results:** Twenty-seven patients were significantly improved after the second operation. The most important parameters associated with a successful outcome were the existence of a pain-free interval after the operation and a postural variation and localization of pain. Clinically, the straight leg-

raising test was highly correlated with the postoperative result, whereas peripheral neurologic deficits were not.

**Conclusion:** These patients represent a wide variety of spinal pathology, and the clinical presentations are often very complex. We found that a systematic use of pain drawings is helpful in the preoperative assessment. Interestingly, the radiographic findings were of diagnostic importance only if the changes were corresponding to the physical signs.

## Size of lumbar disc hernias in relation to sciatic symptoms

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The intraindividual relation between the size of lumbar disc hernias and sciatic symptoms were studied in thirty patients during conservative treatment of longstanding sciatica. In all patients the symptoms were in accordance with the location of herniations as shown by CT-examinations.

CT-examinations were performed before (CT1) and at 3 (CT2) and 24 (CT3) months after start of treatment. The relative size of the individual disc hernias was expressed as an index relating the size of the hernia to the size of the spinal canal. The relative size of the disc hernias diminished ( $P < 0.001$ ) from CT1 ( $m = 0.22$ ;  $SD = 0.11$ ) to CT2 ( $m = 0.12$ ;  $SD = 0.08$ ) and from CT2 to CT3 ( $m = 0.09$ ;  $SD = 0.07$ ;  $P = 0.01$ ). Sciatic pain was related to the size of the hernia ( $P = 0.02-0.001$ ). SLR was related to the degree of sciatic pain ( $P = 0.001$ ) but not to the size of the disc hernia.

## Radiographically occult cervical spinal lesions in fatal head injuries

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Early recognition of cervical spinal lesions in multitraumatized patients, notably comatose patients with head injuries, may be essential for the late clinical outcome. Reports in the literature indicate that soft tissue lesions may be encountered that cannot be recognized on routine radiographs. Clinically, seemingly innocuous cervical spinal "sprains" may entail significant long-term morbidity.

**Material and methods:** Twenty-two cervical spines from road traffic accident victims in the age range of 14-76 years (mean 32 years; 19 males, 3 females) were studied. Eight of the deceased died of craniocerebral injuries alone, and 14 had concomitant multitrauma. During forensic autopsy, all the macroscopic lesions were meticulously mapped. The skull base and cervical spine with all the surrounding soft tissues

were frozen *in situ* with dry ice. Radiographs of the specimens were taken in orthogonal and oblique planes, mimicking realistic clinical conditions. In equivocal cases, additional CT studies were performed. All the frozen specimens were cryoplaned in the sagittal plane; overview photographs and closeups were taken at submillimeter intervals.

**Results:** A surprisingly high incidence of radiographically "occult" lesions was detected. Some minor bony lesions and avulsions were missed on the radiographs. More importantly, clinically potentially relevant soft-tissue injuries were notoriously underrated on the radiographs. Discoligamentous injuries, such as multilevel annular disc tears, frank ruptures of the discs, or avulsions of their end plates, were usually missed. Ruptures of ligaments, joint capsules, and blood vessels, hemorrhage in the facet joints and root canals, as well as paraspinal muscle hematomas and near-root avulsion usually went undetected on radiographs and CT scans.

**Conclusions:** The high incidence and the pathoanatomically consistent pattern of cervical spine lesions associated with head injuries and multitrauma calls for increased clinical awareness and "tailored" diagnostic routines. Magnetic resonance imaging has shown a promising potential of unveiling radiographically "hidden or occult" spinal soft-tissue injuries. Even minute bony avulsions on CT scans may frequently indicate major concomitant discoligamentous lesions.

## Pediatric orthopedics

### Ultrasonic evaluation of the pathologic anatomy in congenital clubfoot

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Ultrasound was used to investigate the anatomy of congenital clubfoot. The findings in a child with a unilateral fixed pes equino-varus is described.

**Results:** In the deformed foot the talus was displaced forwards and rotated in a plantar direction. Flexion and extension of the foot resulted only in a displacement in the joint between the talar and navicular bones. No movement was observed in the talocrural joint, and the relation between the navicular and cuneiform bone remained intact. Compared with the control side, the talus was found to be dysplastic, with delayed development of the ossification center.

**Conclusion:** The pathologic anatomy observed showed that reduction of the talar dislocation should be performed by distracting the talocrural joint followed by posterior reduction of the talus combined with dorsiflexion to reduce the plantar inclination of the bone. Routine ultrasonic evaluation of pathology and therapeutic result is an advantage in the management of clubfeet.

## Occurrence and development of hip instability during the first days of life

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A consecutive study of hip-joint stability was performed in 109 newborns. The children were manually examined during the first and fifth days of life by two trained independent observers using the Ortolani maneuver. On the same occasions, dynamic ultrasonic evaluation was used to determine the true degree of hip instability.

**Results:** Combining both manual examinations, only 28 percent of the babies were considered completely stable in both hips. This contrasts to the findings during ultrasonic control where only 7 percent ( $n = 8$ ) of the hips were found to have a significant instability ( $> 15$  percent). Moreover, in three of the eight unstable hips, no instability was detected by the clinical examiners.

Both the clinical and the ultrasonic examinations detected a 50 percent increase in hip stability from the first to the fifth day of life.

**Conclusions:** Manual examination of neonatal hip instability (NHI) results in a vast overdiagnosis, whereas unstable hips still may be undetected. Already during the first 5 days of life, a considerable increase in hip stability can be expected in children born with NHI.

## Hip instability—a prerequisite for acetabular dysplasia: A case report

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A 9-year-old girl with Down's syndrome was admitted with a traumatic dislocation of the right hip. After reduction of the hip, radiographic examination showed normal symmetric development of both hips. Due to a marked connective tissue hyperelasticity, she was treated in a hip spica with the legs abducted for 4 weeks. Almost immediately after mobilization, the hip redislocated. Conservative abduction treatment was continued for 6 months without gaining complete hip stability. The unstable hip was then accepted, and the girl was mobilized. Surgery was not possible due to grave cardiac disease. There were no peripheral neurologic abnormalities.

At the 2-year follow-up, the hip was dislocated. During the 2-year period of increasing instability, the normal acetabular roof had developed severe dysplasia. The girl was walking without pain with correction for the leg-length discrepancy.

**Conclusion:** It is evident that hip instability definitely leads to acetabular dysplasia not only in infants, but also in older children. In our opinion hip instability is a prerequisite for the development of hip dysplasia, and we do not consider that acetabular dysplasia exists as a separate entity.

## Trauma

### External fixation followed by interlocked nailing in open tibial fractures—increased risk for osteomyelitis

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**Patients:** Eighteen patients, mean age 36 (22–76) years, with tibial pseudarthrosis were treated with drilling and interlocked nailing. Twelve patients were primarily treated with a cast, lag screw, plate, or Ender nailing (9 closed, 2 open Grade 1, and 1 Grade 2). Six patients had an external fixation with or without skin grafts (1 open Grade 1, 4 Grade 2, and 1 Grade 3).

**Results:** All the pseudarthroses not primarily treated with an external fixator healed without complications after 17 (12–24) months. All 6 patients primarily treated with an external fixator had minor pin infections successfully treated with antibiotics. Removal of the frame was performed 9 (8–14) weeks postoperatively; and after another 31 (12–70) weeks, all the patients had a predrilled interlocked nail. Two pseudarthroses healed without any complication, whereas 4 developed osteomyelitis, presenting same cultures as from the pins.

**Conclusions:** External fixation is considered to be the method of choice in open Grades 2 and 3 fractures of the tibia. Many studies have documented the effectiveness of intramedullary nailing in the treatment of nonunited tibial fractures. In this study, 4 out of 6 patients developed osteomyelitis. All the patients had been treated by a sequential procedure of external fixation and intramedullary nailing. In tibial pseudarthrosis after open fractures primarily treated with an external fixator, alternative methods to intramedullary nailing should be considered.

## Malrotation in tibial fractures

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A fluoroscopic method using the femoral condyles and the medial malleolus for determining the lines of reference of the proximal and distal parts of the tibia was used for assessing the malrotation in 38 consecutive tibial fractures. The difference in torsion between the respective tibiae of each subject was calculated, and the result was compared with the values obtained from measurements in 100 normal adults with the same fluoroscopic method. A tibial torsion difference exceeding the normal mean  $\pm 3$  SD was found in one fourth of the patients. The maximum difference was 49° as compared with 15° in normal adults. To reduce the risk of disabling malrotation, measurement of tibial torsion in the operating theater is recommended.

With the use of the above-discussed technique for assessing tibial torsion, it is proposed that closed fractures or open fractures with uncertain points of reference at the fragment ends should be reduced so that the right tibia is 2° more outwardly rotated than the left tibia. In this way, malrotation exceeding 15° can be avoided; and according to the normal distribution curve for tibial torsion difference, three fourths of the fractures will be reduced with a rotational deformity of less than 6°.

## External fixation of Colles' fracture: The influence of the configuration and tightening forces on the mechanical behavior

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In the treatment of comminuted or redislocated distal radius fracture, external fixation has been shown to give better results than conservative treatment. However, the frame should be simple and allow for secondary correction of the fracture in any plane without new pin insertion. Further, the torque moment (TM), used to lock the adjustable components, must be minimized to avoid mechanical failures, but high enough to lock the instrument, and thus reduce the risk of redislocation during the treatment period.

**Material and methods:** Using a fracture model (Hammer and Helland 1987), eight different AO configurations, the Hoffmann C-frame, and the Hammer minifixator were tested in a three-point bending test. The size of the pins (3 mm) and the deformation rate were standardized. TMs were varied from 2 to 4 Nm, and the effective pin length (EPL) from 2 to 3 cm. The maximum load applied was 50 N. The rigidity and the permanent deformation were calculated from the load-deformation curve recorded simultaneously.

**Results:** 1) Of the eight different AO configurations tested, only one fulfilled the requirements of readjustability, rigidity, and load resistance. When TM = 2 Nm, the rigidity was 0.72–0.88 N/mm (EPL 3 or 2 cm) in the lateral plane and 1.04–1.56 N/mm in the AP plane. The PD was 14–15 mm in the lateral plane and 3–4 mm in the AP plane. 2) The Hoffmann C-frame had to be tightened with a minimum of 4 Nm to avoid early slippage. The rigidity of this frame was 0.71–1.28 N/mm (EPL 3 or 2 cm) in the lateral plane and 3.0–3.6 N/mm in the AP plane, but only up to 35 N, after which slippage occurred. The permanent deformation (PD) was 9–14 mm. 3) The corresponding rigidity values for the Hammer minifixator was 1.06–2.5 N/mm (EPL 3 or 2 cm in AP and lateral plane) when TM = 2 NM. This frame was the least sensitive to changes in TM and/or EPL. The PD was 2–5 mm.

**Conclusions:** When external fixation (EF) systems, which allow a variety of configurations, are used, it is important to select a simple frame that fulfills a reasonable level of load resistance and allows for secondary correction of the fracture without repositioning of the pins. The TM used to lock the adjustable components is of decisive significance; too high

tightening force increases the risk of mechanical failure and too low can cause frame dislocation. Besides TM and configuration (AO-frame), adequate pin length had a great importance on the behavior of the EF devices under a load.

## Evaluation of ankle joint stability: A radiographic study

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The purpose of this study was to assess the value of anterior talar translation (ATT) and talar tilt (TT) in diagnostic and therapeutic evaluation of ankle joint instability.

**Patients and methods:** The patient group comprised 120 patients with functional ankle joint instability and the control group 271 individuals with functionally stable ankles. Ankle joint stability has also been compared in patients with unilateral instability. The radiographic investigation has been standardized with stress radiographs, using the same method, instruments, and investigators.

**Results:** The ATT for males with functionally unstable ankles was 10.5 (8–15) mm and 7.3 (4–11) mm in the control group ( $P < 0.001$ ). The corresponding values for females were 11.3 (6–24) mm and 7.2 (3–12) mm ( $P < 0.001$ ). The TT was higher ( $P < 0.001$ ) in the functionally unstable ankle joints than in the control group, 10° (3–27°) and 3.2° (0–8°), respectively, for the males, and 11° (2–23°) and 4.3° (0–8°), respectively, for the females. The ATT in patients with unilateral functional instability was 11.1 (7–20) mm compared with 7.9 (4–11) mm on the stable side ( $P < 0.001$ ). The corresponding TT values were 9.5° (3–23°) and 4.4° (2–8°), respectively, ( $P < 0.001$ ).

**Discussion:** Mechanical instability can be defined as ATT  $\geq 10$  mm and TT  $\geq 9^\circ$ , or an ATT difference of 3 mm or more and TT of 3° or more between stable and unstable ankle joints. The conclusion of this study is that mechanical instability can be an important factor in the development of functional ankle joint instability. Standardized stress radiographs are of value in the diagnostic evaluation of ankle joint instability.

## Range of motion of the ankle joint in patients with chronic lateral instability of the ankle

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**Introduction:** The range of motion of the talocrural joint in patients with chronic lateral instability of the ankle (CLI) has not previously been reported. The aim of the present study was to evaluate the influence of CLI on the range of motion of the ankle joint.

**Patients and methods:** Twenty-nine patients with CLI of the ankle were investigated using roentgen stereophotogrammetric analysis (RSA). With the patients in the supine position, 54 ankles were examined during maximum plantar flexion and dorsiflexion (four ankles previously operated on were excluded). Ankles without symptoms (15) and ankles with unilateral (15) and bilateral (left 11, right 13) symptoms were compared.

**Results:** During maximum plantar flexion, which amounted to about 40° in all the groups, there was an average external rotation of -0.5° of the talus in the nonaffected ankles, whereas an internal rotation of 1.0-2.2° was recorded in symptomatic ankles. Rotations about the sagittal axis showed an irregular pattern. During maximum dorsiflexion (average 12-16°), all the groups displayed an external rotation (average 3.7-6.3°), as well as an abduction (average 0.9-2.5°). There were no significant differences among the groups.

**Conclusion:** In our study, ankles with and without CLI displayed no significant difference in average range of motion.

## The heel-pad shock and the development of overuse injuries

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**Introduction:** Overuse injuries are common in athletes, military trainees, and workers doing repetitive, stereotypic movements; and these injuries have considerable social and economic implications. The etiology of overuse injuries is multifactorial, and a key factor is repetitive loading.

**Subjects and methods:** Sixty-eight military recruits without biomechanical malalignment were repeatedly exposed to the same training program over a 3-month period. They used identical equipment, including shoes with poor shock absorption. The shock absorption of all 136 heel pads in the 68 trainees was determined using a device developed for the purpose—the HPC device. The development of overuse injuries was registered prospectively during the period.

**Results:** Twenty-five recruits sustained 40 overuse injuries, including 13 stress fractures. A significant correlation was found between individual heel-pad shock absorbency and the development of heel strike-dependent overuse injuries.

**Conclusion:** Low shock absorption in the heel pad increases the risk of heel strike-dependent overuse injuries, and this should be considered in patients with overuse problems.

## Fragility fractures

### Hip fracture risk

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**Introduction:** The following hypotheses were formulated and subjected to cohort studies: 1) manual labor reduces the hip fracture risk; 2) access to motor vehicles elevates the risk; and 3) presence of arthrosis reduces the risk. We also wanted to calculate the annual morbidity risk for hip fracture for different age and sex groups during the period 1945-1985. Medelpad is the catchment area of Sundsvall Hospital.

**Material:** In the autumn of 1988, personal identity data were obtained 1) from the hospital staff's payrolls for 206 women who had been employed for at least 15 years as a char-woman or assistant nurse, whose mean year of birth was 1910 (1886-1918); 2) from the driver's license register of 1961 for 163 women with a mean birth year of 1908 (1892-1915); from the register of the radiology department for 257 women who between 1974 and 1978 had had arthrosis of upper extremities diagnosed and who had a mean birth year of 1914 (1897-1927). All the women in the three observation groups had lived in Medelpad since they were 60 years old.

**Methods:** From the parish register, equally large control groups were obtained, matched for age, sex, settlement area, and year of death. All the patients over 59 years of age treated for hip fracture in the hospital since 1943 were registered, and the observation and control groups were checked against this register.

**Results:** The number of women with a hip fracture in the observation/control groups was 1) 13/10, 2) 15/17, and 3) 14/15. During the years 1945-1985, the annual hip fracture risk increased from 11 per thousand to 24 per thousand for women aged 80 years or more. For women aged 60-69 years, this risk remained unchanged at 2 per thousand.

**Conclusion:** None of the factors studied seemed to have a substantial influence on the hip fracture risk. The increase in annual morbidity was confined to high-age groups.

### Hip fracture incidence in Lund 1966-1986

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The hip fracture incidence in the city of Lund, Sweden, and its rural surroundings was studied for the years 1966, 1972, 1981, and 1986. The total incidence over time increased from 3.3 to 5.1 per 1,000 inhabitants. For persons more than 80 years old, the incidence almost doubled from 13.2 to 25.5, i.e., this group caused the whole increase in incidence. In the urban population, men with cervical fractures had an increased incidence. A smaller increase in incidence for both

men and women was found in the rural area. Compared with larger cities, the incidence in the city of Lund was lower over time, but in 1986 the figures were comparable with those in Gothenburg in 1981. The total incidence in the mixed (rural and urban) population of Lund was already in 1981 higher than in Denmark and Finland, but lower than in Norway. If the incidence continues to increase to 1995 in the population aged more than 50 years, there will be three times as many hip fractures as there were in 1966.

## Effects of physical activity on bone mineral content in women

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During and after the menopause, bone mineral content (BMC) declines rapidly. The connection between physical activity and BMC during this period has not been analyzed in detail yet. However, it is known that strenuous physical activity in athletes and ballet dancers increases BMC. In order to study the effects on BMC, a group of 30 women aged 50 (40–64) years that had been engaged in regular training (jogging and aerobics) once a week for at least 3 years was compared with a group of 30 hospital employees that served as controls. The mean age and age distribution was equal in both groups. The BMC at the wrist was measured with single-photon absorptiometry. With covariance analysis, BMC was higher in the observation group ( $P < 0.001$ ) at 6 cm. This indicates that moderate regular exercise can reduce bone loss from compact bone during and immediately after menopause.

## The effect of running on the bone mineral density in the hip and spine

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**Introduction:** A low bone density has been shown to be a risk factor for hip and vertebral fractures.

**Patients and methods:** The effect of running on bone density in the hip and spine was studied by measurements of bone mineral density (BMD) in 22 women, aged 26–57 years, who had run an average of 29.5 miles per week for 10 years. BMD was measured by dual-photon absorptiometry in the femoral neck, Ward's triangle, trochanter, and in L2–L3. The density in the runners was compared with the normal range based on the same measurements in 266 women with average exercise habits. Z-scores were calculated.

**Results:** The z-score for the femoral neck was +0.44 ( $P < 0.05$ ). The average value was 5.7 percent higher in the runners than in the control population. In the Ward triangle (+0.27),

the trochanter (+0.24), and the spine (–0.16), the BMD was not significantly different from the normal population.

**Conclusions:** The result suggests that running positively influences bone density only at sites with a significant age-related loss (femoral neck) and not at sites with a more stable bone density (trochanter, spine) in premenopausal women. The results may also reflect a relatively larger increase in load in the femoral neck than in the trochanter and spine while running.

## A double-blind, placebo-controlled study with synthetic human calcitonin in postmenopausal women

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Calcitonin is one of many drugs studied in the treatment of postmenopausal osteoporosis. We have tried to find the optimal dose of synthetic human calcitonin for long-term treatment. A placebo-controlled study over 4 months was carried out. Sixty-two women (aged 56–80 years) with a vertebral crush fracture within the last 12 months were randomly included for treatment with either 0.125 mg or 0.25 mg calcitonin (Cibacalcin®) or placebo injected three times weekly.

In the placebo group, BMC fell 3 percent ( $P < 0.05$ ), but there were no changes in serum osteocalcin, fasting urinary calcium/creatinine, or hydroxyproline/creatinine. Between the two doses of calcitonin, there were little differences in biochemical variables, reductions of urinary calcium, and hydroxyproline; and there were no changes in BMC. For both regimens, there were, however, significant differences from the placebo for both the reductions in urinary Ca/Cr and for BMC.

**Conclusion:** During a 4-month treatment period, calcitonin significantly changed the biochemical parameter and protected against further bone loss even when the low dose was used.

## Hip fractures registered in 1988—examples from northern and southern Sweden

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Totally, 232 hip fractures in Sundsvall (S), 116 in Örnsköldsvik (Ö), (both northern Sweden), and 325 in Lund (L); southern

Sweden) were studied. The mean patient age was 79 years. Three out of 4 patients were women.

The majority of the cervical fractures were operated on with two screws according to von Bahr (S) or hook-pin osteosynthesis (Ö and L). For the trochanteric fractures, Ender nailing (S) or a sliding screw with plate (Ö and L) was used. The mean hospitalization time at the orthopedic department was 21 days (S, Ö) and 16 days (L). The hospital stay was in all instances longer for the trochanteric than for the cervical fractures: 24/17 days (S), 31/16 days (Ö), and 18/14 days (L). Of patients coming from their own home, 69 percent (S), 75 percent (Ö), and 50 percent (L) could return directly home from the orthopedic department. Geriatric rehabilitation or a nursing home was used by 9 percent (S, Ö) and 15 percent (L). A convalescence home was used by 15 percent of the patients in Lund, but hardly by any in Sundsvall and Örnsköldsvik.

In the three areas studied, the structure for taking care of elderly differs, which influences the referral pattern. In recent years the availability of nursing home facilities, administered through the primary care system, has increased in Lund. In Sundsvall the majority of the primary care resources have been concentrated on home care facilities.

## Hip fractures during the next decades and their consequences for rehabilitation

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The expected number of hip fracture in Gothenburg and Malmö (1986) is 0.26 during a woman's lifetime. We have now observed an increased life expectancy for the elderly, today around 1-1.5 percent per year. Only with this increase, the expected number of hip fractures in 1996 will be 0.28 for 1 percent increase per year and 0.30 for 1.5 percent increase per year. If we also have an increased incidence (as we had earlier), the expected number of hip fractures in 1996 for 1 and 5 percent increased incidence per year will be 0.32 and 0.48, respectively. Another effect of this increase is that the mean age for hip fractures will increase, e.g., in Gothenburg the mean age in women will be 85 years in the year 2010.

This will have a consequence for the rehabilitation. Totally 1,400 hip-fracture patients in Malmö were followed for 1 year. They were divided into age groups of 5 years. In those coming from their own homes, there was an important increase in the need of rehabilitation with increasing age, e.g., the need of help before the fracture in a 60-year-old woman was 23 percent, whereas the corresponding figure for an 85-year-old woman was 41 percent. After 1 year, the figures were 28 percent and 90 percent, respectively. The same was observed for the other parameters.

## Holding power of screws and hook-pin in cadaver femoral heads from rheumatoid and nonrheumatoid donors

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*Introduction:* A firm grip in the femoral head is a prerequisite for stable fixation when treating femoral neck fractures. We have studied the holding power of three different devices when inserted into cadaver femoral heads from donors with or without rheumatoid arthritis (RA).

*Material and methods:* Thirty-six femoral heads from RA donors and another 36 femoral heads from donors without RA were used. In a randomized way, implants (sliding hip screw [SHS], von Bahr screw, or Hansson hook-pin) were inserted, with the tip of the screw/pin ending 4 mm from the surface of the femoral head. The implants were then pulled out by the use of a MTS machine while measuring the load and displacement.

*Results:* The maximal holding power (N) for the SHS (mean  $\pm$  SD) was 2,549  $\pm$  909 (non-RA) and 1,622  $\pm$  411 (RA;  $P < 0.02$ ), for the von Bahr screw 2,282  $\pm$  590 (non-RA) and 1,177  $\pm$  368 (RA), and for the Hansson hook-pin group 851  $\pm$  207 (non-RA) and 603  $\pm$  194 (RA). For the SHS the maximal holding power was reached after 1.9 mm (non-RA) and 1.7 mm (RA), and for the von Bahr screws after 2.7 mm (non-RA) and 2.5 mm (RA) of extraction after which the holding power rapidly declined. For the hook-pin the corresponding figures were 10.4 mm (non-RA) and 7.7 mm (RA), after which the holding power slowly declined. The work needed for extraction was less ( $P < 0.01$ ) in the RA group irrespective of device, whereas there was no significant difference between the devices.

*Conclusions:* The holding power in bones from rheumatoid donors was significantly less when compared with specimens of the same age without RA. The SHS showed the highest peak load necessary for extraction, although there was no significant difference when compared with von Bahr screws. The resistance to extraction of the screws declined rapidly, an effect of the screw design. The hook-pin showed a different pattern, because the peak load was smaller while the resistance to extraction continued until the pin was completely extracted from the specimen.

## A prospective randomized comparison of Uppsala screws and hook-pins for internal fixation of femoral neck fractures

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*Introduction:* We have compared the Uppsala subchondral screw technique for internal fixation of femoral neck fractures

with the hook-pin (Hansson) technique. The study was conducted as a prospective, randomized trial.

**Patients and methods:** The series comprised 132 consecutive patients with femoral neck fractures. Sixty-seven patients were allocated to treatment with the Uppsala screw technique, and 65 were allocated to treatment with the hook-pin technique. There were 109 women and 23 men. Their mean age was  $80 \pm 9$  years. Forty of the fractures were undisplaced, and 92 were displaced. Follow-up was performed with clinical and radiographic examinations 4 and 12 months after the trauma.

**Results:** In the Uppsala screw group, six complications have been encountered, as compared with 19 in the Hansson pin group. All the complications except one nonunion in the Hansson pin group have occurred among the displaced fractures. The differences between the treatment groups were significant ( $P < 0.05$ ).

**Conclusions:** The subchondral fixation technique with Uppsala hip screws results in significantly fewer complications during the first postoperative year than the Hansson pin technique in the treatment of femoral neck fractures.

## Internal fixation of cervical hip fracture: A randomized trial comparing a single nail vs. two hook pins

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**Patients and method:** From March 1984 to December 1985, 410 patients with cervical hip fractures were randomized between two methods of osteosynthesis: Group 1 = single nail (Rydell) and Group 2 = two hook pins (Hansson). The mean age of the men and women was 76 and 78 years, respectively. Seventy-five percent of the patients were women of whom 71 percent were living in their own homes at the time of the fracture; further, 69 percent were alive after 2 years. The patients had a clinical and radiographic examination after 1, 3, 6, 12, and 24 months postoperatively. There were no significant difference between the groups regarding the patients' background factors. Totally 8/285 patients alive after 2 years were only examined clinically. One patient was lost to follow-up.

Table. Results in percent of those alive 2 years postoperatively, divided into nondisplaced (Garden 1-2) and displaced (Garden 3-4) fractures

	Group 1		Group 2	
	G 1-2 n 48	G 3-4 n 97	G 1-2 n 42	G 3-4 n 98
Early displacement	2	14	2	14
Extraction after healing	10	7	7	7
Nonunion/LSC	23	54	19	54
Reoperation (THA)	19	35	10	38

**Results:** No differences were found between the two groups regarding quality of reduction, early displacement within 3 months, extraction after healing, nonunion, late segmental collapse (LSC) or reoperation (THA; Table 1).

**Conclusions:** The result after internal fixation of cervical hip fracture is not determined by the method of osteosynthesis. In selected cases, internal fixation of displaced cervical hip fractures should not be the method of choice.

## Varia

### Effects of platelet-derived growth factor (PDGF) and diclofenac on experimentally induced bone formation in rats

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**Introduction:** Heterotopic bone formation (HBF) is believed to be mediated by proliferation of connective tissue cells to bone-forming cells. The most important growth factor for fibroblasts in culture is PDGF. PDGF is also believed to act as a wound hormone, and is released from platelets as a response to tissue trauma. Heterotopic bone formation is also frequent after tissue trauma, such as hip arthroplasty. Nonsteroidal anti-inflammatory drugs NSAIDs are known to reduce HBF both clinically and experimentally. We have studied the effects of both PDGF and diclofenac, on the ash weight of experimentally induced bone in rats.

**Methods:** Urist's classical method for bone induction with decalcified bone was used. Each rat was given either PDGF (20 g/mL) or diclofenac (200 g/mL) from microosmotic pumps containing about 200 L. The pumps emptied their contents in about 2 weeks. Each rat served as its own control, and physiologic NaCl was administered to an additional decalcified piece of rat femur. The 6-mm-long pieces were implanted in each great gluteal muscle through a dorsal incision. The rats were killed after 4 weeks, and the wet and ash weights were recorded. Twelve rats were given diclofenac and 31 rats were given PDGF.

**Results:** Nineteen rats had to be excluded because of a bad condition postoperatively, with early death, wound ruptures, defective preparation, and nonfunctioning model. Left for analysis were 9 rats in the diclofenac group and 14 rats in the PDGF group. There was no difference with regard to weights. The mean ash weight in the PDGF group was 7.8 mg and the controls 5.2 mg ( $P < 0.05$ ,  $t$ -test). The mean ash weight in the diclofenac group was 3.6 mg and their controls 7.6 mg ( $P < 0.05$ ,  $t$ -test).

**Conclusion:** The results confirm that NSAIDs decrease induced bone formation and indicate that PDGF may stimulate bone formation.

## C-reactive protein (CRP) levels following elective orthopedic surgery

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**Introduction:** The usefulness of sequential serum levels of C-reactive protein (CRP) is well established in joint and skeletal infections. The levels of CRP following elective surgery are less well documented. We have studied the postoperative serum levels of CRP in patients undergoing elective orthopedic surgery.

**Patients and methods:** Using a quantitative method, the serum levels of CRP were determined prior to surgery and on days 1–5, 10, 14, 21, and 42 following operation. The patients included were operated on with total hip arthroplasty (79), revision hip arthroplasty following mechanical loosening (6), unicondylar knee arthroplasty (25), or open microsurgical lumbar discectomy (26). All the patients had normal levels of CRP (< 10 mg/L) prior to surgery, and there were no infectious complications after surgery.

**Results:** Following hip arthroplasty the CRP level (mean  $\pm$  SD) reached a maximum of  $118 \pm 44$  (primary) and  $151 \pm 76$  (revisions) on the third postoperative day. Ten days following surgery the levels were  $27 \pm 13$  (primary) and  $32 \pm 28$  (revisions). Following unicondylar knee arthroplasty, a maximum of  $132 \pm 40$  was seen on the second day after the operation, whereas on the tenth day a decline to  $35 \pm 23$  was observed. For both hip and knee arthroplasties, normal values were recorded 21 days after surgery. Following microscopic lumbar disc surgery, a maximum of  $44 \pm 24$  was seen on the second day with normalized levels 5–10 days after surgery.

**Conclusions:** Following elective surgery the serum levels of CRP increased in all the patients, reaching a maximum on the second or third postoperative day and declining to normal within 10–21 days, depending on the type of operation performed. The increase in CRP levels can obviously be interpreted as an effect of tissue injury during surgery. In patients with postoperative infections, it seems reasonable to believe that the CRP levels will remain elevated. Routine measurements of CRP will probably improve the possibilities for early detection of postoperative infections.

## Experimental anaerobic osteomyelitis: A novel rabbit model

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**Introduction:** Anaerobic bacteria are now recognized as pathogens in osteomyelitis, but experimental studies of anaerobic osteomyelitis have so far been hampered by methodologic difficulties. In this paper a new animal model is presented.

**Materials and methods:** Male New Zealand white rabbits were used. A cavity was made in both proximal tibial metaphyses. After rinsing with a sclerosing agent, sodium morrhuate, we filled the cavity with a polyvinyl sponge, into which a suspension of *Bacteroides fragilis* was injected on one side; on the other side, saline was injected. Blood samples for immunologic tests, radiographs, and bone scans were obtained preoperatively and then at regular intervals. The animals were killed after 18 weeks, and samples were taken for microbiologic and histologic analyses.

**Results:** The animals regained their preoperative weight within 5 weeks. All the animals developed radiographic changes compatible with a low-grade chronic infection around the operated sites; the changes were more pronounced on the inoculated side, except 1 animal with symmetric changes. *B. fragilis* was isolated from all the inoculated sides but one, and also from all the control sides. In addition, all the rabbits developed raised titers against *B. fragilis*. No other microorganism was found. The histologic analysis showed chronic osteomyelitis, with periosteal bone formation, inflammatory response, and microabscesses.

**Conclusions:** This experimental model gives a high infection rate without killing the animals. Further, it gives reproducible immunologic, radiographic, and histologic changes. The model is appropriate for studying the role of anaerobic bacteria in osteomyelitis, alone or in combination with traditional pathogens, and also for studies of metastatic infections.

## Total-contact casting in diabetic foot ulcers: A study of predictive factors

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**Introduction:** Foot ulcers and gangrene are major medical and economic problems among diabetic patients. The aim of this study was to identify prognostic factors for ulcer healing in treatment with a total-contact plaster cast.

**Materials and methods:** In a prospective study, 44 consecutive patients with 58 foot ulcers were treated with a plaster cast. Thirty-seven patients were insulin-dependent, aged 53 years ( $\pm 14$ ), and had a longer diabetes duration, 21 years ( $\pm 11$ ) as compared with the noninsulin-dependent patients, 73 ( $\pm 5$ ) and 14 years ( $\pm 4$ ), respectively. The clinical parameters were correlated with the degree of healing by using a logistic regression analysis.

**Results:** Thirty-two of the 58 wounds healed in 4 months ( $\pm 3.5$ ); 17 ulcers did not heal, and 9 patients were amputated. The following factors were correlated with healing: ulcer grade according to Wagner, ulcer area, and the calf-arm blood pressure index. Further, the association between blood-pressure index and the degree of wound healing corresponds to a second-degree equation. Thus, indices below 0.45 or above 1.40 were associated with low healing rates.

**Discussion:** We found that a high index is a negative prognostic factor. One possible explanation of the high blood

pressure in the leg is arterial media sclerosis, which allows detection of pulsatile flow, but no compression of the arteries. Arteriovenous shunting in diabetic patients with neuropathic foot ulcers is another possible cause. These factors degrade nutritive blood circulation in the skin.

### **A Scandinavian system for computer-aided design and manufacturing of below-knee prosthetic sockets**

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*Introduction:* The application of CAD/CAM to amputee socket design and manufacturing aims at achieving better and

more uniform quality, shorter production time, and automated shape and process recording. This paper presents a low-cost CAD/CAM system to design and manufacture below-knee prosthetic socket molds.

*Methods:* The shape of the stump is first obtained using a laser scanner. A custom-made CAD program is then used to modify the shape to design a well-fitting socket according to the prosthetist's empirical experience of socket-stump biomechanics. The three-dimensional coordinates describing the final socket-model design are finally sent to a custom-designed numerically-controlled milling machine, which carves a plaster socket mold.

*Patients:* Totally, 21 below-knee amputees have initially been fitted.

*Results:* Preliminary evaluation shows very good results of practical use of the equipment. A complete socket can be produced in 1 hour. The quality of the fittings were generally very good.

*Conclusions:* The system seems to be ready for a broader scale clinical evaluation at several orthopedic centers.