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### 21 095 HIP FRACTURES IN STOCKHOLM DURING 1972–1980: AN EPIDEMIOLOGIC STUDY

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Scandinavian studies of the incidence of hip fractures have shown an increased incidence during the latest decades (Mårtensson – 62, Alffram – 64, Nilsson and Obrant – 78, Falk and Ilebäck – 78, Zetterberg – 81). In the county of Stockholm 18 985 patients sustained 21 095 hip fractures during 1972–80. This patient material has been studied using data routinely collected in a computerized medical information system. We have found the highest incidence of hip fractures ever reported.

Our results indicate an unaltered hip fracture incidence in Stockholm county from 1972 to 1980, with a notable exception of cervical fracture incidence in women, which has decreased significantly during the years under study.

### HIP FRACTURES IN GOTHENBURG, SWEDEN: EPIDEMIOLOGY AND PROGNOSIS

CARL ZETTERBERG & GUNNAR B. J. ANDERSSON

A dramatic increase in incidence of fractures of the proximal femur (hip fractures) has occurred in Gothenburg, Sweden during the years 1940–79 (Zetterberg & Andersson 1982). The number of fractures has increased from 104 in 1940 to 788 in 1979. From 1965 to 1977 there was a total incidence increase of 42 percent. Only 6 percent of this increase can be explained by an increasing proportion of older people in the population.

Thus, 36 percent of the incidence increase cannot be explained by age factors.

A prognosis was made, which takes expected mortality rates and migration into account. With the present trend the incidence can be predicted to double by the turn of the century. The incidence will double in 16 years for men and in 30 years for women. This will put a heavy demand on the orthopaedic and aftercare resources not only for hospital beds but also for operation facilities.

The average hospital care time at the orthopaedic wards was 20 days in 1978 and 1979. If the present incidence trend continues and no change in average hospital care time occurs, the number of beds per year occupied by hip fracture patients will increase from 46 in 1979 to 63 in 1990 and 83 in 1999. The average care time will be increased beyond 20 days if the after care resources are held constant. Thus, the number of beds needed per year given above can be considered as a minimum. There is no reason to postulate that the incidence increase from 1940 to 1979 suddenly would disappear, although it is unexplained. Care should be taken when extrapolating these figures to other populations as the population in Gothenburg is a genuine urban population. A similar increase has however been found in Oslo, Norway (Falch & Ilebekk 1978).

These findings call for further research to find background factors relevant to the factor etiology and to evaluate possibilities for prophylaxis and intervention.

References: Falch, J. & Ilebekk, A. (1978) Fractures of the proximal end of the femur. Prevalence and incidence in Oslo 1950–1975. *Tidsskr. Nor. Laegeforen.* **14**, 738–739 (In Norwegian). Zetterberg, C. & Andersson, G. B. J. (1982) Fractures of the proximal end of the femur in Gothenburg, Sweden, 1940–1979. *Acta Orthop. Scand.* **53**, 419–426.

### PRE- AND POSTOPERATIVE TC-MDP-SCINTIMETRY AFTER FEMORAL NECK FRACTURE

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Tc-MDP-scintimetry performed within 2 weeks from operation for femoral neck fracture is a reliable predictor for the postoperative course. Defective isotope uptake in the femoral head is connected with complications such as redislocation, pseudarthrosis and segmental collapse. Singular cases have been presented where the operative procedure seems to have injured a preoperatively intact circulation.

The aim of this study was the direct comparison between pre- and postoperative femoral head uptake.

Twenty-three patients with femoral neck fracture (seven undisplaced and 16 displaced) were submitted to scintimetry on the day after admission, before operation. One week after operation, which was performed with a 4-flanged nail (Rydell), the procedure of scintimetry was repeated. The femoral head uptake was calculated as a ratio fractured/intact side.

As judged from the preoperative scintimetry the patients could be divided into three groups: Nine with the ratio 0.45–0.80 (group 1), seven with a ratio 0.90–1.05 (group 2) and seven with the ratio 1.15 (group 3). Patients in group 1 with one exception also postoperatively showed a defective uptake. Patients in group 3 retained their pattern of good circulation postoperatively while of the patients in group 2, five postoperatively showed a defective uptake and two an intact uptake.

Patients with preoperative isotope uptake defects and patients with well preserved uptake, both retain these patterns at their postoperative investigation while a group in between might improve or deteriorate postoperatively, probably depending on the operative procedure.

### RESULTS OF EARLY REHABILITATION AT HOME OF ELDERLY PATIENTS WITH HIP FRACTURE AND CONSUMPTION OF RESOURCES IN PRIMARY CARE

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From 1976 onwards an active rehabilitation programme has been applied to patients with hip fracture. This involves mobilization in the hospital (interval fixation and immediate weightbearing) and rehabilitation

at home (in co-operation with community health care personnel already on admission of the patient). The purpose of this investigation was to evaluate the effect and assess the consumption of resources for rehabilitation at home for patients with hip fracture.

The basic material consisted of 161 consecutive patients, age 50 or above, admitted from their own homes with a hip fracture to the Orthopaedic Department in Lund during 1978–80. Of these, 102 (63%) returned directly home upon discharge from the Orthopaedic Department. 100 patients were followed up until 4 months after the fracture by the primary care unit. The mean age was 73 years (range 50–97). Of the patients 49% were living with someone and 74% were females. Shortly after discharge the patients had resumed many of their prefracture activities. Already at discharge 90% could do ADL-activities, such as personal hygiene and dressing. Two weeks after discharge 90% of the patients were climbing stairs. Five weeks after discharge home 63% were able to use walking sticks or no walking aid. Four months after the fracture 80% could do out-door activities such as walking and 74% shopping. Communal homehelp was needed by 29% before the fracture, by 57% at discharge and by 43% at 4 months after the fracture.

In total, 1087 home visits by health care personnel were done including 77 visits by the primary physician. The mean number of home visits was 11 per patient. However, the majority of the patients needed less than five home visits each. The total cost per patient treated by the home care unit was only somewhat higher than one extra day at the Orthopaedic Department. The rehabilitation scheme was thus of benefit to both the patient and society.

### HIP FRACTURES. BACKGROUND FACTORS AND POSSIBILITIES FOR PROPHYLAXIS AND INTERVENTION

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Fractures of the proximal femur (hip fractures), in the elderly account for about 50% of all hospital beds utilized for the care of fracture patients. A number of studies in Scandinavia and Great Britain have shown a rising fracture incidence rate. The incidence can not be explained by an increasing proportion of older people in the population. It is therefore of great interest to find background factors of importance in the fracture etiology and evaluate possibilities for prophylaxis and intervention.

The material in this study consisted of 114 consecutive hip fracture patients: 85 women and 29 men. No patients under 65 years of age were included. The patients

were examined and interviewed. Muscle biopsies from the lateral vastus muscle was obtained at surgery. The mean age was 81 years for women and 82 years for men. The mean age was higher among the patients coming from institutions, i.e. 85 years for the women and 91 years for the men. 66 patients had a cervical fracture and 47 a trochanteric. The accidents occurred at all hours of the day but the frequency was highest at 10 a.m. to 2 p.m. and around 7 p.m. 17 percent of the patients had an additional fracture. 47 percent of the fractures occurred in the home of the patient, 29 percent at an institution and only 15 percent outdoors. The prefracture status was rather poor as only 20 percent were completely healthy; 35 percent used a cane or other types of walking aids. The prevalence of gastric resection was 15 percent among the women and 5 percent among the men. Investigation of the marital status showed that 44 percent were widowed. The muscle biopsies showed a higher frequency of fiber-hypotrophy of both type I and type II fibers. Signs of neuropathy were also more often encountered than in healthy 70 to 80 years old subjects. The results indicate a deterioration in muscle function which, at least partly, can be due to inactivity.

To summarize, it can be postulated that the increased hip fracture incidence is accompanied by a similar increase in osteoporosis prevalence. The patients sustaining a hip-fracture seem to have a rather poor prefracture health-status and known osteoporosis inducing factors such as gastric resection, paresis and inactivity are frequent.

#### FEMORAL NECK FRACTURE: A COMPARATIVE COST STUDY

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Two series of patients with femoral neck fracture from 1975 to 1977 were compared with special reference to cost of hospitalization time in relation to the result of the treatment. The series included 194 fractures from a surgical and 191 fractures from an orthopaedic clinic in Stockholm County. Only patients over the age of 50 admitted from their own homes and after all treatments discharged to their homes were included into the study. According to the type of treatment and consumption of hospital resources the series were divided into three groups: (a) primary osteosynthesis without hospital time consuming complications, (b) primary osteosynthesis with hospital time consuming complications and (c) primary arthroplasty including both non-complicated and complicated cases. About 60 percent of the fractures from both series could be referred to group a. The average cost of the fracture in Group a was 24000 Sw.kr. in the orthopaedic clinic and 36000 Sw.kr. when treated in the surgical clinic. In Group b comprising 30 percent of the orthopaedic and 40 per-

cent of the surgical fractures the cost amounted to 49000 Sw.kr. for the orthopaedic cases and as much as 90000 Sw.kr. for the surgical cases. No primary arthroplasty was performed in the surgical clinic but 24 (12 percent) in the orthopaedic clinic were treated with Moore or Christiansen endoprosthesis at an average cost of 49000 Sw.kr. Thus the actual study indicates that femoral neck fracture seems to be 3-4 times more expensive when complicated especially when treated in a surgical clinic. Primary arthroplasty does not seem to be an economic alternative treatment.

#### ARTHROGRAPHY IN THE PRETREATMENT DIAGNOSIS OF CHILDREN'S HIP DISORDERS

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Since hip joint arthrography is a resource-demanding procedure, it was considered of interest to assess the value of the additional information to be obtained from arthrography as compared to X-ray without contrast medium. A retrospective analysis was made of hip joint arthrographies carried out for pretreatment diagnosis in 120 consecutive patients with dislocation of the hip (congenital or associated with neurological disease) or Perthes' disease. In most cases arthrography was performed bilaterally, and in 11 patients it was done twice, making a total of 246 hip joint examinations. 60 percent of the children were less than 1 year old, and 70 percent less than 2 years of age.

Arthrography played a decisive role for the choice of treatment in two-thirds of the cases and served to verify the diagnosis in the remainder.

Fifteen cases with unsatisfactory results following primary treatment were included in an analysis of prognostic signs, which showed that arthrography provided several signs indicative of a poor prognosis which could not be detected in roentgenograms.

#### PYOGENIC ARTHRITIS OF THE HIP IN CHILDREN

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Ten children with septic arthritis of the hip with debut between the ages of 2 weeks and 11 years were followed for 1-7 years after the debut of symptoms. Five of the children were less than 2 years at the onset of the disease. Two of these children were neonates. They were unexpectedly unaffected by the local lesion and their hip symptoms attracted attention late. The two neonates and a third, older, child were all treated early

with adequate, intravenously administered antibiotics but joint evacuation was not accomplished during the first month after the onset of arthritis in any case. All three children developed severe destructive lesions of their femoral heads.

Seven children developed distinct symptoms of a seriously elevated intraarticular pressure which persisted for only a short period, or a series of short periods, before decompression was accomplished by hip aspiration and/or arthrotomy. An unexpected decompression was accomplished by hip aspiration and/or arthrotomy. An unexpected subacute course with intermittent attacks of hip pain was seen in 3 children. Two of these children showed radiological signs indicating a pre-arthritis phase of osteomyelitis. The third child had three separate periods of intense hip pain and fever interrupted by more or less pain-free intervals up to 6 days. This child was found to have *Salmonella coxitis* without signs of osteomyelitis.

Direct arthrotomy was performed in one case. Aspiration was successful in two cases but was seen to be an insufficient therapeutic procedure in four children who showed signs of inadequate decompression early after aspiration. These children became arthrotomized secondarily. There seemed to be no guarantee for adequate drainage without arthrotomy.

At the end of the observation period none of the seven children who had been properly drained showed signs of hip sequelae.

#### LONG TERM RESULTS IN SLIPPED CAPITAL FEMORAL EPIPHYSIS WITH DIFFERENT PRIMARY TREATMENT

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This investigation is part of a follow-up of long term results in 500 cases with slipped capital femoral epiphysis from southern Sweden treated in different ways. The primary case record has been followed up until now. Clinical examination has been done using the Merle d'Aubigné hip rating system, as well as radiological examination.

Previously the long term results from 46 cases, which had no primary treatment, have been presented. Only five had operations in adult life and the remaining cases had relatively small problems from their slipped hips, although the observation time was 20–62 years.

The investigation has now continued by 56 cases primarily treated by closed reduction and plaster. Although the observation time in this group is the same (24–66 years), 17 cases have been operated in adult age (7 arthrodeses, 1 osteotomy and 10 arthroplasties). In the remaining cases the results are less favourable than in the group with no primary treatment.

The long term result in cases treated with closed reduction and plaster is worse compared to cases with no primary treatment. The reason for this is that many cases after closed reduction develop avascular necrosis and early deformation of the hip resulting in osteoarthritis of the hip.

#### GAIT IMPROVEMENT EVALUATION OF CEREBRAL PALSY CHILDREN AFTER OPERATIVE TREATMENT OF DEFORMITIES IN "ONE OPERATIVE SESSION"

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In cooperation between the children's habilitation centre, the Department of Orthopaedic Surgery and the Department of Clinical Neurophysiology, children suffering from cerebral palsy are investigated and treated. For the last 4 years at the Orthopaedic Department, University of Linköping, we have been operating such children in one operative session. This consists of lengthening of the hip flexors, transposition of the adductors to the ischial tuberosity, lengthening of the hamstring muscles distally or peripherally, and lengthening of the Achilles tendon or fascia *m. gastrocnemius*. Postoperative immobilization in plaster cast is maintained for 4 weeks and then intensive training. Before any surgery starts and after the operative treatment, the gait pattern of every child is recorded in the gait laboratory of the Department of Clinical Neurophysiology. After operative treatment the gait pattern is recorded at 3, 6, and 12 month intervals. All data obtained were computerized. In order to study pathological changes of gait velocity and gait parameters we performed parallel studies of gait in normal children. Our results after 3 years' observation of 35 children show that there is a significant improvement of gait and posture in children operated in "one operative session".

#### RESULTS AFTER HEMIARTHROPLASTY WITH UNCEMENTED SOFT TOP PROSTHESIS AFTER COMPLICATION TO FEMORAL NECK FRACTURES

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October 1977–April 1982 (4.5 years) 141 patients were operated with a Soft Top Bipolar hemiprosthesis after complication to femoral neck fractures. Mean age at the time of operation was 76 years. 109 patients were women and 33 men. The indication for operation was severe hip pain and the radiologic diagnosis was

pseudarthrosis in 35 percent, necrosis of the femoral head in 20 percent and fracture dislocation in 30 percent. In 15 percent the arthroplasty was performed as a primary procedure.

All patients are followed prospectively and each year a radiological and clinical assessment is made (M d'Aubigné and Postel 1954). 86 patients have been followed 1–4 years postoperatively (mean 2).

The result concerning pain was excellent (5–6 points) in 74 patients (86 percent), good (4 points) in 2 and poor (2–3 points) in 10 (12 percent). Five patients have been reoperated with total hip replacement.

So far no radiologic signs of "plastic disease" have been noticed. We conclude that our short time result is satisfactory, but we warn against using this type of prosthesis in patients with rheumatoid arthritis, long standing painful necrosis of the femoral head and in patients with osteoarthritis.

#### MULTIPLE-BEARING INSERT IN HIP JOINT RECONSTRUCTION: A PRELIMINARY REPORT

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The Bateman prosthesis is a multiple-bearing implant which has been referred to as a single assembly total hip, a universal proximal femur or a bipolar endoprosthesis. The design properties include an apron area making the outer bearing slightly greater than a hemisphere to protect an underlying polyethylene insert which is placed over the sphere of the femoral stem. This prosthesis has been in use since January 1980. Fifty-nine operations have been carried out in 58 patients: 13 (22%) men and 45 (78%) women. The mean age was 72 years (21–94 years). The mean age of the men was 67 years (34–94 years) and of the women 73 years (21–92 years). In 52 patients the diagnosis was sequelae of femoral neck fractures and in six patients the diagnosis was femoral head necrosis secondary to renal transplantation. A follow-up was carried out on the average 362 days following operation (39–773 days). In the fracture group the time from first fracture operation to the Bateman replacement was 246 days (mean time). The distribution was 0–1137 days.

There was marked improvement in all the fractured hips following Bateman replacement. Pain was evaluated by the Merle d'Aubigné-Postel score; the grade before operation was 4.9 and after operation 0.5. There was an increase in mobility from 133.3° preoperatively to 156° postoperatively. There was an increase in walking ability.

In the transplantation group the observation time is still very short, but the trend is very promising as all patients are completely pain-free and have a normal function in the hip so far.

As yet radiographic examination has not disclosed any migration of the cup into the acetabulum.

#### SURFACE TOTAL HIP REPLACEMENT: A PRELIMINARY EXPERIENCE OF THE ICLH METHOD

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Surface replacement arthroplasty of the hip has been advocated in recent years as an alternative to conventional total hip replacement.

Over the last 4 years we have performed 61 arthroplasties (55 patients) using the ICLH prosthesis. The method has been used in "younger patients" between 40 and 65 years of age, and mainly patients who are otherwise healthy and live a fairly active and normal life. 30 patients were women and 25 men. The indication for operation was severe hip pain and greatly impaired function. The preoperative diagnosis was: primary osteoarthritis in 51 hips, secondary osteoarthritis in 3, rheumatoid arthritis in 5 and necrosis of the femoral head in 2. All patients are being prospectively followed and each year a radiological and a clinical assessment are made (M d'Aubigné & Postel 1954). Six patients have been followed 6 months and 49 1–3 years postoperatively (mean 2 years).

The result concerning pain was excellent in 95% (5–6 points). 81% had good walking ability (5–6 points). 7 patients (excluded) have been reoperated with conventional total hip replacement (loosening of the prosthesis in five and fracture of the femoral neck in two).

In conclusion our preliminary result with surface total hip replacement is as good as the conventional arthroplasty, with respect to pain and function. However, we have noted a significant number of serious complications relatively early. As a result of this failure rate the attitude towards surface replacement should be one of caution. The surgical technique is demanding and the operation should be performed by well trained surgeons. We warn against using this type of prosthesis in patients with bad bone quality such as those with rheumatoid arthritis and osteoporosis.

#### TOTAL HIP REPLACEMENT IN CONGENITAL DISLOCATION OF THE HIP

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Arthroplasty was performed on 57 hips in 44 patients, 37 women and 7 men, during 1974–1981. Twenty-nine patients were referred from other hospitals. The average age was 49 years  $\pm$  13 years (range 10–79).

Twenty-two hips had dysplasia with subluxation of the femoral head and a subjective disability as in coxarthrosis. Thirty-five hips had a complete dislocation with nearthrosis and walking pain as the major complaint rather than pain at rest or instability of the hip joint. The surgical procedure in every patient was carried out according to Harris with implantation of the socket in the original acetabulum. A reconstruction of the acetabular roof was made in 23 of the 35 completely dislocated hips. Complications were 4 preoperative fractures of the femur, 5 postoperative dislocations, one femoral nerve injury and one postoperative infection with a later loosening which has required a revision arthroplasty. Another 8 patients have been re-operated on, all due to mechanical loosening of one or both components. All patients but four have reported a postoperative improvement.

#### WORKING CAPACITY AFTER TOTAL HIP REPLACEMENT

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In order to determine the working capacity after total hip replacement 108 patients including 132 operated hips have been studied. The patients have been followed up for a period of at least 2 years. Before the operation many patients suffered from rheumatic arthritis or osteoarthritis in multiple joints of such a degree that regardless of a successful operative procedure returning to work was impossible. However, in most cases patients unable to work only because of the actual hip-disease, returned to work. This study suggests that patients who had waited a considerably long time for the operation were less likely to return to work.

#### LAB-SCREENING FOR POSTOPERATIVE THROMBOSIS AFTER ELECTIVE TOTAL HIP-ARTHROPLASTY

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Postoperative thrombosis is a problem after many surgical procedures, especially after hip surgery in elderly people. Consequently there is a great need for preoperative screening methods to detect patients at risk. Preoperative saline-dilution-test using thromboelastography has been suggested as a predictor of postoperative deep vein thrombosis according to Heather et al. based on a study on general surgical patients. We have used the saline-dilution-test in correlation with the fibrinogen uptake test ( $I^{125}$ ) in a prospective trial of 27 patients operated with total hip-arthroplasty. In this study we found no correlation between the preoperative saline-dilution-test and postoperative thrombosis.

#### BONE SCANNING IN FAILURES AFTER TOTAL HIP REPLACEMENT

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Preoperative bone scintigraphy was performed in 32 patients scheduled for exchange of a total hip because of infection, non-infectious loosening or recurrent dislocations. Infection was diagnosed by multiple aerobic and anaerobic cultures obtained at surgery. The prosthetic component was classified as loose only if it was found to be movable.

Two to three hours after i.v. injection of 400–500 MBq  $Tc^{99m}$  MDP or DPD bone images of the pelvis and the proximal femora were obtained with a low energy high resolution gamma camera. The images were interpreted blindly and the bone uptake of the radionuclide around the socket, the stem and the tip of the prosthesis was classified as normal or increased in three different grades compared with the surrounding bone. The scintigraphic findings were then correlated with the final diagnosis.

In all eight infected cases, the activity around the stem was diffusely increased whereas the uptake at the acetabulum was increased in 6/8.

All but one of 14 loose and non-infected femoral prostheses had an increased uptake, more pronounced at the tip in 11 cases. However, this uptake was considerably lower than in the infected hips.

Non-infected loose socket showed increased uptake in 4/7 cases.

The stable femoral prostheses showed increased uptake in 5/8 cases, whereas increased uptake was found only in 2/7 stable sockets.

With the present semiquantitative method it may be difficult to differentiate between infection and non-infectious loosening. However, a normal bone scan is unlikely in infection. The search for a useful reference area in digital scintimetry is crucial for improvement of the method.

#### EXCHANGE ARTHROPLASTIES OF THE HIP DUE TO STERILE LOOSENING

*A comparative study on medical efficiency*

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Between October 1969 and January 1981 1734 hip arthroplasties were performed at the clinic. 54 of these were exchange arthroplasties carried out because of sterile loosening. This group of exchange arthroplasties was compared with a control group consisting of primary arthroplasties performed at the clinic. The control group was matched with regard to surgeon, type of prosthesis implanted and date of operation.

The consumption of resources measured in length or operation time, number of blood transfusions and number of days spent at the clinic, was twice as high in the exchange arthroplasty group as in the control group. Moreover the amount of serious complications in the form of postoperative mortality, further revision due to infection or sterile loosening as well as permanent hospitalisation, was four times larger in the exchange arthroplasty group.

#### FOREARM FRACTURES AND COMPARTMENT SYNDROME

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Between 1978 and 1981 a consecutive series of 13 patients with forearm fractures and compartment syndrome was treated at the Karolinska Hospital. A high energy trauma was the causative factor in nine cases, five of which had an open fracture with skin defects. Intraarticular fractures occurred in four cases. All developed a compartment syndrome with involvement of the median nerve in all cases, and of the ulnar nerve in five cases. Fracture reduction, fixation and opening of the forearm and carpal compartments was performed as emergency procedure in seven cases and in six cases within 3 days. Hoffmann fixation was used in eight cases. Skin grafts were used to cover the defects. Pain disappeared immediately, whereas sensibility returned gradually during the first two postoperative months with improvement of median nerve function in all cases, but persistent ulnar nerve deficiency in one case. There was no deep infection and all skin grafts healed, in three cases by repeated transplantation. Fracture healing averaged 8 weeks. Nonunion occurred in three cases requiring further operative treatment. Impaired range of motion was noted for the wrist joints. The functional results after reexamination more than 1 year postoperatively are presented.

#### A DIAGNOSTIC METHOD FOR CHRONIC COMPARTMENT SYNDROME IN M. INTEROSSEUS DORSALIS I

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Writer's cramp and guitar cramp may be caused by a chronic compartment syndrome in the first dorsal interosseus muscle. The condition occurs in occupations where the key grip and pinch grip are often used. The diagnosis can be verified by continuous monitoring of the total muscle pressure during exercise.

Under local anaesthesia or digital radial nerve block at the wrist, a specially prepared polyethylene catheter was introduced into the muscle compartment of two patients. The catheter was connected to a receptor, pressure monitor and an infusion system with a constant infusion rate. The patients were allowed to exercise with the key grip and pinch grip bilaterally, while the grip strength and muscle pressure were recorded continuously. Four other patients were operated on for the same symptoms but without a preoperative registration. During exercise the muscle relaxation pressure and the muscle pressure amplitude increased significantly. The resting pressure after exercise remained on a high level for 10–20 min. All six patients became symptomless after fasciotomy. Monitoring of postoperative muscle tissue pressure was performed in two patients and showed normal levels.

With the described provocation method a suspected chronic compartment syndrome in the first dorsal interosseus muscle can be verified. The infusion technique is well suited for registration of dynamic pressure changes in the muscle compartment. Elevation of the muscle relaxation pressure during exercise, the development of increased pressure amplitude and the elevated resting pressure after exercise are general diagnostic criteria for chronic compartment syndromes that also apply to the first dorsal interosseus muscle. Fasciotomy results in relief of symptoms and normalization of intramuscular pressure.

#### POSTERIOR AND POSTERO-LATERAL DISLOCATION OF THE ELBOW. A RETROSPECTIVE STUDY OF 51 PATIENTS

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Recommendations for treatment of dislocation of the elbow still differ. Some advocate repair of the elbow ligament after reduction of the dislocation, while others recommend immobilization in plaster only.

In 1978–81, 51 patients with posterior and posterolateral dislocation of the elbow were treated at the Departments of Orthopaedic Surgery in Gothenburg. 25 were men and 26 were women. The cause of injury was fall on the same level in 2/3 and fall from height in 1/3. After reduction of the dislocation the ligaments were sutured in eight patients. In 43 no ligament repair was performed. All elbows were immobilized in a plaster splint (mean 3 weeks).

The follow-up comprised 42 patients.

The subjective result was excellent and good in 41 patients and poor in one. The stability was equal in the injured and uninjured elbow in all patients and the motion was recorded as excellent and good in 90%.

### ACROMIO-CLAVICULAR SEPARATIONS TREATED CONSERVATIVELY: A 5-YEAR FOLLOW-UP STUDY

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Seventy patients with acute acromio-clavicular separation were studied retrospectively. All patients were treated with a minimum of immobilization. In 37 patients the separation was classified as partial (PS-group) and in 33 as complete (CS-group). All patients were reexamined clinically and radiologically. The mean interval between injury and follow-up was 5.7 years. In the PS-group all 37 patients had a satisfactory result (24 excellent, 13 good).

In the CS-group 30 patients (91 percent) had a satisfactory result (7 excellent, 23 good) and 3 patients (9 percent) were classified as unsatisfactory (1 fair, 2 poor). The radiological findings are discussed, especially the remodelling of the joint.

### INTERNAL FIXATION AND EARLY MOBILIZATION AFTER COMMUNUTED AND METASTATIC FEMORAL FRACTURES

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At the Department of Orthopaedic Surgery in Lund a prospective series of 59 fractures and one non-union were operated with semi-elastic fixation. Twenty-five fractures, mainly situated in the midshaft of the femur, are presented in this paper while 34 fractures of the distal femur are presented in a sound-slide program. Stabilization with crossed intramedullary nails and distal coupling to screws prevented extrusion of the nails and torsion of the fracture. The operation is performed closed through 5–7 cm incisions on each side of the knee.

Indications: Segmental, comminuted, osteoporotic and metastatic femoral fractures unsuitable for Küntscher nailing. One ipsilateral open tibial fracture and one non-union were operated.

Postoperative mobilization started with an anterior plaster slab, followed by hinged castbrace after 2 weeks. All fractures healed. No infection appeared. Angular deviation, shortening and final function are assessed.

### COMPRESSION SCREW FIXATION OF NONUNION OF THE CARPAL SCAPHOID: LONG-TERM RESULTS

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A consecutive series of 25 patients with nonunion of the scaphoid was operated between 1964 and 1971 by one surgeon (G. Strandell) with a standardized method – styloidectomy, bone grafting and internal fixation by a compression screw.

The mean interval between trauma and operation was 34 months. All patients were male and the mean age was 30 years (range 19–65).

Clinical and radiological reexamination after a mean observation time of 15 years according to a specific protocol could be performed in 17 patients. Fracture healing was observed in 65% (11/17) and radiocarpal arthrosis in 65% (11/17) as compared to 26% (3/17) at the time of operation. Passive and active range of motion in the wrist and strength of the grip was measured. Impaired motion, especially with respect to dorsal extension and radial deviation, was noted as well as a marked decrease in strength.

In all patients (8/8) operated on the dominant side strength of the grip was higher in the non-dominant hand. Subjectively three patients were very satisfied, 11 satisfied and none felt worse. All had returned to and continued in their previous occupation.

Among the various methods used for operative treatment of scaphoid nonunions the McLaughlin method has proved to be very beneficial.

### DOES PELVIC INSTABILITY CAUSE INCREASED MOBILITY OF THE SYMPHYSIS?

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A special electromechanical measuring technique was adopted to measure symphyseal mobility. A 3-mm-thick metal pin is inserted into the pubic bone on either side of the symphysis. By attaching two transducers in three different ways, movements may be registered in three different planes, i.e. the frontal, sagittal and vertical plane. Mobility was tested with the hips in flexion and passive abduction, with the subject standing on alternately the right and left leg, and during walking.

In order to obtain normal values, measurements were made in 12 healthy controls, six men and six 0-Para women, aged 20–30 years. Subsequently the same method was used for measurement in 10 patients with clinical signs of pelvic instability, one man and nine women, age range 22–54 years.

In the normal control series symphyseal mobility showed the following mean values (range):

	Men	Women
I. Horizontal plane	0.5 mm (0.1–0.7)	1.0 mm (0.6–2.0)
II. Sagittal plane	0.7 mm (0.2–1.3)	0.4 mm (0.0–0.5)
III. Vertical plane	1.0 mm (0.5–1.9)	1.3 mm (0.8–2.6)

The values measured in each of the 10 patients with suspected pelvic instability were compared with normal values of the control series ( $\alpha = 0.01$ ). Seven of the 10 patients showed increased mobility in the sagittal plane, four in the vertical plane, and two women in the horizontal plane. The largest movements were registered in the vertical plane, i.e. 7.8, 5.5, 3.8 and 3.7 mm. Increased mobility was noted in all nine women, in six cases in one plane, in one case in two planes, and in two cases in all three planes. Normal values were registered for the male patient with sequelae after a pelvic fracture.

#### DOES DELAYED SURGERY AFFECT THE RISK OF INFECTION IN ANKLE JOINT FRACTURES?

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Postoperative infected ankle-joint fractures reported to the Patient-insurance company in Sweden have been analysed regarding the type of fracture, interval between the accident and the operation and fractures decreasing infections resistance. The investigation shows that 73 percent of the infected cases have been operated later than 8 hours after the accident and those fractures are mainly not severely dislocated. The 27 percent infected cases which were operated within 8 hours were in most cases severely dislocated.

#### THE EFFECT ON MUSCLE STRENGTH IN THE THIGH AFTER ARTHROSCOPY AND ENDOSCOPIC AND OPEN MENISCECTOMY

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The muscle strength of the thigh is of importance to the function of the knee. One of the most common knee

injuries is the meniscus tear. In this study we measured the effect on the muscle in the thigh in connection with: diagnostic arthroscopy with central approach (I), arthroscopy with endoscopic operation of bucket-handle ruptures (IIa), flap tears (IIb), total endoscopic meniscectomy (IIc) and open meniscectomy (III). All together there were thirty-seven patients in the study. They were tested preoperatively and 1, 4 and 8 weeks postoperatively with a Cybex II isokinetic dynamometer. The extensor muscles of the knee joint were most affected. The flexor muscles were generally recovered in all groups within a month. Diagnostic arthroscopy and endoscopic operations for bucket handle ruptures showed no significant effect on the thigh muscle torque. With the other endoscopic operations there was a 30 percent decrease of quadriceps function 1 week after operation. After 8 weeks there was normal function again. Open meniscectomy, however, had a much more negative effect on the quadriceps muscle with a decrease of about 70 percent after 1 week. After 8 weeks, the rehabilitation was still not complete. In this way endoscopic meniscectomy is an attractive alternative in patients where rapid rehabilitation is desired.

#### LONG-TERM FOLLOW UP OF A DISTAL ILIOTIBIAL TRANSFER (DIT) FOR ANTEROLATERAL INSTABILITY OF THE KNEE

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60 patients ranging in age between 19 and 44 years (mean 27 years) underwent a DIT procedure for chronic antero-lateral rotatory instability. These patients were reviewed at 16 and 40 months postoperatively. The DIT-procedure was performed by rerouting a strip of the iliotibial band under the fibular collateral ligament and fixing it to the ligament with sutures. The distal insertion point was advanced anteriorly about 2 cm. The intention of this method was to provide a static extra-articular stabilizer on the lateral side of the joint. As part of the evaluation of these patients a knee function score (Lysholm & Gillquist 1982) was obtained on each patient both preoperatively and at follow-up. The maximum score possible was 100 points. Patients with a score above 77 points were rated as good or excellent. The mean preoperative score was 59 points ( $\pm 12.6$ ). At 16 months follow-up the mean score was 87 points ( $\pm 14.9$ ), an improvement of 28 points ( $P < 0.001$ ). However, at 40 months the mean score had dropped to 74 points ( $\pm 18.9$ ) ( $P < 0.001$ ). Preoperatively 7 percent of the patients were rated above 77 points, all were in the good category. At the 16-month follow-up 71 percent of the patients were rated in the good or excellent category, but at 40 months this figure had dropped to 41 percent. 7 patients (11.7 percent) had to be reop-

erated because of instability during the follow-up period.

Preoperatively all the patients were unstable showing antero-lateral rotatory instability. At 16 months 70 percent of the patients had a negative pivot-shift or Slocum-sign, but at the 40-month follow-up only 50 percent of the patients remained stable by physical examination.

While the initial results were encouraging, at 40-month follow-up it was concluded that the DIT-procedure does not function as a satisfactory method for providing extra-articular stability on the lateral side of the knee-joint. The study also shows that a longer follow-up than 16 months is necessary when evaluating the results of operations for knee instability.

#### LATE RESULTS AFTER HIGH TIBIAL OSTEOTOMY FOR MEDIAL GONARTHROSIS

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For a lasting result the magnitude of the required angular correction at high tibial osteotomy (HTO) must be accurately judged and the operation must be done with precision. To facilitate this a precise orthoradiographic method, the three-point technique, was devised for measuring the varus/valgus deviation of the knee. An instrument with high precision, the SAAB jig, was designed for removal of a wedge of the pre-determined size.

The purpose of the present study was to evaluate the results after 5.0–7.8 (mean 5.7) years, in terms of the patients' rating of the result and in terms of changes on X-ray according to the three-point technique.

On average the results lasted. 78 percent were "Acceptable" and 22 percent "Poor" compared with 81 percent "Acceptable" and 19 percent "Poor" after 1–2 years.

According to X-ray there was a return towards varus of 0.85° on average. This was not statistically significant. No knee that was corrected to more than 2.5° of valgus had a return towards varus. All knees with a varus/valgus deviation of more than 1° of valgus had acceptable results.

To get an acceptable *lasting* result HTO should aim at 3°–7° of valgus according to the three-point technique. In this series 78 percent of the knees had acceptable results compared with 81 percent after 1–2 years.

#### UNICOMPARTMENTAL ARTHROPLASTY OF THE KNEE WITH THE RICHARD MODULAR KNEE IN OSTEOARTHRITIS

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During 1974 to 1981 84 unicompartmental arthroplasties were made in 46 women and 32 men. Their mean age was 64 years. Five arthroplasties were made in the lateral and 79 in the medial compartment. Six of the medial were primarily combined with replacement of the patellofemoral joint. The follow up was 3.5 years on the mean, and more than half of the patients were followed for a minimum of 4 years. Five patients (with 6 operated knees) died during the time of observation. Of the remaining 73 patients 90 percent were still free or almost free from pain. In 90 percent the range of knee motion exceeded 80 degrees.

Early complications in 4 patients (5 percent) included 2 superficial wound infections which healed uneventfully. One patient was reoperated with re-positioning of the femoral component because of patellar conflict, and in another the arthroplasty was replaced by a tricompartmental prosthesis. Four patients (5 percent) had late complications. In 3 joints loosening of the prosthesis was suspected and one of these was revised. From the fourth knee a loose piece of bone cement was extracted after 1.5 years. Severe patello-femoral pain indicated subsequent patello-femoral replacement in 7 patients. Thus patello-femoral pain, severe enough to justify patello-femoral replacement, was present in not less than 15 percent of the cases.

It is concluded from this study that elderly patients with a moderate osteoarthritis of the knee can be treated safely with a unicompartmental arthroplasty. In addition the study shows that patello-femoral pain is frequent and often severe enough to indicate operative treatment.

#### SYNOVECTOMY IN BACTERIAL ARTHRITIS

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Twenty patients with bacterial arthritis with either delay in diagnosis or not responding to earlier treatment are presented. Synovectomy could prevent joint destruction in the knee but not in the hip.

## THE TOURNIQUET IN EXTREMITY SURGERY; HOW CAN COMPLICATIONS BE AVOIDED?

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The use of inflatable tourniquets in hand- and extremity surgery is a generally accepted method to induce a bloodless field. Still there is considerable disagreement with respect to critical limits for "ischemia time" and pressure in the tourniquet. We review all reported complications following bloodless field in the upper extremity. Complications were reported in one case per 1500–5000 surgical procedures. The symptoms varied from slight paresthesiae to complete paralysis of all three nerves in the arm. Usually, but not always, the lesions were reversible within 3–6 months. The "ischemia time" varied from 15 min to 2 hours and 30 min, and there was no or little correlation between severity of complications and length of ischemia. In 11 of 13 complications the *pressure in the tourniquet* was found to be *too high* when the equipment was checked postoperatively – the error varied from 100 to 310 mmHg. In 10 of these cases there was a *calibration error* involving the manometer; in one case the manometer was incorrectly adjusted to "leg pressure". Of the two remaining cases, one had a neurophysiologically diagnosed *conduction block* at the tourniquet level and one presented a very thin musculature in the upper arm.

*The conclusion* is that the neurological complications reported after bloodless field are based upon a *compression injury* induced by pressure from the tourniquet on underlying nerve structures. This conclusion is in line with our and other observations of "nerve fiber invagination phenomena" with corresponding myelin derangement at the marginal zones of compressed nerve segments. We have recently demonstrated that experimental compression of nerves is associated also with intraneural edema formation, increase in intrafascicular tissue pressure and interference with axoplasmic flow, and that the risk for nerve injury increases with increasing pressure.

Consequently, the pressure in the tourniquet should be kept as low as possible, preferably 50–75 mmHg above systolic blood pressure at surgery in the upper extremity and 100–150 mmHg at surgery in the lower extremity. *Calibration of manometers* is essential and should be performed at least once a week. The tourniquet should not be inflated for more than 1.5–2 hours.

## PROTECTIVE TREATMENT OF ULCERS ON THE DYSVASCULAR AND/OR NEUROPATHIC FOOT

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The treatment program of the dysvascular foot by F. William Wagner was adopted some years ago at the department of orthopaedic surgery of Norrköping. As an alternative to total contact walking casts, two types of protective shoes have been worked out in the treatment of foot ulcers in the neurovascular patients, mostly diabetics.

The first shoe, designed "walking bed" consists of a rigid foot-bed produced from a mold of a foot impression. It has a rigid rocker-bottom sole to distribute the pressure during walking and has an open fenestration over the ulcer.

The second shoe is to be used after healing of the ulcers and is made from the same last. It is a temporary shoe for the control of healing until the patient is fitted with an orthopaedic shoe or ankle-foot orthosis.

The course of treatment is demonstrated by two cases where amputation was suggested but healing achieved by protective treatment.

## FOLLOW-UP STUDY OF PATIENTS OPERATED FOR HALLUX VALGUS DURING A 5-YEAR PERIOD

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The author presents a follow-up study of patients operated for hallux valgus during a 5 year period 1976–80. The study is based on post-operative examinations of the patients. The results and complications are presented.

## LENGTHENING OF LONG BONES

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Since 1975 we have used the Wagner lengthening technique or the Hoffmann double frame system in treating severe arm or leg shortening (>40 mm). We have performed 37 lengthenings in 35 patients with shortening of congenital, infectious or traumatic origin, involving the femur in 23 cases, the tibia in 10 cases, the humerus in 2 cases, and the radius in 2 cases. The patients' age ranged from 1–21 years. Healing resulted in all cases, even though healing disturbances and complications requiring additional procedures did occur. Reversible partial peroneal paralysis and loss of knee and ankle mobility was noted during the lengthening and healing period but was always restored in the subsequent course. The use of the Wagner device in tibial lengthening invariably produced a substantial varus angulation. This complication could be avoided by changing to Hoffmann instrumentation or by using a Wagner device on both sides of the tibia.

The Wagner technique offers an accurate and safe method for lengthening the femur and humerus. For lengthening of the tibia or radius we prefer to use the Hoffmann instrumentation. However, lengthening of the long bones is always a time-consuming procedure, frequently associated with delayed healing, reversible paralysis, and impaired mobility of the adjacent joints. The treatment puts high demands on the cooperation of the patients and their parents.

#### THE HUMAN GROWTH PLATE. MORPHOLOGICAL APPEARANCE OF THE DIFFERENT CELL COMPONENTS. AN ELECTRON MICROSCOPIC STUDY

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Immediately after amputation through the upper part of the femur because of osteogenic sarcoma, the epiphyseal plate from the proximal tibia of three children, 8, 9 and 11 years old, was prepared for electron microscopic examination. Multiple samples were taken at different levels of the epiphyseal plate. The morphology of the cells composing these epiphyseal plates was studied. The chondroblasts in the epiphyseal plate are different in size, shape and organelle content depending on which part they are located in. Near the epiphysis, they are flattened with a scanty, organelle-poor cytoplasm with the endoplasmic reticulum as the dominating organelle. These cells seem to be in a resting phase. Chondroblasts located in the vicinity of the metaphysis are rounded, large and have an organelle-rich cytoplasm. The endoplasmic reticulum consists of dilated cisternae containing an electron-dense, finely granular material. The Golgi apparatus is well developed. The cytoplasm also contains a large number of lysosome-like structures. These findings indicate that these cells are very active. Intermediary forms between these two cell types can be found at different levels of the growth plate, with a progressive degree of differentiation the nearer their localization to the metaphysis. Furthermore, osteoblast-like cells and multinucleated giant cells occur frequently interspersed with the hypertrophic chondroblasts at the metaphyseal part of the growth plate. Thus the chondroblasts in the growth plate seem to migrate in a metaphyseal direction and develop from flat, organelle-poor cells with low functional activity into large, organelle-rich ones with a high metabolic rate of proliferation and hypertrophy. These findings suggest that most of the hypertrophic chondroblasts do not die. It seems likely that these cells take an active part in the process of mineralization and successively assume the appearance of osteoblasts.

#### WHAT IS THE TRUE TISSUE RESPONSE TO BONE CEMENT IN MAN? – AN ELECTRON MICROSCOPIC ANALYSIS OF THE INTERFACE

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An interesting combination of tissue reactions at the bone/cement interface was present in one patient with a loose McKee-Farrar total hip replacement. In the acetabulum there was the "usual" radiolucency of 2–4 mm. In the proximal femur the cortical bone had undergone almost complete resorption and the cement had fragmented. The metal stem was loose in the distal cement mantle, but the cement in turn was rigidly attached to the endosteal bone without signs of radiolucency in the X-rays.

At revision, biopsies were taken from the interface tissue in the acetabulum and from the bone surrounding the distal femoral cement. The tissue was fixed in glutaraldehyde and prepared for transmission electron microscopy.

In the acetabulum there was a connective tissue membrane separating the cement from the bone surface. The membrane was necrotic closest to the cement but vital in deeper parts, where it contained numerous active macrophages and fibroblasts. The macrophages contained lysosomes with an as yet unidentified digested substance. The bone was vital, resorbed in parts, but also covered with newly formed bone and a seam of active osteoblasts.

In the femur there was no soft tissue between the cement and the bone. The bone was vital. At the interface was a layer of proteoglycans of several microns between the collagen of the bone and the cement. Although in the light microscope the bone had no abnormal appearance, ultrastructural analysis showed important qualitative differences between this reaction and the reaction to inert materials, such as titanium.

#### EFFECTS OF GRADED COMPRESSION AND NUCLEUS PULPOSUS ON NERVE TISSUE: AN EXPERIMENTAL STUDY IN RABBITS

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Compression of a normal nerve root may be associated with numbness and motor weakness, but does not usually cause pain. However, if the nerve tissue is chronically irritated, mechanical deformation may induce radiating pain. Thus, intraneural inflammation seems to

be a factor of importance in the pathogenesis of pain production in nerve root compression syndromes. It is debated whether such intraneural inflammation is the result of an inflammatoric effect of nucleus pulposus on nerve tissue ("chemical radiculitis") or is an effect of mechanical nerve root deformation by the herniated disc.

A method is being developed for studying the effects of nucleus pulposus on nerve tissue, alone or in combination with pressure. The rabbit lumbar spine is exposed by a lateral, retroperitoneal approach and 1-4 discs are incised through the annulus fibrosus. Nucleus pulposus is removed and placed around the tibial nerve in the same animal. The contralateral tibial nerve is used as control and various autologous tissues, e.g. fat, muscle and fascia, are applied to this nerve. Animals have been analyzed 1 week later for intraneural edema formation (fluorescence microscopy of the nerves following intravenous infusion of albumin labelled with Evans Blue) and intraneural inflammatory cell reactions (histological analysis). We have not found any significant edema formation or inflammatory cell reaction in the nerves exposed to autologous nucleus pulposus as compared to the control nerves, exposed to autologous fat, muscle and fascia.

In long-term experiments, nerves are subjected to both nucleus pulposus and controlled compression. The tibial nerves in both legs are exposed and simultaneously compressed by "mini-cuffs" for 2 hours at pressure levels varying from 50 to 200 mmHg. Directly following pressure release, autologous nucleus pulposus is applied to one of the nerves and the wounds are closed. At various time intervals, nerves are analyzed as described above, and also with respect to nerve function and nerve fiber structure. This model allows the analysis of the relative importance of mechanical and chemical factors respectively, for the development of nerve tissue damage in connection with herniated nucleus pulposus.

#### SHOULDER MUSCLE LOAD IN DIFFERENT WORKING POSTURES

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Overload of shoulder muscles followed by pain and at times chronic diseases, are common impairments in the working population. These disorders are incompletely diagnosed and classified. In order to clarify how working postures and hand tool weight influence muscle load, the force distribution between various muscles in the shoulder complex is of interest. EMG signals were collected from three elevating and three stabilizing shoulder muscles. 20 postures were studied within

0°-90° of upper arm flexion and abduction at zero, one and two kilogram hand tool weight in nine healthy male subjects. The signals were picked up by means of single intramuscular wires and they were analysed for r.m.s. content using a special software analysis package. The results show that increased hand tool weight, within these postures, only influence the load on one stabilizer; the infraspinatus muscle. For all studied muscles, a high upper arm angle yields a high muscle load. Flexion or abduction of the upper arm does influence the elevators but not the stabilizers. Change of elbow angle or of upper arm rotation does not influence muscle load. The findings indicate that it is more important to position the elbow at a low level rather than to avoid hand load in order to avoid overload of shoulder muscles.

#### THE RELATION BETWEEN INTRAMUSCULAR PRESSURE AND SPECTRAL EMG CHANGES DURING ISOMETRIC MUSCULAR WORK

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Spectral changes of the EMG signal have previously been shown to correlate well with localized muscular fatigue. The shift towards lower values of the EMG signal mean frequency accompanying muscular fatigue is probably mainly caused by a lowered propagation velocity of the muscle fibre membrane action potential. As the membrane function of the muscle cell is dependent upon normal metabolic functions, spectral changes of the EMG signal should be elicited by intramuscular pressures large enough to disturb the capillary filtration equilibrium of the muscle. This hypothesis was tested in the present investigation.

Eight healthy male subjects performed standardized isometric contractions of the biceps brachii with the elbow fixed in 90 degrees of flexion. The EMG signal and the intramuscular pressure were recorded simultaneously from the *m. biceps brachii*. The intramuscular pressure was visually fed back to the subject, who was told to generate by isometric contractions a pressure of 60-80 mmHg for 20 seconds and then for another 20 seconds a lower pressure of 0, 10, 20 and 30 mmHg, respectively in different series of measurements. The 40 second cycle was repeated three times in each experiment.

At each contraction to 60-80 mmHg the EMG mean frequency was significantly lowered indicating muscular fatigue. During the lower contraction levels following the high ones the spectral changes recovered to 90 percent when the pressure was 0 and 10 mmHg and to 80 percent when it was 20 mmHg. However, when the

lower pressure was 30 mmHg there was only recovery with 10 percent.

The present data shows that the ability to recover spectral EMG changes elicited by fatigue is greatly affected by the intramuscular pressure. At a pressure between 20 and 30 mmHg this ability rapidly decreases, which coincides well with the interstitial pressure that can abolish capillary filtration.

#### ELECTRICAL STIMULATION OF BONE FORMATION IN TITANIUM IMPLANTS

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Several experimental studies of fracture healing have shown that electrical stimulation with direct current of 5–20  $\mu$ A has resulted in increased bone formation (for review, see Becker 1979). Much less is known of implant behaviour in an electrical field. In the present experiment, titanium electrodes were placed at 6 mm distance from a titanium implant, the Bone Growth Chamber (Albrektsson et al. 1982), which was inserted in the rabbit tibia. The chamber allows quantitative and qualitative evaluations of the bone response, in this case following electrical stimulation with constant current of 5, 20 and 50  $\mu$ A amplitude.

A computer-based analysis of microradiograms obtained from bone that had grown into the implants, showed that electrical stimulation produced a statistically significant increase in bone formation. On the average, there was 65 per cent more bone on the stimulated side compared to the control implant in the contralateral extremity of the same animal. There was a general tendency of increased bone formation in the immediate vicinity of the titanium cathode. In the 50  $\mu$ A-Group there was bone resorption noted around the anode, which affected its anchorage and in some cases led to displacement of the anode. This may have changed the quality of electrical stimulation in some of the 50  $\mu$ A-cases. All other electrodes were stable in the bone 3 weeks after insertion.

This experiment has shown a numerically verified increase of osteogenesis after electrical stimulation of the healing-in of a titanium implant in a long bone of the rabbit. The material is, however, too small to allow a safe comparison between the different stimulation levels.

#### RELIABILITY OF THE MOIRÉ METHOD IN DIAGNOSIS OF STRUCTURAL SCOLIOSIS

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The moiré method was used for diagnosis and documentation in a consecutive series of scoliosis patients during 1 year. The moiré findings were compared with X-ray findings. Analyses of 157 observations in 132 patients are presented. There were 108 structural curves, i.e. a scoliosis with a Cobb angle  $\geq 5^\circ$  and rotation.

One false negative finding was observed. That was in a  $5^\circ$  thoracolumbar scoliosis. There were 13 per cent false positive moiré findings. An asymmetry of one moiré fringe implied a curve of  $\leq 20^\circ$  except for one patient with a thoracolumbar curve of  $21^\circ$ . With an asymmetry of  $\geq 2$  fringes there was 25 per cent risk of finding a structural curve exceeding  $20^\circ$ . A wide distribution of radiographic lateral deviation was observed in all intervals of moiré asymmetries. A closer relationship between the moiré asymmetry and X-ray findings was found for the lumbar curves as compared with the thoracic or thoracolumbar curves.

The risk of obtaining false negative findings with the moiré method is negligible. The indication for subsequent X-ray control can be set at an asymmetry of  $\geq 2$  moiré fringes without the risk of missing a presumptive case requiring treatment. The moiré method can essentially reduce the number of X-rays in the management of smaller curves.