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Experimental orthopedics

Inhibition of fracture healing by oral and by local treatment with indomethacin

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The effect on fracture healing by oral administration of indomethacin was compared with the effect of local application of the drug in the fracture area. Totally, 160 young, male rats were used. A unilateral, mid-diaphyseal closed femur fracture was performed in all the animals, and the fractures were left to heal without immobilization. In one group of rats, half of the animals were given indomethacin via a stomach tube once daily (2 mg/kg/day) for 10 days; the controls received only the vehicle. In a second experiment, a bioerodible polymer impregnated with 0.5 mg indomethacin was applied in the fracture area in half of the rats at the start of the experiment; in the others, only the polymer was applied. In both experiments, groups of animals were killed on days 0, 5, 10 and 20. Fracture healing was evaluated by measuring the ventral angulation of radiographs and by manually testing the stability of the fractures in the dissected femurs.

The serum concentration of indomethacin by oral treatment was in the range of the lower human therapeutic levels (about 0.5 g/ml), whereas the drug could not be detected in the serum (i.e., less than 10 ng/ml) by local treatment.

Our results show that indomethacin inhibits fracture healing both when given orally and applied locally. The amount of indomethacin applied locally was only about one fourth of that given systemically. The inhibiting of the fracture healing seems, however, to be about the same.

Inhibition of prostaglandin synthesis and bone healing: An experimental investigation in rabbits

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Prostaglandins are supposed to play a major role in the fracture healing process. In the present study the influence of indomethacin was assessed after a midshaft osteotomy of rabbit tibia fixed with an AO plate. One group of rabbits (N=6) served as a control. Regional blood flow was measured with the tracer microsphere technique. The AO plate was removed after which bone mineral content was determined by photonabsorptiometry and mechanical strength of the osteotomy was recorded in a testing machine applying three-point bending.

The blood flow of the osteotomy side was significantly increased in the indomethacin group compared with the control group. Both mechanical strength of the osteotomy and the bone mineral content of the tibia were significantly reduced in the indomethacin group. The results suggest that the metabolism at the osteotomy side was still elevated 6 weeks after the osteotomy.

In conclusion, we found that the healing of the tibial osteotomy was delayed after inhibition of the prostaglandin synthesis, probably due to an inhibition of the inflammatory response.

Prevention of experimentally induced ectopic bone formation: A comparative study of the effects of radiation, indomethacin, prednisolone, and oral EHDP

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Several treatment modalities have been used in the prevention of ectopic bone formation, but no comparative study has previously been done. We have compared radiation, indomethacin, prednisolone, and EHDP treatment in the prevention of myositis ossificans in rabbits using immobilization and passive manipulation of the knee.

Forty male New Zealand rabbits were used, and the amount of ectopic bone was determined by planimetry of serial transverse sections through the femur. In addition, the degree of stiffness was recorded during the course of treatment.

We found that the amount of ectopic bone was significantly lower in the groups treated with radiation, prednisolone, and indomethacin, but insignificantly higher in the EHDP group. The control animals and EHDP-treated group became very stiff, whereas the prednisolone group and the indomethacin group offered the least resistance to the manipulations. Histologically, we found that most of the bone was formed by intramembranous bone formation, but cartilage was also present.

It appears that radiation, indomethacin, and prednisolone treatment were equally good in preventing ectopic bone formation, but that most likely there is a difference in their mode of action.

Intraarticular administration of indomethacin in rabbits

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The adverse reactions from the intestine and the central nervous system following peroral administration of NSAIDS, e.g., indomethacin, limits the utility of these drugs in the treatment of joint diseases. One possible way to reduce these side effects would be to inject the drug into the joint. A prerequisite for this treatment is, however, that the drug itself does not cause any damage to the joint structures. This study was undertaken to investigate whether intraarticular injections of indomethacin were accompanied by harmful local effects.

Indomethacin (Indocid) was injected at a concentration of 3.3 mg/kg body weight in one knee of 12 rabbits, whereas the other knee served as the control and was injected with the same volume of isotonic saline. The injections were repeated three times at 5 days' interval. Following an injection-free period of 4 and 8 weeks, respectively, the animals were killed. All the internal organs were examined macroscopically, whereas specimens from the knees were processed for histopathologic studies. Thus, coded specimens of the synovial membrane from three predetermined sites of the joint were evaluated semiquantitatively for the parameters edema, hyperemia, and cellularity. Further, the thickness and the cellularity of the cartilage was estimated.

No significant differences could be detected between drug-injected and saline-injected knees in terms of signs of reactive or inflammatory changes in the synovial membranes. Moreover, the drug-injected knees showed no signs of degenerative changes in the cartilage when compared with the control knees. The results of the present study thus indicate that indomethacin itself causes no harm to joint structures when injected.

Wear tests on surface-hardened C.P. Titanium combined with UHMWPE

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It has been questioned whether titanium and its alloys can be used for bearing surfaces in combination with UHMWPE in joint replacements. Although several laboratory wear studies indicate that Ti-alloy (Ti-6Al-4V) produces about the same wear rates as stainless steel or chrome-cobalt alloys, there are other reports (Rostocker & Galante 1981) revealing that "the wear behaviour of the system titanium – polyethylene is unstable." To increase the wear resistance of articulating Ti-alloy implants, surface hardening techniques have been developed and adopted in the production of joint substitutes for clinical use (Harris & Galante 1985).

Even if it seems clear that the articulating surface of a Ti-alloy implant passivated by a protective film more effectively resists the effects of primary or third-body friction or wear, it remains to be settled if any one of

the available surface treatments may be superior; and also if commercially pure titanium, which is softer than Ti-alloy, benefits from surface treatment with respect to the influence of polyethylene wear.

Nitrogen-ion implantation of titanium wear surfaces was investigated as a means of improving the wear resistance of c.p. titanium utilizing a pin-on-plate wear screening device. Surfaces modified by nitride coating (TiN) and nontreated titanium surfaces were also tested, as well as 316 stainless steel surfaces serving as controls. Most tests were run at a contact stress level of 8 MPa and human serum was used as a lubricant. The weight and length of each PE-pin were assessed before and after testing. Light and electron microscopic examinations of metal surfaces were performed.

The results of the tests indicate that nitrogen-ion implantation of Ti surfaces produce lower UHMWPE wear rates than nontreated titanium. By varying load and speed of the running PE-pin, different friction coefficent values were obtained – all within the range of 0.02 and 0.18 – and were distributed along Striebeck curves that had identical appearances for both ion-implanted titanium and stainless steel. These two couples also had similar surface appearances, with only minimal microscopic signs of abrasion. Finally, the polyethylene wear rates did not show any dissimilarities between ion-implanted Ti/PE and stainless steel/PE combinations.

Strain gauge implantation and in vivo strain measurements in rat femora

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Prefabricated, unidirectional strain-gauge units were implanted bilaterally in rat femora to measure strain in vivo. The strain signals proved to be synchronous with the rat's walking. The mean peak strain values varied between 328×10^{-6} and 394×10^{-6}. There were no statistical differences between recordings at different times after operation as evaluated by measurements at days 2 through 7. Nor were there any significant differences between the three different speeds – 6, 10.2, and 14.7 m/min – or between the peak strain values of the right and left femur.

Showing good reproducibility from one implantation to another, this method is applicable to rats as a group.

The method seems suitable for the in vivo study of mechanical changes in bone.

The effect of a penetrating biodegradable polydioxanone implant on the epiphyseal plate: An experimental study on growing rabbits

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Epiphyseal injuries are common in children. Transepiphyseal injuries are perhaps the most significant ones clinically. Central epiphyseodesis – caused by an undisplaced fracture or transepiphyseal wires or pins used to fix a growth plate injury and later removed – generally do not produce permanent growth cessation, because the pressure of growth will be able to break a minor bone bridge. Bone bridge formation after trauma to the growth plate can be prevented with allograft cartilage, autogenous fat, and with a silicone-rubber implant. There are no experimental studies on the effect of the growth plate piercing a biodegradable polydioxanone (PDS-) implant on the epiphyseal plate and on the growth of the bone.

Eighty rabbits, 5 weeks of age, were operated on. In two groups a drill hole – 2.0 mm or 3.2 mm in diameter – was made in the intercondylar portion of the right femur across the central portion of the growth plate up to the diaphysis. In two other groups, similar drill holes were made and a polydioxanone implant, 2.0 mm or 3.2 mm in diameter and 25 mm in length, was placed in the drill hole.

A polydioxanon implant placed through the growth plate of a growing rabbit femur caused similar retardation of growth as a drill hole of equal bore when a 3.2 mm drill was used. A 2.0 mm polydioxanon implant did not cause any permanent growth inhibition.

Porous glassy carbon as a bone substitute

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Cylinders of porous glassy carbon (4.5×4.5 mm and 4.5×3 mm, surface porosity 55 per cent, average pore size 200–300 μm) were implanted in drill holes in

diaphyses and metaphyses of rabbit tibiae. The implantation time was 1, 3, 6, 12, and 24 weeks. Bone ingrowth into the glassy carbon implants was examined by histologic, fluorochromic, radiographic, and microradiographic methods.

At first the implants appeared radiolucent, but later on increasing radiopacity was observed. As measured from the side projections of the implant cylinders at 24 weeks, the implants were were surrounded by an 1.6 fold thickened cortex.

Tissue ingrowth into the pores was seen in all the methods of investigation. The ingrowth was more distinctive in those areas where the implant was in intimate contact with cortical bone or the trabeculae of the cancellous bone. The material itself does not seem to induce osteogenesis; bone growth into the implant pores was scanty in the region of the medullary cavity.

Experimental osteotomies treated with internal plate fixation or a plaster cast

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The optimal conditions for fracture healing are still a controversial question. The aim of the present study was to compare the speed of bone union after plate fixation with that after plaster immobilization.

Sixteen rabbits were used. After unilateral, transverse osteotomy of the tibial shaft, fixation was accomplished with a 6-hole steel plate (cross-section 5×1 mm) in half of the animals, and with a plaster bandage from the toes to the midthigh in the other half. The animals were killed after 6 weeks, and bone healing assessed by radiography, measurement of periosteal callus, and biomechanical testing in 4-point bending.

Radiographic healing had taken place in all the plated osteotomies and in 5 out of 8 osteotomies in the plaster group. The plated bones healed without angulation. In all the bones with a plaster cast, moderate angulation occurred. The amount of periosteal callus was small in the plated group and relatively abundant in the plastered bones, and the difference was highly significant (P=0.0002). The median strength and stiffness of the plated bones were 107 and 126 per cent, respectively, of their contralateral control tibiae, compared with 50 and 47 per cent, respectively, in the plaster group. The difference in strength was significant (P=0.013), but that in stiffness was not (P=0.065).

We concluded that the speed of bone healing in the rabbit tibia was more rapid after rigid plating than after plaster immobilization. The cause of the better healing after plating might be the more rigid fixation, the faster and more complete restoration of the function of muscles and joints, or a combination of these factors.

Stabilization of femoral pseudarthroses in rats

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Hypertrophic pseudarthroses are believed to have good potential for bony healing, and union may be achieved by mere stabilization. It is uncertain if this potential for union is preserved for an unlimited time. This experiment was designed to evaluate the potential for union at different time intervals

Thirty-nine young adult rats were operated on with midfemoral transverse osteotomies on the left side. Rotationally unstable intramedullary osteosynthesis was performed by reaming to a diameter (1.9 mm) slightly greater than the nail diameter (1.8 mm). At 6 weeks, 11 of the ununited femora were stabilized by cementing the nail ends to the bone with composite resin. At 18 weeks, 7 of the still ununited femora were stabilized in the same way. Union was evaluated from radiographs taken with 2-week intervals, and healing was followed for 1 year or until union occurred.

Stabilization at 6 weeks increased the rate of union compared with unstabilized femora. Stabilization at 18 weeks could not be proved to have this effect. Union did not ever take place more than 22 weeks after osteotomy. The pseudarthroses still appeared to be "hypertrophic" after 1 year.

We conclude that the potential for union gradually declines and that ununited femora in rats after 22 weeks may be termed nonunions.

Immobilization results in early aseptic arthritis and subsequent capsular osteochondromatosis in rabbit knee

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The aim of this study was to analyze the intraarticular and periarticular changes in rabbit knees after immobilization.

Material and methods. The right hind knee of adult rabbits was immobilized using a splint in extension with the hip free and movable for various periods of time. The synovial and fibrous capsules and the cartilage were studied histologically. In the synovial fluid the cells and the content of the lysosomal enzyme N-acetyl-D-glucosaminidase were analyzed.

Results. Within a few days an aseptic inflammation developed in the immobilized knees, with a marked effusion of synovial fluid, proliferation of the lining cells in the synovial membrane, and diffuse mononuclear cell infiltration, and subsequent fibrosis in the capsule of the joint. Within a few weeks after the 5-week immobilization period, typical synovial villi and pannus were visible. Under the pannus, depletion of proteoglycan from articular cartilage was observed. During the first few days of immobilization, there was a high content of N-acetyl-D-glucosaminidase in the synovial fluid. Within 2 months, periarticular cartilaginous and osteocartilaginous masses developed in the capsule especially if the limb was passively exercised during the immobilization period.

Conclusion. Immobilization of rabbit knees, especially in extension, is obviously deleterious, resulting in early changes in all the tissues of the joint. After an immobilization for a few weeks, the changes are usually permanent, with thickening, stiffening, and degenerative osteocartilaginous changes as the end result.

Patellar malalignment: An experimental study in rabbits

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Patellar malalignment was induced in 30 rabbits by lateral displacement of the tibial tuberosity on the right knee. On the left side (control) the tuberosity was osteotomized and refixed in situ. The knee joints were not opened. Half of the animals were killed after 6 weeks and the remainder after 3 months. Safranin-0-fast green-iron hematoxylin was used for histologic-histochemical grading of the cartilage changes (grades 0–12).

After 6 weeks, only slight degrees (grades 1–3) of microscopic cartilage degeneration was seen on the experimental side, but the content of glycosaminoglycans was reduced in 14 knees on the right side and 2 on the left side. After 3 months, macroscopic changes were visible in 5 knees on the experimental side, especially on the facets submitted to hyperpressure. Microscopic changes similar to early arthrosis (chondromalacia) grades 1–10 were found in all right knees compared with 2 control knees. In no case was the subchondral bone exposed.

This experimental model reproduces articular changes resembling those of chondromalacia patellae and suggests that patellar malalignment plays an important role in the development of patellofemoral arthrosis. The model can be used for further studies on the etiology and pathology of chondromalacia of the patellae.

Septic arthritis: The natural course in rabbits

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An experimental infection model was developed to disclose the time-related changes in the course of untreated septic arthritis, the purpose being to compare different therapeutic measures.

Eighty-seven rabbits were infected in one knee with *Staphylococcus aureus*. No treatment was instituted and the animals were killed at different periods from 1 to 94 days after inoculation. The intraarticular temperature was measured and the lysosomal reaction was examined semiquantitatively. The joint destruction was evaluated macroscopically and microscopically in serial sections of the patella stained with Hematoxylin-eosin and Safranin 0.

From the fifth day, marginal erosion and undermining of the cartilage border was observed. This process continued gradually with total joint destruction after 5 weeks. The GAG depletion could be visualized from the surface of the cartilage on Day 2 and was total after 2 weeks.

In this model of septic arthritis, the synovial tissue demonstrated increasing destructive characteristics, and signs of irreversible changes of the cartilage were demonstrated from the fifth day. Early and aggressive treatment appears mandatory.

Osteoporosis

Micromorphology of bone tissue after fracture

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It is known from many noninvasive studies that after a fracture considerable amounts of mineral are lost in the fractured extremity. In some case this loss of calcium can be more than 50 per cent at a distance away from the fracture site.

Because of inaccessibility of suited bone samples, but also because of unavailable microscopic and ultrastructural technique, this loss of mineral has not previously been morphologically investigated in man.

In this study, histomorphometry and quantitative electron microscopy, as well as conventional radiography, have been used. Biopsies were taken from the

greater trochanter in 32 patients who had had a fracture of the same femoral neck some time previously, and from the proximal metaphyseal part of the tibia in 20 patients who had had a diaphyseal fracture also at various times earlier. The bone samples were investigated undecalcified by the above-described technique. The width of the femoral diaphyseal cortex after tibial fracture was also studied in 21 patients.

We found that not only the cortical and trabecular bone volumes were decreased, but even more so: there was demineralization of the remaining bone. In central parts of bone trabeculae, the concentrations of calcium and phosphorus were decreased from 45 weight per cent and 21 wt per cent to 29 wt per cent, respectively. The osteoclast activity was increased until half a year after the fracture. The osteoblast activity was proportional to the increase of osteoid tissue. The mineral loss was most pronounced during the second half year after fracture, but even many years later there was a persistent total bone loss.

The influence of postfracture osteoporosis on the occurrence of later fractures

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Some fractures lead to persisting osteoporosis of the fractured bone/s and also adjacent bones. This study was undertaken to determine whether past fractures increase the probability of later fracture in the same extremity.

Patients with fractures treated in the orthopedic and casualty departments of Trondheim University Hospital were questioned with regard to earlier fractures. A total of 5,572 patients were registered during a 37-month period.

In the upper extremity there was a significantly increased incidence of metacarpal/phalangeal fractures on the side where such fractures had occurred previously compared with the contralateral side and few Colles' fractures on the same side as previous Colles' fractures.

In the lower extremity, as previously reported, second ipsilateral hip fractures were uncommon. We found a significantly increased risk of femoral shaft, subtrochanteric and supracondylar fractures, tibial condyle and shaft fractures, and patellar fractures to occur on the same side as previous lower extremity fractures compared with the contralateral side. Furthermore, lower extremity fractures after past femoral shaft and tibial fractures occurred significantly more frequently in the ipsilateral extremity. The same was found for hip fractures and hip prostheses when subsequent hip fractures were disregarded.

Heredity and osteoporosis

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Environmental and genetic factors have been considered to be of etiologic importance for osteoporosis. Negroes have greater bone mass than Caucasians, but it is not known if there is a hereditary factor within the ethnic groups. In Malmö there is a defined population of about 250,000 and one department for diagnostic radiology where all radiographs since the beginning of the century have been saved.

Osteoporosis was, for the purpose of this study, defined as crush fractures of one or several vertebrae in the thoracic or lumbar spine following low-energy trauma. Cases with osteopenia due to known disease or drug use were excluded. The files were screened for daughters of women who in the 1950s were between 55 and 75 years of age and who at that time had radiographic osteoporosis. Totally, 114 women – mothers – were found. By using community records, we could identify 49 of their daughters who are still residing in Malmö. Two randomly age-matched controls for every daughter were sampled from the city files and all the fractures during the past 35 years in the two groups were recorded. The age of the subjects at the time of the investigation was 64±8 years. Eighteen of the 49 daughters had had one or more fractures – all types – compared with 33 of the 98 controls. Fragility fractures were nine and 24, respectively. Consequently, we found no evidence of a hereditary factor predisposing to fractures in our population.

Bone mass and menopause

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Totally, 140 women were followed from aged 49 years for 7 years. During this time, their menopause occurred. Only women who had not received any hormonal substitution were included. The bone mineral mass was measured repeatedly (forearm single-photon absorptiometry). Also, repeated hormonal analyses were performed and the exact time of menopause was established from the estron, estradiol, and FSH levels, rather than merely from the cessation of menstrual periods.

There was a rapid loss of bone after the hormonal menopause – 3 per cent per year in the trabecular bone and 1 per cent in the cortical cone, whereas before menopause there was no decreasing tendency.

In the past, there has been some disagreement about the importance of the menopause for bone loss in women. It has not been possible to make any sharp distinction between menopausal changes and changes with age. In cross-sectional studies, we see the effect of both. Also, menopause is a somewhat elusive concept.

In this prospective study of women of the same age and with their menopause established by hormonal analyses, it became obvious that the breaking point is the menopause. The rate of loss in mineral mass in one of our measuring sites, the trabecular bone in the distal end of the forearm, is very rapid and may explain the early rise in the incidence of Colles' fracture, the earliest of the fragility fractures.

Changes in fracture type and bone mass in hip fracture patients during 30 years

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There is ample evidence of an increasing incidence of hip fractures during the last few decades. The objective of the present study was to examine possible changes in bone mass of the hip in hip fracture patients over the last three decades by retrospective bone mass estimates and by classification of the fractures.

Radiographs of hip fractures between 1950 and 1957 (841 fractures) and between 1983 and 1984 (888 fractures) were reviewed. Cervical fractures were classified according to Garden, trochanteric fractures according to Evans. Bone mass was estimated by the Singh index and by the femoral neck index (FNI - thickness of the medial cortex of the femoral neck in relation to the total width of the neck).

Results. Fracture patients were on the average 7 years older in the 1980s compared with the 1950s in both sexes.

Cervical fractures were significantly more displaced (Garden 3 and 4) in the 1980s in both sexes as compared with the 1950s. FNI was significantly less in women – in men, only below aged 75 in the 1980s – and the Singh index was significantly less in women.

In trochanteric fractures there was no change in the distribution between Evans' groups of classification. FNI was less in the 1980s, but the difference was significant only in men over aged 75, whereas the Singh index was significantly lower in women.

In the 1980s, cervical fractures had significantly lower FNI than the trochanteric fractures in both sexes, whereas trochanteric fractures had a significantly lower Singh index than cervical fractures.

It appears as if the bone loss differs between the two types of fractures. Also, our findings suggest that bone mass in hip fracture patients has decreased over the last three decades.

Changes in the incidence of fracture of the upper end of the humerus during 30 years

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The hip fracture incidence has increased in the last decade.Fracture of the upper end of the humerus is another fragility fracture that may have increased in a similar way.

Material and methods: Virtually all the fractures that occur in Malmö residents, a defined population, will be examined and recorded in the Department of Diagnostic Radiology. All the radiographs have been saved over the years, and since 1950 the classification and registration have remained unchanged.

All the radiographs of fractures of the upper end of the humerus from the years 1950–1954, 1961–1964, 1971–1973, and 1981–1982 were reexamined and the fractures classified according to Neer. Number, age, and sex were recorded and related to city-population census figures for the corresponding time periods. Totally, 2,125 fractures were studied.

Results: There has, over the years, been a steady increase in the age- and sex-specific incidence of fractures. In elderly women the fracture risk is now doubled as compared with the 1950s, and men today have as many fractures as women had in the 1950s.

Today, 32 per cent of all the men with a fracture of the upper end of the humerus in the age-group 35–54 were registered at the Department of Alcohol Diseases. In total, 18 per cent of all the men with this fracture were registered.

Not only the simple Neer I-type fracture has increased, but also, and even more, the more severely dislocated and comminuted fractures.

The fracture of the upper end of the humerus follows closely the pattern of change previously observed in hip fractures in both sexes.

The partridge cerclene system for femoral fractures in patients with osteoporotic bone

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Eight cases of femoral fractures around or just below a hip prosthesis are reported. The patients were treated with nylon splints and nylon cerclage using the method described by Partridge & Evans. All 8 fractures united without complications, and early mobilization with a Thomas' splint was possible.

We find that the method provides a satisfactory alternative to conservative treatment in elderly patients with osteoporotic bone and fractures around or just below a hip prosthesis.

Regional osteoporosis after nailed and plated femoral shaft fractures

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Totally, 22 patients who had been operated on for isolated femoral shaft fractures between 1978 and 1983 were studied. None had suffered previous or subsequent injuries to either lower extremity. Eleven patients had been treated with intramedullary nailing and 11 with AO-plates. These two groups were comparable with respect to fracture type, sex, and clinical end result. The plated patients were studied 55 (±16) months and the nailed patients 37 (±18) months after fracture. The mean time from fracture to full weight bearing was 16 (±3.5) weeks for the plated patients and 7 (±6) weeks for the nailed patients.

Photonabsorptiometric determination of the bone mineral density (BMD) in both lower extremities was performed. The BMD of the injured side was compared with that of the contralateral side. A mean of 12 per cent had been lost in the distal femoral metaphysis, 7 per cent in the proximal tibial metaphysis, and 2 per cent in the tibial mid-diaphysis. The mean loss was almost identical in the two groups.

Conclusion: After operative treatment of femoral shaft fractures, the bone mineral loss is moderate in the metaphysis at the knee and insignificant in the tibial diaphysis. Whether the fracture is treated by plating or intramedullary nailing does not affect the degree of bone loss.

Bone density of the femoral and tibial condyles evaluated by computed tomography

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Quantitative computed tomography may offer a useful means of estimating bone mineral content and the development of osteopenia. To test this approach in localized peripheral regions, measurements were made in the femoral and tibial condyles of patients after ankle fractures.

Six females and 6 males were evaluated. The median age was 54 (24–69) years. Half of the patients have been followed for more than 6 months.

Contiguous slices were made from the cranial part of the femoral condyles to the caudal part of the tibial condyles. Consistent slices from each condyle were selected for quantitative analyses. The density was measured as the mean of a volume containing mainly cancellous bone.

The initial measurements showed a range of density from 110 to 280 Houndsfield units (HU) in the femoral condyles and 70 to 250 HU in the tibial condyles. The median coefficient of variance for bone density in longitudinal measurements was 0.06 in the femoral and 0.03 in the tibial condyles of the uninjured limb. The coefficient of variance of all consistent tomograms was 0.22 in the femoral condyles and 0.23 in the tibial condyles of the same limb. The latter figures included the biological and methodological variability of the method.

Thus, for the detection of incipient osteopenia, longitudinal studies in the same patient are required. The study also suggests that the determination of bone density by computed tomography is more accurate in the tibial than in the femoral condyles.

Posttraumatic osteopenia after ankle fractures

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Lasting ipsilateral osteopenia and increased amounts of osteoid tissue have been reported after femoral and tibial shaft fractures. Geiser and Trueta (*J. Bone Joint Surg.* **40-B**, 282–311, 1958) proposed that immobilization, rather than the fracture itself, was important for

these posttraumatic bone changes. To test this hypothesis, the bone mineral content of the femur and tibia was studied after ankle fracture.

Twelve randomly selected patients – 6 males and 6 females – were studied. Their median age was 54 (24–69) years. All the fractures were treated with osteosynthesis, and the ankle joint was immobilized with plaster for 3 days. The patients were mobilized on crutches with weight bearing on the affected limb for 6 weeks postoperatively. Full weight bearing was allowed 8 weeks after the operation.

Quantitative computed tomography was used to determine the bone mineral density in the femoral and tibial condyles. The precision of this method is about 5 per cent. The mineral content was determined on the first or second postoperative day, at 2 and 6 weeks, and at 3, 6, 9, and 12 months after the operation.

At present, 6 of the patients have been followed for 12 months and the others for shorter periods. The ankle fracture imposed a minor, but significant, osteopenia in the hips, and later in the femoral and tibial condyles. The osteopenia was most pronounced 6–9 months after the fracture and amounted to 10 per cent. The osteopenia seemed to be reversible in the tibial condyles.

The findings suggest that 8 weeks without full weight bearing is sufficient to cause regional osteopenia in a nonimmobilized leg with ankle fracture.

The influence of early weight bearing and muscle activity on the development of regional osteoporosis after ankle fractures

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Fifty-seven patients who were operated on for ankle fractures were randomized to one of three groups for the 6 postoperative weeks: A) No immobilization or weight bearing – active muscle activity; B) Leg cast – no weight bearing; C) Leg cast – full weight bearing. Photonabsorption determination of bone mineral content (BMC) at various levels of the lower extremity was performed on both legs 2 days after the operation and 6, 16 (n=54), 34 (n=45), 52 (n=27) weeks postoperatively.

No significant change in BMC was observed in the femoral diaphysis. Group A patients lost significantly less bone in the distal femoral and proximal tibial metaphysis than groups B and C. BMC values were identical in all the groups in the tibial mid-diaphysis. In the distal tibial diaphysis, group B lost the least bone initially; but bone loss continued for a longer period of time in this group. Towards the end of the study, most measured levels showed a tendency for lost bone to be regained.

Conclusion: The least amount of bone is lost after ankle fractures if muscle activity without weight bearing is allowed.

Pediatric orthopedics

Does the paresis of the antagonist change after an elongation of the agonist in cerebral palsy?

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The strength of the dorsiflexors of the foot and of the m. quadriceps was measured before and after elongation of the Achilles tendon or the hamstring tendons.

The result showed that the weak antagonist becomes stronger after the elongation of the agonist.

The conclusion is that a free mobility of a joint is a precondition for the best function of the surrounding muscles in cerebral palsy.

Are dislocated hips in cerebral palsy suitable for operative treatment?

Cato Hellum

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Dislocation is caused by inappropriate body positioning, unbalanced muscular activity, and uncontrolled voluntary movement. The risk is greatest in the most seriously affected children with deep psychomotor retardation and no walking ability.

A "windswept" appearance is common and is often associated with a wrong sitting position, increasing care problems, occasionally hip pain, and often the development of scoliosis. Conservative treatment over a long period is difficult to maintain.

In Kronprinsesse Märthas Institutt, 116 children in this category were treated operatively during the period 1973–1984. The main goal was to counteract the asymmetry including the threatening scoliosis and to a lesser extent to reverse the dislocation. Our methods have been more or less radical adductor tenotomies, iliopsoas transfers, rotational osteotomies, and shelf operations.

Most of the patients had a temporary improvement. It appeared, however, almost impossible to achieve a stable equilibrium in a system influenced by so many

forces. Consequently, long-term results are disappointing. Hip problems returned to the original level, and the scoliosis increased.

Operative treatment should not be abandoned, but be reserved for immediate problems, like alleviation of pain, troublesome spasms, fixed contractions making difficulties in hygiene and dressing, or preventing the use of standing aids.

The best prophylactic measure is regular weight bearing with a standing aid, which is reasonably simple to accomplish, combined with a night splint, which is very difficult to manage.

Early and late radiographic versus late clinical assessment of the level of the neurologic lesion in patients with myelomeningocele

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An accurate picture of the disability of a newborn child with myelomeningocele is not always possible to give from the extent of the sac or from the early neurologic examination. Because this is important in parent management, the predictive value of early radiographic assessment in regard to late neurologic level was studied.

In all, 64 patients with myelomeningocele underwent radiographic examinations during the first week of life to assess the level of spinal deformity. During the course of treatment, additional radiographs were obtained when the patients were between 2 and 5 years of age. Comparison of findings showed a similar appraisal at both examinations in 39 patients. In 18 patients the radiographic lesion was, in the later study, found to be one segment higher, in 2 patients two segments higher, and in 1 patient three segments higher than initially indicated.

The early clinical estimation carried out by several pediatricians was disregarded in this investigation. The radiographic findings were compared with the "late" neurologic deficit, established on an average 10 years later. On this occasion, the early radiographic findings conformed with the late clinical appraisal in 30 patients. In 16 patients the level of the clinical deficit was established as being one segment higher and in 7 patients one segment lower. Three patients were found to have a neurologic deficit three segments or more above the radiographically estimated one, whereas 4 patients were found to have a neurologic deficit three segments or more above the radiographic level. The reason for this discrepancy remains obscure in 3 patients. An identical distribution of differences between radiographic and clinical assessment was found in a larger series consisting of 24 additional patients who had their first examination performed during the first 2 months of life.

From the practical point of view, this range of radiographic and clinical conformity is considered acceptable. The level of the neurologic deficit may, with the same degree of confidence, be assessed on radiographs during the first week of life, as well as during the next few weeks.

Functional ambulation in relation to radiographic level in patients with myelomeningocele

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Factors that affect the ambulatory status in myelomeningocele patients include the level of the neurologic lesion, scoliosis, pelvic obliquity, and lower extremity deformities. Normally, there is a good conformity between the radiographic and clinical level of the lesion. However, transitions in ambulatory status occur because there are nonfunctional and nonambulators with low lumbar radiographic lesions. The following study was undertaken to evaluate the cause of the discrepancy between the radiographic level and the predicted walking ability.

The radiographic and neurologic levels of the lesion were assessed by radiographic and by clinical examination of 150 patients with myelomeningocele. The radiologic level was defined as the highest vertebrae with posterior element defects. The neurologic level was assessed according to Lindseth. The patients were divided into two groups: functional ambulators and nonambulators including nonfunctional ambulators.

Ninety-four patients had radiographic fourth lumbar levels or lower. Seventy-six of these patients were functional ambulators and 18 were not. In 15 of these 18 patients, it was possible to explain the inability to walk. It was due to syringohydromyelia in 4 patients, the Chiari II malformation with brain stem compression in 1 patient, and complications of a shunting procedure in 1 patient. One patient had deteriorated neurologically and had arm weakness and sensory disturbances for unknown reasons. Three patients had pronounced spinal and lower extremity deformities. Five patients were under 4 years of age and still had the potential for functional ambulation. In 3 patients there were no obvious reason for their inability to walk other than obesity and age.

Our findings confirm the predictive value of the

radiographic level in relation to future functional level. Impaired walking ability in children with myelomeningocele is often caused by progressive neurologic lesions. This emphasized the importance of repeated neurologic assessment. Patients with a clinical course markedly deviating from the expected should be examined in search for these lesions.

Cervical deformity and instability in skeletal dysplasias

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A potentially serious complication of skeletal dysplasias is cervical instability, which entails a substantial risk of tetraplegia or sudden death. The instability may be due to vertebral malformations (most commonly affecting the dens axis), ligamentous laxity, or both. In certain disorders like Morquio's disease and spondyloepiphyseal dysplasia congenita (SED), neurologic symptoms are very common and tend to run a progressive course.

We reviewed 6 patients: 3 had SED and 3 had one of the following: Morquio's disease, chondrodystrophia calcificans congenita, and pseudoachondroplasia. The 2 last-mentioned patients also suffered from cervical kyphosis due to vertebral malformations of the lower cervical spine, and the other 4 patients had atlantoaxial instability. Four patients developed neurologic complications, which in 1 patient had an acute onset; in the other patients, the clinical presentation was insidious, most commonly decreased physical strength and stamina. In all the patients posterior cervical fusion and immobilization with a halo brace was performed; the clinical course was uneventful. However, recovery from the neurologic lesions was limited.

Therefore, it is recommended that radiographic examination of the cervical spine, including pictures taken in full flexion and extension, should be carried out in all patients with skeletal dysplasia. In the event of instability with or without neurologic symptoms, cervical fusion should be performed early.

Surgical treatment of severe spondylolisthesis in children and adolescents according to McPhee and O'Brien's procedure

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Between 1980 and 1983, 5 patients, aged 11 to 16 years, with symptomatic severe spondylolisthesis – Grades 3–4 – were treated.

The procedure described by McPhee and O'Brien was used. This includes three stages:

1. A Gill-type procedure involving removal of the whole lamina including both attenuated parts combined with an alartransversal fusion.

2. Application of the halo-femoral traction with the patient in extension in order to achieve full reduction of the olisthesis.

3. Anterior interbody fusion using bone blocks from the iliac crest. The reduction of the lumbosacral joint is secured using internal fixation with a single cancellous screw.

The time from the first stage of the procedure to anterior interbody fusion was between 9 and 18 days. All the patients were, to a certain extent, mentally affected during traction and in the postoperative period. All of them required heavy medication.

One patient developed a unilateral transient peroneal palsy with full recovery. Another had a bilateral L5-root lesion with persistent neurologic sequelae.

At the time of follow-up, 2.5 to 5 years after the operation, all 5 of the former patients had sound fusion and had resumed full, unrestricted activity. The authors find the procedure worth considering in the treatment of severe spondylolisthesis in children and adolescents.

Reason for failure of early abduction treatment in neonatal hip instability

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Twenty-two cases of failure of early abduction treatment have been examined clinically and arthrographically at the University Hospital. Further, data from records on pregnancy, delivery, and the neonatal period were collected. Radiographs taken before referral to the University Hospital have been studied.

Factors determined to account for treatment failure were a) insufficient primary immobilization, b) pro-

nounced joint laxity, c) narrowing of the joint capsule and interposition of a capsular fold alone or in combination with breech position and/or oligohydramnios, or d) unknown factors.

It is important that those exceptional failures are recognized early – preferably within 6–8 weeks – before further derangement of the anatomy of the hip takes place.

An obstacle to reduction should be suspected if a) abduction is restricted at birth, b) primary reduction is difficult, c) reduction is difficult to maintain, or d) instability still persists after 6–8 weeks of treatment.

Arthrography should be done in these cases at an early stage.

Intracapsular pressure in congenital dislocation of the hip: A possible cause of iatrogenic necrosis of the epiphysis

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Avascular necrosis of the proximal femoral epiphysis (PFE) following closed treatment of CDH is a known complication. The purpose of this study was to evaluate the intracapsular pressure as a possible etiologic factor in this iatrogenic complication.

Patients: Six consecutive children aged 3–8 months referred to our department because of late discovered CDH with a dislocated femoral head and acetabular dysplasia. The diagnosis was confirmed on subsequent arthrography.

Methods: The hips were manipulated under general anesthesia and under image intensifier control. All the hips were easily reduced, but could not be retained in extension and neutral position of the hip joint. A 0.7 mm cannula connected via a saline-filled tube to a piezoelectric pressure transducer was introduced anterolaterally into the joint. The intraarticular position of the cannula was verified when instilling a contrast medium via the same cannula at the end of the procedure. Pressure was recorded in the unreduced position in extension and neutral position of the joint, in the "frog-leg" position, and in moderately forced internal rotation in the same position.

Results: Intracapsular pressure in the unreduced neutral position was 8 (2–20) mm Hg. In the "frog-leg" position, it was 80 (45–145) mm Hg. In 30 degrees of flexion and internal rotation, it was 103 (75–155) mm Hg. In moderately forced internal rotation and 30 degrees of flexion, pressure rose to 161 (109–114) mm Hg. In one patient, 0.3 ml of joint fluid was aspirated. In the other patients, aspiration was resultless.

Conclusions: The vascular supply to the PFE is dependent mainly on intraarticular branches of the medial circumflex artery. This supply is potentially vulnerable to an increase in intracapsular pressure as demonstrated experimentally and clinically in various hip conditions associated with intraarticular tamponade. The intraarticular pressures noted in this study are well above hazardous levels and may be considered as an etiologic factor in the development of iatrogenic avascular necrosis of the PFE. We conclude that care must be exercised not to immobilize these hips in a more forced rotational position than is absolutely necessary to retain the reduced hip in position.

Sonography in osteomyelitis of the hip in the child

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Septic arthritis of the hip has to be diagnosed and treated, or excluded, without delay. To date, synovitis has only been possible to exclude by computed tomography, diagnostic aspiration, or arthrotomy. We have successfully used sonography in the investigation of septic conditions in the hip region of 4 children: in 2 a septic arthritis of the hip was confirmed and in 2, intracapsular involvement was excluded in osteomyelitis in the hip region.

Case I: A 13 year-old boy with a 3 day history of pain in the left hip and rising body temperature. ^{99m}Tc-MDP scintimetry revealed ischemia in the proximal femoral epiphysis. Sonography with 5MHz real time scanner revealed intracapsular effusion confirmed on subsequent arthrotomy and joint drainage.

Case II: A 13 year-old girl was treated with antibiotics for 2 weeks because of sepsis and pneumonic abscesses. She was admitted with a 3 day history of pain in the left hip. Sonography revealed intracapsular effusion and synovitis. This was confirmed on aspiration and on subsequent arthrotomy and joint drainage.

Case III: An 11 year-old girl presented with a 2 day history of pain in the right hip-knee region. Her body temperature was elevated. Conventional radiographs were negative. Sonography revealed normal symmetric capsular anatomy in both hips, thus excluding synovitis. ^{99m}Tc-MDP scintimetry revealed increased isotope uptake intertrochanterically, indicating osteomyelitis. Hip joint aspiration was negative, whereas subperiosteal aspiration intertrochanterically yielded 0.5 ml of pus

with growth of *Staphylococcus aureus*. The girl was treated with antibiotics and did not develop septic arthritis.

Case IV: A 2 year-old girl with a 2 day history of pain in the right hip region. Sonography revealed increased uptake in the right sacroiliac region, indicating osteomyelitis. A follow-up radiograph 1 month later confirmed the diagnosis. The child was successfully treated with antibiotics.

Conclusion: Sonography is a useful noninvasive diagnostic tool in the investigation of septic conditions in the hip region of the child.

General fractures

Evaluation of the 3M staplizer: A new internal fixation system

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The 3M staplizer is a new tool for simple and rapid internal fixation of fractures in metaphyseal bone. The staplizer consists of a hand piece with a pneumatic hammer function and four staple drive attachments of different sizes. To each attachment different lengths of staples can be used. Certain technical rules must be respected when using the staplizer; otherwise, it will invariably fail. The technique is not difficult, but practice on a piece of wood is recommended. The staples are driven in across the fracture line, avoiding to be perpendicular to it, and thereby compensate shearing forces. The strength of the fixation is excellent in metaphyseal bone.

We have used the staples in the ankle, the olecranon, the knee, and the great trochanter of the femur in 50 patients. The staplizer has been used in 21 ankles, 1 knee, and 3 elbows with very few complications. No failed union and no deep infection occurred. One staple was removed for other reasons, and one slight redisplacement occurred. All the patients have been followed until union and have anticipated range of movement and function. No scientific comparison between the 3M staplizer and other internal fixation methods was made in this study.

The 3M staplizer is in experienced hands superior to other methods of internal fixation in many fracture types. It cannot, however, be used in cortical bone. The staplizer will soon be available on the free market. It is our belief that the staplizer successfully can be applied on many different locations in both fracture treatment and in reconstructive surgery.

A novel tubular external fixation device for unilateral application

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Ease of management and appropriate mechanical properties are essential features of a future external fixation device. With reduction of the number of pins, increased pin diameter, predrilling, and unilateral mounting, the surgeon is encouraged to a more active attitude. This in turn should reduce further the well-known complications.

Since 1976, a variety of external fixation prototypes have undergone biomechanical testing and clinical evaluation. The present design consists of two lockable ball joints and a tubular connecting rod. The ball is secured in different positions by simply tightening a compression screw. Attached to the ball is an S-shaped rod at one end of which three 4.0 or 5.0 mm bone pins can be secured. The maximum rigidity of the ball joint occurs at a highly specific relationship between the diameters of the ball and socket, and between the hardness of the materials used in these two parts. The ball joint can resist a concentrated load on the pin retainer of more than 750 N, corresponding to a locking moment of 35 Nm. No gliding was observed when the connection between the socket and the tubular connecting rod was tested in axial loading up to 5000 N. The weight of a complete frame is 500 g.

It is possible to construct a simple and inexpensive adjustable external frame, the mechanical characteristics of which allow unilateral mounting in all types of long bone fractures. It is calculated that by increasing the diameters of the ball and socket, the rigidity of the ball joint can be augmented to 70–80 Nm, which is enough for use as a single anterior frame in an unstable pelvic fracture.

Spine

Unstable fractures of the thoracolumbar spine

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All patients with unstable fractures of the thoracolumbar spine in our departments have been followed prospectively from January 1984.

Until January 1986, 55 patients have been treated. They have been followed clinically and radiographically at 4 and 12 months.

Thirty men and 25 women have been treated. The mean age was 33 (14–74) years. The women were younger, with 13 below aged 20 years as compared with only 4 men. Twenty-three patients were treated at Haukeland Hospital and 32 at The Regional Hospital in Trondheim.

Seventeen patients were injured in car accidents (11 women), and only 2 were using safety belts. Five patients were injured on motor bikes and 21 when falling down from heights. Ten patients were clearly intoxicated on arrival. Sixteen patients were injured when working (only 1 woman). Twenty patients had a neurologic deficit at once, whereas 23 had no neurologic deficit. All the patients were transported on ordinary stretchers to the hospitals. Only 1 patient was unconscious on arrival. Twenty nine patients had other injuries, but this was of importance for future treatment only in 8 patients. Nineteen patients had their injury to the first lumbar vertebrae. The type of injury was as follows: flexion 17, flexion/rotation 6, burst 20, luxation 7. Thirty-six patients had a fracture fragment in the spinal canal. All but 3 patients were operated on using the Harrington rods. The operation was performed within 3 (0–23) days in 28 patients. Twenty patients were out of bed within 10 (2–30) days. Twenty-eight patients have been followed for 12 months. Five of these are paraplegic and another 4 have deficits due to lesions in the sacral segments. Only 2 patients have low back pain, and 4 have radiating pains.

Internal transpedicular fixation of thoracolumbar fractures: Early result in 12 cases

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The need for stabilization of the unstable thoracolumbar is generally recognized because it makes the mobilization of the patient easier and is essential for an optimal neurologic recovery in cases with neurologic deficits. Harrington rods have been widely used, but have the disadvantages of including five to seven segments; and there is also a difficulty in maintaining the natural lordosis and a postoperative corset is needed. With a transpedicular internal device, only two segments (three vertebrae) have to be included in the fixation. We have used this technique, which also includes transpeduncular bone transplantation, posterolateral fusion, and sometimes laminectomy – in 12 cases. A device of our own construction has been used. The fractures treated have all been of crush or crush-cleavage type fractures and resulted from high-energy trauma. It has been possible to achieve a complete or almost complete reduction in all cases. In the cases with neurologic deficit, the anterior floor of the spinal canal has been visualized and if necessary openly reduced. Early mobilization without external support has been permitted. In one case with total paraplegia, no neurologic recovery has occurred. In 6 cases with varying degrees of paraparesis, good neurologic recovery has been seen. There has been one case of insufficiency of the device, with some loss of correction; but in all the other cases, the correction has been maintained. Healing of the transplanted vertebra should take 1 year and after that the device should be extracted. All 12 patients still have the device left. After mobilization, some have minor discomfort from the instrument.

Traumatic sacroiliac joint dislocations treated with open reduction and internal fixation

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Dislocation of the sacroiliac joint usually is the result of blunt trauma to the pelvis. The dislocation is often combined with severe damage to the large vessels, the urinary tract, peripheral nerves, and the abdomen. Left untreated, the dislocation often results in nonunion with leg shortening and pain from the pelvis and the lumbar spine.

During the last 4 years, we have treated 13 patients surgically, aged 21 (18–45) years, with dislocation of one or both sacroiliac joints. Eleven patients also had other fractures or lesions.

Through an anterior retroperitoneal approach, the joint was reduced under direct vision and internally fixated with a special square plate and bone screws. The pelvic ring was secured with an external fixation frame for 3 months. Thus, 9 patients could become mobilized to gait with crutches within a couple of months. Due to other injuries, the other 4 patients were mobilized within 3–4 months. All the dislocated joints were clinically healed and 7 patients returned to work 6 months after surgery. None of the patients had residual back pain.

Reduction of intervertebral disk hernias after autotraction verified by computer tomography

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The suggested effect of treatment with autotraction in sciatica is to reduce an intervertebral disk hernia. Despite adequate clinical results, regression of the hernias verified by computed tomography (CT) has not been conclusively demonstrated.

Autotraction was used in 2 males with long-standing sciatica and CT-verified, clinically relevant, large disk hernias. The patients improved dramatically during the autotraction. A new CT scan 3 months after the treatment began showed an almost complete reduction of the hernias.

At follow-up 2 years after traction, both patients were asymptomatic and had returned to their former work. A third CT investigation disclosed only minor signs of the former disk hernias.

The effect of decompression on the natural course of spinal stenosis

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It is a common opinion that the natural course of spinal stenosis is so poor that the patient should be operated on without too much delay. In this study, we have compared the further course of 20 patients (5 women) with spinal stenosis not operated on with a follow-up of 33 patients (11 women) operated on with laminectomy and facetectomy. The mean age was 60±9 and 65±8 years, respectively. The duration of symptoms prior to myelography of those not operated on was 24±25 months and the preoperative duration was 30±33 months. On the myelogram, the anterior posterior (AP) measurement was 11 mm or less in all cases. Fourteen of 17 (3 missing) and 27 of 33 had neurophysiologic findings typical of spinal stenosis. In the nonoperative group the period of observation was 32±12 months, whereas the period of observation postoperatively was 50±33 months. The patients were asked to compare their situation prior to the myelogram or operation with their present situation on a visual analogue scale (VAS) graded from 0–100.

	Worse 0–45	Unchanged 46–55	Improved 56–100	
Not operated	2	12	5	(1 missing)
Operated	9	3	20	(1 missing)

Only 3 out of 53 patients returned to work.

The nonoperated on patients remained unchanged significantly more often than those operated on and only 2 became worse. The majority of the operated on patients improved, but more than one fourth of them deteriorated.

Observance for a year or two seems to be a good alternative – immediate operation should be advised only if pain is intolerable.

MMPI in the evaluation of chronic LBP patients

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The value of personality tests in the examination of chronic low back pain (LBP) patients is disputable. The main unanswered questions in this field are the following ones: Is the person's psychical abnormality a primary phenomenon followed by "functional" LBP, or is it secondary to chronic low back disease? Do the personality tests possess some prognostic value as regards the LBP patient's recovery? Should attempts of treating the patients be directed mainly to psychologic, psychiatric, psychiatric, or orthopedic measures? Our goal was to find answers to those questions of our prospective clinical follow-up study.

Fifty problematic LBP patients referred by other orthopedic surgeons were examined during the period 1978–1981. In addition to careful physical and radiologic evaluation, the patients filled out a social questionnaire and the Minnesota Multiphasic Personality Inventory (MMPI). Until now, the first 25 patients have attended a 5 year follow-up, which included the same examinations. The mean age of the patients was 33 years at the beginning of the study. Eight were females and 17 males. All but 1 of the patients had some radiographically confirmed disease of the lumbosacral spine, spondylolytic or degenerative. Twelve patients were subjected to operative fusion of the lumbosacral spine, whereas the other 13 were treated nonoperatively.

The patients with a long LBP history had more abnormal values in many specific MMPI scales than those with a short history. Many of the abnormal scales

showed a trend towards normalization during the follow-up period. Thus, it seems that abnormal personality of the LBP patient might be secondary to the disease. By correlation analysis, we could not find any predictive value of the MMPI as regards the patients' recovery. The tendency to psychosomatic symptoms increased with duration of LBP in our patients. The following suggestion might be justified: Evaluation and treatment of the patient suffering from chronic LBP should always be based on team work of numerous specialists.

Upper extremity

Standard approaches in diagnostic and therapeutic arthroscopy of the shoulder joint

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Arthroscopy of the shoulder joint has proved to give excellent information about normal and pathologic intraarticular anatomy. However, no documentation is available so far as to the limits of survey through different approaches, and concerning the optimal combination of arthroscope and instrument in intraarticular surgery.

To find the most suitable approaches to the shoulder for diagnostic and surgical work, an experimental study of 50 cadaver shoulders was carried out. Storz arthroscopic equipment was used together with Storz endovision TV and Dyonics intraarticular motorized surgical equipment.

Four standard approaches were found that made an adequate survey possible and gave sufficient space for diagnostic and arthroscopic surgical work, such as removal of free bodies, biopsy, synovectomy, and cuff repair.

In conclusion, operative arthroscopy is possible in the management of common shoulder disorders using four or fewer approaches to the shoulder joint.

Arthroscopy of the shoulder in evaluation of patients with shoulder pain

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Arthroscopy has been used increasingly in the diagnosis of shoulder problems. Some have advocated its use in evaluation of patients with instability problems. In evaluation of patients with shoulder pain, however, the value of arthroscopy has been considered more questionable.

Material and methods: 34 patients (40±12 years) were examined with arthroscopy during the period 1982 to 1985 (29, 1984–1985). Nineteen (Group I) had 20±12 months of nontraumatic symptoms and signs of rotator cuff impingement. Totally, 75 per cent had work-related symptoms and as many problems from their right arm. Fifteen (Group II) with 10±6 months history had posttraumatic symptoms usually caused by falling on the arm. Eighty per cent had symptoms and signs of subacromial impingement.

Arthroscopy was done using the posterior approach; the point of insertion was situated 2 cm below and 1–2 cm medially of the posterolateral corner of the acromion. A 5 mm arthroscope with a 30° telescope (occasionally a 70° telescope) was used. Additional portals for the probe and other instruments were located anteriorly or in some instances posteriorly.

Results: The operation time for diagnostic arthroscopy was 21±7 min. There were no complications. In Group I, a partial tear of the rotator cuff was found in 33 per cent. In half of the patients, the arthroscopy was normal. In Group II, a partial tear of the rotator cuff was found in 65 per cent. Twenty-five per cent had a torn labrum, and in only one patient the arthroscopy was normal.

The patients with a partial rotator cuff tear were treated with acromioplasty a.m. Neer. Patients with normal arthroscopy were treated conservatively. In some of the conservatively treated patients (40 per cent), a Neer acromioplasty had to be performed later because of continuous symptoms and signs of a rotator cuff impingement. In the latter group the results of the operation were significantly worse than among those patients with a partial cuff tear diagnosed during arthroscopy.

Conclusion: Arthroscopy of the shoulder can be done with a short operation time and with a minimal risk for complications. The examination gave additional information that seems important in the choice of treatment.

Acromioclavicular dislocations treated by coracoacromial ligament transfer

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Recommendations for treatment of total acromioclavi-

cular dislocation still differ. Some advocate surgical repair after reduction of the dislocation, whereas others recommend conservative treatment.

Surgery has been recommended because the unstable clavicle can give rise to pressure symptoms, and complaints of pain, instability, and fatigue have been common. The high-riding clavicle is also a definite cosmetic deformity.

Forty-seven patients with acute total acromioclavicular dislocation were treated with open reduction and coracoacromial ligament transfer. The ligament is detached with a sliver of bone from its insertion at the acromion and then refixed with osteosutures to the superior surface of the clavicle. The acromioclavicular joint is transfixed for 6 weeks with two Kirschner wires. Free movement is allowed after 3–4 weeks, strengthening exercises after 8 weeks, and sports after 12 weeks.

In a follow-up study 1.6–10 (mean 6) years postoperatively, 44 patients had excellent or good functional results and 3 (6%) fair or poor results. Two patients with unsatisfactory results had degenerative joint changes. No dislocation of the acromioclavicular joint was seen at follow-up, but subluxation (3.5 mm) was found in 3 patients. Two of these patients had unsatisfactory functional results. Minor calcifications of the coracoclavicular ligaments were found in 19 patients, but had no bearing on the functional results. Complications were infrequent and cosmetic results satisfactory.

Muscular activity in patients with an unstable humeroscapular joint

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Activity of the shoulder muscles in patients with an unstable humeroscapular joint was studied with EMG using bipolar surface and intramuscular fine-wire electrodes. EMG was full-wave rectified, low-pass filtered, and average over time. Eight muscles were recorded simultaneously during standardized movements of the arm in 3 patients with general joint laxity and problems with a recurrent dislocating shoulder joint.

During flexion, extension, abduction, and internal rotation, the muscle activity was almost the same as in stable shoulders. During external rotation – tested in 0, 45, and 90 degrees of abduction – in contrast to controls, there was a very high activity in the subscapular muscle. Upon provocation of forward dislocation, the activity in the subscapular muscle increased. A corresponding increase in activity was recorded for the infraspinatus muscle on backward provocation. In 1 patient, dislocation occurred during external rotation without provocation. Increased activity of the subscapular muscle was recorded, the activation occurring too late to prevent the dislocation.

In conclusion, high EMG activity of the subscapular muscle was observed for the unstable shoulder when compared with controls, and the activation was too slow to prevent dislocation.

Unusual glenoid fractures: A report on 92 cases

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Introduction: Glenoid fractures are unusual. They can be treated conservatively, but surgical intervention is recommended in fractures with wide displacement. This retrospective study, which originated from the University Hospital, Uppsala, Sweden, reports results of treatment of 92 glenoid fractures.

Material: Totally, 300 glenoid fractures were identified in 30 hospitals. Eight of the fractures could not be referred to any type; according to my classification, 183 were so-called chip fractures, Type 1. Another 109 were Type 2–5 fractures, and 92 of these were followed up 6 months to 24 years after treatment (74 men and 18 women). Patient age was 44 (6–84) years.

Methods: The fractures were divided up according to the my classification. Displacement was measured before and after treatment on the radiographs and was referred to one or two displacement groups: *minor*=less than 10 mm after treatment, and *major*=10–50 mm. Residual pain and function were estimated by the patients as excellent, good, fair, or poor.

Results	Type 2		Type 3		Type 4		Type 5	
	minor	major	minor	major	minor	major	minor	major
Excellent-good	8 (4 op.)	6	18	1 (op.)	19 (2 op.)	2	12 (1 op.)	4
Fair-poor	1	5 (2 op.)	3	1	3	3	4 (2 op.)	2.

Comments. In 3 cases, closed reduction was attempted, but failed. Surgery corrected the displacement in 12 cases, but 2 redislocated. Surgery for other shoulder lesions was necessary in 4 cases. In 12 fractures with major displacement, good results were obtained mainly through early mobilization. There was some improvement of the displacement of fragments in most of the conservatively treated fractures. Poor results in fractures with minor displacement was caused in Type 2 by necrosis after humeral head fracture, in Type 3 by acromial pseudarthrosis and acromioclavicular joint disruption, in Types 4 and 5 by nerve lesions, muscle lesions, thoracoscapular incongruity after rib fractures, and unknown causes.

Conclusions: Good results have been obtained in glenoid fractures with considerable displacement mainly by early mobilization. Equally good results can be obtained by surgery in a shorter time. Associated lesions will modify the result.

Long-term strength and viability of humeral reconstructions with autoclaved bone supplemented with allogeneic bone matrix

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The aim of the present study was to investigate whether reconstructions by autoclaved, reimplanted bone supplemented with allogeneic bone matrix (ABM) after implant incorporation, in the long run, remain metabolically active and capable of meeting normal mechanical demands.

In 8 adult rabbits the middle third of the humerus was resected unilaterally, autoclaved, and subsequently reimplanted using intramedullary fixation. At 6 months postoperatively, the internal fixation was removed and 2 months later the animals were killed. The contralateral humerus was left intact, serving as a control.

The reconstructions were investigated in vivo by serial radiography and scintigraphy (Tc-99m-MDP). The reconstructions were further investigated by autoradiography (45-Ca), histology, and the torsional test.

Radiography showed that seven out of eight implants were incorporated at 3 months. Scintigraphy and autoradiography disclosed bone metabolic activity in the reconstructions still 8 months postoperatively. Histology showed abundant, new viable bone partially having replaced the implants at 8 months.

The torsional test disclosed that the mean strength of the reconstructions was 84 per cent of the normal strength, which is sufficient for meeting normal mechanical demands.

Reimplantation of autoclaved tumorous bone supplemented with allogeneic bone matrix may provide a simple combined means for tissue devitalization and reconstruction in the treatment of bone tumors suitable for local resection.

Experimental instability of the elbow joint

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In a cutting study of osteoligamentous elbow preparations, the contribution of the ligaments and the capitulum radii to stability of the elbow was evaluated. Twenty-two elbow specimens were investigated in a standard experimental set-up. Angle sensors were situated at the axis of flexion; and a lever, fitted with strain gauges to measure the corresponding external torque, was fixed to the forearm via a steel cylinder.

The study was divided into four series. In the first isolated cutting of the anterior collateral ulnar ligament created a valgus instability of a mean of 12 degrees at an elbow flexion of 70 degrees. In the second series, transection of both the posterior collateral ulnar ligament and the medial capsule left the stability unchanged. Cutting the anterior collateral ligament created a valgus instability with a mean of 20 degrees at a flexion of about 60–70 degrees.

In the third series, division of the annular ligament created a varus instability that peaked at 13 degrees. Excision of the capitulum radii increased the varus instability maximally 6 degrees at 70 degrees of flexion. In the last series, isolated excision of the capitulum created a slight varus instability with a mean of 5 degrees at 50 degrees of elbow flexion. Cutting of the annular ligament further increased the varus instability, with a mean of 22 degrees at flexion of about 70–80 degrees.

Conclusion: In the position of function, the prime stabilizer of the ulnar side of the elbow is the anterior collateral ligament. The annular ligament is the important stabilizer of the radial side. The elbow has an inherent stability at flexions <20 degrees and >120 degrees, independent of the capitulum radii. Isolated excision of the head of the radius produces only a slight varus instability, provided the annular ligament is intact.

Cerclage and Kirschner wire versus crossed Kirschner wires in interphalangeal fusion

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Fusion of the proximal and distal interphalangeal joints in the hands is commonly indicated in rheumatoid arthritis. Reliable stability of the fusion that allows immediate activity is of great importance in this group

of patients. The aim of the present study was to test mechanically the stability of the two most common methods of interphalangeal fusion, cerclage and Kirschner wire, and crossed Kirschner wires.

Twenty proximal interphalangeal joints of index fingers of female subjects, aged over 70 years, were fused. The specimens were divided into two equal groups. Group I was fixed with cerclage and Kirschner wire, and Group II was fixed with crossed Kirschner wires. Continuous increasing transverse compression loads were applied 15 mm from the joint fusion, and the angle of displacement was measured.

In Group I the load at 3° displacement (the limit of acceptable displacement) was 0.4±0.15 kp; in Group II the corresponding load was 0.05 kp. The displacement curves were approximately linear. At 9.6° of displacement, the applied loads were 1.17±0.47 and 0.67±0.15 kp for Groups I and II, respectively. The rigidity, defined as the coefficient of increase or tangent to the load/degree of displacement curve, was in Group I 174 per cent of that of Group II.

The study demonstrates that the joint stability is significantly greater when the fixation is made with cerclage and Kirschner wire when compared with crossed Kirschner wires. The former method allows the patients to almost immediately exercise the operated on finger, and gives an early ability to manipulate objects.

Suprascapular nerve entrapment

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Entrapment of the suprascapular nerve is one cause of shoulder pain and weakness. It may occur as a sequel of direct or indirect trauma to the shoulder, but also without any obvious trauma. A series of 15 operated on patients is presented. There were 9 men and 6 women, aged 35 (10–55) years. The right side was involved in 9 cases.

In most cases the onset of symptoms was related to some kind of injury, like falling down on the shoulder or excessive exertion of the extremity, such as that which occurs in a strenuous tennis match. No provoking factor was found in only 3 cases. The dominating complaint was a poorly localized shoulder pain. Three patients had a painless atrophy of the spinati muscles, whereas 7 patients had shoulder pain without any atrophy. In 6 cases the Enmg was normal. Three of these patients had only chronic vague shoulder pain and tenderness on the suprascapular notch. All three of them recovered after surgery.

Treatment was sectioning of the transverse scapular ligament. No widening of the notch was made. The approach was dorsal: after a sabre-cut skin incision, the trapezius muscle was divided along the length of its fibers, the supraspinatus muscle was retracted backwards, and the transverse scapular ligament was divided. If necessary, external neurolysis was performed.

The most dramatic effect of the operation was prompt disappearance of the ache. This occurred in 8 cases. Muscle weakness improved more slowly. In 2 cases atrophy of the spinati muscles disappeared in 6 months, and 2 cases improved in some degree during 1 year. However, 4 cases with atrophy did not improve, although the pain lessened. The operative delay was on an average 4 years in these cases.

Suprascapular nerve entrapment should be considered as a differential diagnosis in cases with aching in the shoulder region. In certain chronic cases the only positive finding can be local tenderness on the suprascapular notch.

Which plaster-treated Colles' fractures are unstable? A radiographic study

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A certain number of Colles' fractures redislocate irrespective of the type of plaster splint. The use of external fixation, which is more stable, is increasing. The external fixators are generally not applied until the fracture has redislocated. There are potential benefits in applying the stable fixation initially.

The purpose of the present study was to find out early characteristics of the fractures that are valid in predicting redislocation.

Material and Methods. Prospectively, 187 Colles' fractures were studied. There were 23 men and 164 women. The mean age was 62 years. The fractures were classified according to the system of Lidström and of Frykman, and the degree of comminution in the fracture line was also regarded. The initial malposition was characterized by 5 parameters, and the malposition was also measured after initial reduction at 10 days, after treatment with a dorsal plaster splint for 4 weeks, and finally after 8 weeks.

Results and Discussion. After 10 days, 20 fractures had redislocated to the extent that rereduction and external fixation were performed. Neither the classification of Lidström nor that of Frykman was adequate for predicting the risk of redislocation, not even when the degree of comminution of the fracture was considered. A good predictive parameter seemed to be the

initial malposition. By using the two parameters shortening and dorsal angulation to characterize the degree of malposition, the 69 most displaced fractures were analyzed. These 69 fractures included 17 of the 20 fractures that were rereduced and externally fixated. Of the remaining 52 fractures, the anatomic end result was unsatisfactory in 34 cases. The initial malposition of a Colles' fracture thus seems to be a fairly good parameter for predicting subsequent redislocation in a plaster splint.

Comminuted intraarticular Colles' fractures treated with external fixation

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In a controlled prospective series, comminuted intraarticular Colles' fractures were studied. The results of early external fixation were compared with traditional treatment of reduction and plaster cast fixation. The material consisted of the treatment group of 75 patients and the control group of 32 patients. All had Colles' fracture type Frykman VIII. The two groups were equal with regard to sex and age distribution.

The treatment consisted of reduction under general anesthesia or arm block followed by application of a small Hoffmann device from the radial diaphysis to the second metacarpal. The device was left in place for 5 weeks after which the patients were allowed to exercise freely.

Comparison between the groups was made with the following variables: Radiographic appearance with regard to radial length and volar angulation. Healing in of the styloid process of the ulna. Subjective evaluation according to the Lindström score. Objective evaluation including range of motion and grip strength.

In all the variables the treatment group was significantly better than the control group. For example, according to the Lindström score, 90 per cent in the treatment group as compared with 30 per cent in the control group were excellent or good.

The prognosis of conservatively treated Colles' fractures Type VIII is poor. The results after external fixation are, however, very encouraging and the method can be recommended.

External fixation of displaced distal radius fractures: A prospective investigation

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In a prospective investigation, external fixation a. m. Hoffmann was used in 41 patients with displaced, intraarticular distal radius fractures (Older Types 2, 3, 4). Complications: In 12 of the 41 patients, a transitory paralysis of the dorsal branch of the superficial radial nerve was noted;, and in 2 of these cases, the damage was permanent. Two other patients had temporary paresthesia of the median nerve. In 5 cases, secretion from the pins was noted; 1 of these developed osteitis of the second metacarpal bone, but healed after removal of the pins. Four patients had stiffness of the fingers, in 2 cases with permanent symptoms.

The radiographic and functional results were evaluated after 3, 6, and 12 months. The radiographic result could be significantly improved compared with a series of patients treated with immobilization in a plaster cast. The average length of the radial styloid at follow-up was 12.8±4 mm in type 2 fractures, 10.1±2 mm in Type 3 fractures, and 8.4±3 mm in Type 4 fractures. The corresponding values in conventionally treated patients were 7 mm, 3.8 mm, and 4.5 mm. The average residual dorsal angulation was reduced similarly. The functional results corresponded to the radiographic results evaluated by a score system described by Gartland & Werley (1950). The function of the wrist improved during the first year of observation.

External fixation of displaced distal radius fractures can be recommended as the primary treatment. The anatomic results are excellent and the function of the wrist after 1 year better than after a conventional treatment. The immediate rate of complications is high, but most complications are temporary and the rate after 1 year is not higher than after reduction and immobilization in a plaster cast.

Radiocarpal traction force during external fixation for Colles' fracture

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External fixation is often utilized to stabilize a Colles' fracture that has redislocated in plaster treatment. The

fixation pins of most fixators are placed in the metacarpal bones distally. Consequently, the stability of the fracture is due to traction in the capsule and ligaments of the radiocarpal joint (i.e., osteotaxis). The traction force may be harmful to the function of the soft tissues. The aim of the present study was to elucidate the magnitude and duration of the traction force in the radiocarpal joint after external fixation.

Material and methods. Measurements were performed on 3 patients who 14 days after fracture were externally fixated with a single bar Hoffmann fixator. The connecting bar had been supplemented with a ring transducer equipped with 4 strain gauges, coupled in a full bridge arrangement. Recordings were performed 3–5 times during the first day, daily during the first week, and thereafter at weekly intervals during the next 4 weeks of fixation.

Results. The initial traction force was close to 30 N in all 3 patients. After 7 days the force had declined to one third of the initial value. In the fifth week, when the Hoffmann external fixator was removed, the traction force was less than 10 per cent of the initial value.

Discussion. Because the patients were rereduced and externally fixated 2 weeks after fracture, it was necessary to apply a significant force to reduce the fracture. The initial level of traction force persisted for 7 days. This force must be transmitted over the radiocarpal joint by collagenous structures.

Carpal tunnel pressure in fresh Colles fracture

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Carpal tunnel syndrome is considered to be caused by an increased pressure in the carpal tunnel. It is a complication of Colles' fracture where it can occur either acutely or at a later stage. Several mechanisms have been considered, such as swelling or bleeding from the fracture, pressure from fracture fragments, or fixation in extreme positions of the wrist. Elevated pressures in the carpal tunnel have been recorded in patients with Colles' fractures and symptoms of carpal tunnel syndrome. Documentation of "normal" carpal tunnel pressures after Colles' fractures are, however, sparse. The following investigation was undertaken to analyze the carpal tunnel pressure in the acute phase of Colles' fractures, the effect of locally administered anesthetics, and the effect of volar angulation of the wrist on this pressure. The values were compared to a control group of healthy volunteers.

The pressures were measured using a wick-catheter technique.

The mean pressure was significantly higher in the fracture than in the control group. The pressure increased significantly after local anesthetic injection into the fracture hematoma. Also volar angulation increased the carpal tunnel pressures in both the fracture and the control group.

Compression neuropathies after Colles' fractures: The value of CT examination

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A retrospective-prospective study was carried out on 166 patients with Colles' fractures. The conservative management of fractures was associated with a 4 per cent rate of acute nerve compression symptoms and a 12 per cent rate of late compression neuropathies. Nerve complications were not related to the fracture type nor the degree of initial fracture displacement. Malunion was more common in patients with compression neuropathies than in patients without nerve symptoms. The rate of late neuropathies was most common (43 per cent) in malunion with radial collapse as the only deformity.

Seven patients with persistent ulnar nerve paresthesia suffered from serious functional disability. However, electrodiagnostic studies were negative. Two of them had volar subluxation of the ulnar head shown by CT, although the distal radioulnar joints appeared normal in routine radiographs. Six patients out of 7 with late carpel tunnel syndrome had a malunion with radial collapse. One of them had a volar subluxation of the lunate shown by CT.

Anatomic derangements following Colles' fractures play a crucial role in the development of late compression neuropathies. CT seems to be the technique of choice for determination of distal radioulnar incongruency.

Regional bone mineral density changes after Colles' fractures

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Epidemiologic studies have shown that patients who sustain a second Colles' fracture refracture the previously injured wrist only in one of five instances. The

present study was undertaken to determine whether this could be due to persisting changes in bone mineral content in the fracture area.

Bone mineral density (BMD) measurements were performed on 20 women who had sustained a Colles' fracture. It was found that there was an increase in BMD in the distal radius of the fracture side when compared with the uninjured side of 39 per cent and a decrease of 9 per cent in the ulnar diaphysis. No difference was found in the radial diaphysis and metacarpal shafts on the two sides.

Conclusion: The protection of wrists where Colles' fractures have occurred from subsequent Colles' fractures is due to increased bone strength induced by the healing process.

A free scapular flap for covering large skin defects

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In 1980, dos Santos developed a free skin flap in the scapular region that is nourished by a direct cutaneous branch of the circumflex scapular artery, which passes through the triangular space bounded superiorly by the teres minor, inferiorly by the teres major, and laterally by the long head of the triceps muscle. Since September 1985, we have treated 5 patients with this free scapular flap.

The free scapular flap is a very applicable skin flap with uniform thickness and large surface dimensions. The flap is easy to isolate; it has a long vascular pedicle with large external vessel diameters, and the morbidity of the donor site is minimal.