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BONE CELL DIFFERENTIATION

MARSHALL R. URIST

Bone Research Laboratory, Los Angeles, USA

The central problem of orthopedic experimental research is bone cell differentiation. Upon bone cell differentiation depends bone growth and development, internal remodelling of bone, bone turnover in health and disease, fracture healing, bonding of implants to periarticular spongiosa, and skeletal tissue disorders, both congenital and acquired. A new approach to the study of bone cell differentiation is the isolation and characterization of bone morphogenetic protein (BMP). The three most common sources of BMP are bone, dentin matrix, and osteosarcoma tissue. BMP induces differentiation of perivascular mesenchymal type connective tissue cells and the cartilage into bone. BMP is a low molecular weight glycoprotein associated with, but completely separable from, bone collagen. Implants of BMP in subcutaneous spaces, muscle pouches, and bone defects, induce differentiation of cartilage within 10 days, bovine bone within 15 days, lamellar bone and bone marrow within 20 days. In the adult skeleton, preosteoblasts and osteoblasts are so limited in distribution and numbers that recruitment of new cell populations under the influence of BMP is essential for replacement of bone cells lost by injury, aging and disease.

There are four methods of isolation of BMP. Three are so technically difficult or expensive as to have limited research progress as well as clinical applications of BMP. Recently we found an inorganic-organic solvent mixture that is inexpensive and efficient for extraction of BMP from human and bovine bone matrix. A complete characterization of BMP is bound to emerge from a concerted international research effort. When the BMP is completely characterized, it will be possible to perform radioimmunoassay of BMP, apply DNA recombinant technology, and make BMP available on the operating room shelf like suture material for the treatment of patients with bone defects from injury, old infection, malignancy, and congenital malformation.

TREATMENT OF VERTEBRAL FRACTURES IN THE THORACOLUMBAR SPINE

ERIK B. RISKA

Department of Orthopaedics and Traumatology, University of Helsinki, Finland

In our clinic the treatment of vertebral fractures in the thoracolumbar spine is organized according to the following lines: Stable fractures without neural involvements are treated conservatively. Unstable fractures are treated operatively with internal fixation and fusion. Stable fractures with neural involvements are rare and should be treated operatively if compression of the spinal cord or cauda equina is detected, otherwise conservatively. Unstable fractures with neural involvements are always treated operatively.

In cases of unstable vertebral fractures with or without neural involvements, reduction and internal fixation with Harrington rods and fusion of the injured segment is undertaken as soon as possible, even during the night, and under general anesthesia. Partial reduction is obtained by hyperextension, avoiding direct pressure over the area of injury. The spine is exposed from three vertebrae above to three below the area of injury. The Harrington hooks are placed two to three levels above and below the injured segment. The operative reduction is undertaken with the Harrington equipment. The operation is completed by local fusion of the injured segment with iliac bone grafts. The anatomical result is measured on X-rays. Lateral tomograms are obtained on the next day. In some cases a myelogram is necessary to demonstrate a compression of the spinal cord. If narrowing of the neural canal and compression of the spinal cord are verified, an antero-lateral decompression operation with interbody fusion is undertaken during the next days. The patient is kept in bed for 6 weeks. Mobilization is started with a hyperextension

brace and continued for an average of 3 months. The Harrington rods are removed after 9–12 months.

THE VALUE OF COMPUTERIZED TOMOGRAPHY OF UNSTABLE THORACO-LUMBAR FRACTURES BEFORE AND AFTER TREATMENT WITH HARRINGTON INSTRUMENTATION

JAN WILLÉN & ANDERS NORDWALL

Department of Orthopaedic Surgery I, Sahlgren Hospital, Gothenburg, Sweden

Fifteen consecutive patients with unstable fractures of the thoraco-lumbar spine were examined by conventional X-ray and by computerized tomography (C.T.) before and after surgery with Harrington instrumentation. According to the Holdsworth classification five fractures were of the compression type, eight were of the flexion-rotation type and two were luxations. One patient was operated 3 weeks after the injury, 14 patients within 2 weeks of the injury. Paired Harrington distraction rods were used. Two patients were also operated with laminectomy.

With conventional X-ray fragments dislocated posteriorly in the spinal canal were difficult to detect. In an experimental study it was shown that such fragments could be detected with computerized tomography if the thickness of the fragment was more than 1.25 mm cortical or spongious. The C.T. gave an accurate picture of the fractured vertebral body and posterior elements and special patterns of fracture could be recognized. In eight patients posterior element fractures were diagnosed with conventional X-ray while with C.T., posterior element fractures were detected in 11 patients. With C.T. the cross-sectional area of the spinal canal could be estimated. It was decreased at its narrowest point to an average of 67 per cent of the normal area. The interpeduncular distance was increased by 9 per cent and the sagittal distance was decreased by 30 per cent. Postoperatively, the most narrow part of the spinal canal was still only 80 per cent of the expected normal cross-sectional area, the interpeduncular distance was still increased by 7 per cent of expected normal and the sagittal diameter of the spinal canal was still decreased by 22 per cent. Plain lateral X-rays showed an average decrease of the flexion deformity of 12 degrees and generally the normal spine configuration was restored after surgery.

C.T. is a valuable complement for detecting fractures of the posterior elements and narrowing of the spinal canal. Although good or perfect general alignment of the spine usually was accomplished with the Harrington operation, the normal width of the spinal canal was not restored.

TREATMENT OF UNSTABLE CERVICAL SPINE LESIONS WITH HALO VEST

SIGVARD BLÅDER, BENGT LIND & ANDERS NORDWALL

Department of Orthopaedic Surgery I, Sahlgren Hospital, Gothenburg, Sweden

In a consecutive series since 1976, 45 patients with traumatic unstable cervical spine injuries were treated with the halo and vest fixation at the Sahlgren Hospital, Gothenburg.

33 patients had fracture luxations and 12 patients had luxations. There were 6 odontoid fractures. 15 patients had neurological symptoms.

Treatment consisted of immediate halo application, traction for fracture or luxation reduction and then fixation of the halo to the vest for 12 weeks. In 39 patients the halo and vest were applied within 1 week, in 6 patients, all with neurological symptoms, the halo and vest application was delayed for a mean time of 29 days. Patients without neurological deficit were ambulated immediately after the halo vest application and stayed in hospital a mean time of 8 days.

The fracture or luxation was considered healed when no movement occurred in flexion-extension provocation on lateral X-ray on two occasions with 1 month's interval after halo vest removal. In 38 patients healing occurred after halo vest treatment with an average duration of 80 days. In 7 patients healing did not take place after halo vest treatment and in these patients a surgical fusion was performed. In 5 of these 7 patients, halo vest application was delayed more than 3 weeks, the patients first being treated with Crutchfield tongs. These patients all had tetraplegia. 2 patients did not heal in spite of early halo vest treatment.

There were complications with halo vest treatment. In 30 per cent, screws had to be tightened after the first 2-week period because of screw loosening and irritation around the screws. 4 patients were treated with antibiotics because of local infection at the screw sites, in one of these patients this progressed to osteitis. One patient with tetraplegia developed decubitus ulcer over the right scapula under the vest. It healed without further complications after change of vest. In one patient the luxation redislocated during halo vest treatment but the lesion healed without further problems after re-reduction and change of the halo vest. No neurologic complications occurred.

Halo vest treatment is an effective fixation method for unstable cervical spine fractures. It allows early rehabilitation and ambulation. If the halo vest is applied within the first week of the injury healing with stabilization occurs in more than 90 per cent of the injuries.

CERVICAL SPINE LESIONS IN CHILDREN

MAGNE JUHL & KARIN KJÆRGAARD SEERUP

Department of Orthopaedic Surgery, Odense University Hospital, Odense, Denmark

A material of all children admitted to neurosurgical and orthopaedic surgical departments, Odense Hospital, in 1972–80 on account of verified or suspected lesions of the cervical spine is analysed.

From the registry maintained by the Danish National Health Service data have been collected for all children admitted in Denmark in 1978 and 1979 with a cervical spine lesion. For each of these 156 children data concerning the accidents, lesions and treatment have been obtained from the hospitals.

In the 59 children admitted in Odense 34 distorsions were demonstrated, and in the remaining 25 children the following lesions were found: 14 fractures, 10 lesions of the spinal medulla, 3 lesions of the cervical spinal roots and 9 dislocations. Seven patients developed permanent pareses and two limitation of movement in the cervical spine.

In 26 patients lesions in the cervical spine were diagnosed and subsequently disproved. The great mobility between the second and third cervical vertebrae, in particular, may raise suspicion of dislocation, normal conditions in the axis may easily be interpreted as pathological. The same diagnostic difficulties were observed in cases from the rest of the country. Knowledge of the radiographic findings in healthy children is essential to avoid erroneous diagnoses.

INTERNAL FIXATION OF CERVICAL SPINE FRACTURES

S. OLERUD

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

The traditional primary treatment of unstable fractures of the cervical spine with or without neurological involvement has obvious drawbacks, among them a high rate of chronic instability.

The introduction of the halo-vest method meant that treatment in many cases was simplified and the period of confinement to bed considerably shortened. However, the method is somewhat cumbersome and inconvenient for the patient and may also result in chronic instability. For this reason we have for the past 2 years adopted primary internal fixation, sometimes in combination with bone grafting, as an even better alternative.

Instability was assessed by radiographic examination, sometimes including stress projections.

Indications for surgery were unilateral facet dislocation with root pain, bilateral facet dislocation, extension and compression injuries with or without tetraplegia, as well as pathological fractures with neurological involvement.

The internal fixation methods used were simple screw fixation of the facets, interspinal cerclage with or without fusion, posterior and anterior plate fixation with fusion, in pathological fractures also combined with bone cement.

In all cases complete reduction of the fractures was achieved. Only semi-rigid foam collars were used postoperatively as protection against too free movement of the neck. Healing was completed within 3 months. All except the tetraplegic patients became ambulant the day after surgery.

The advantages of primary internal fixation of cervical spine fractures may be summarized as follows:

1. Adequate and complete reduction is possible
2. The method provides rapid relief from pain
3. Early ambulation is possible, preventing complications caused by prolonged bedrest
4. A high rate of bone healing may be expected.

THE HEALING OF THORACOLUMBAR FRACTURES AFTER SURGERY

A. J. AHO, T. J. SAVUNEN & P. MÄKELÄ

Department of Surgery and Department of Diagnostic Radiology, University Central Hospital, Turku, Finland

The purpose was to analyse primary and late results of surgically treated fractures in the lumbar and thoracic spine. The correlation of the anatomic site of the primary trauma (the type and dislocation grade of the vertebral fragments) to neurological symptoms was studied. The material consisted of 41 adult patients treated operatively in the Department of Surgery in 1966–78. The method of internal fixation used most often was Williams' plate-osteosynthesis with or without bone graft. The main types of fractures were wedge-shaped and bursting. 36 patients had neurological symptoms and 15 patients had complete paraplegia. Bursting and severe fracture dislocation in anterioposterior direction led most often to paraplegia, whereas other fracture types with only moderate dislocation caused less severe neurological symptoms. The primary operation resulted in improvement of the dislocation in nearly all cases but perfect anatomical reconstruction was performed in only a few cases. However, this anatomical correction was seldom permanently stable because in most cases kyphosis increased during the follow-up time (4–15 years). Partial improvement of neurological symptoms was seen in 12 cases but there was no recovery from paraplegia. Primary bladder paresis in 6 patients without paraplegia recovered in all cases. In conclusion, internal fixation a.m. Williams has brought an apparent improvement to the general care and mobilization of the patient with dislocated fractures. Done with technical care and simultaneous spondylodesis (bone graft), the result should be adequate.

COMPUTED TOMOGRAPHY OF SPINAL AND PELVIC FRACTURES

OLAVI SUOMALAINEN, KAUKO KETTUNEN, SEPPO PELTTARI & TAPANI SAARI

Department of Surgery, University Central Hospital, Kuopio, Finland

The purpose of the study was to evaluate the value of computed tomography (CT) in spinal and pelvic fractures as compared with conventional X-ray.

Fifteen cervical, 4 thoracic, 10 lumbar spine and 9 pelvic fractures underwent CT following conventional radiographs. Two of the spinal fracture patients had complete and 2 had partial pareses.

In so-called bursting fractures of spinal vertebrae we were able to demonstrate, by CT, the position of fragments in the neural canal, invisible in conventional X-ray. Several times the neural canal was remarkably narrowed without the patients having any clinical symptoms. In addition CT showed in 3 patients a fracture of laminae or luxation of the joints between two vertebrae. Somewhat surprising were the vertical fractures of vertebral body, also very difficult to discern in conventional X-ray. One of the patients underwent an anterolateral decompression operation. CT was helpful in planning the operation.

In cases of pelvic trauma, sacroiliac joint diastasis was readily shown by CT which provided a unique appreciation of the spatial relationship of displaced bones and associated fracture fragments. Occasionally it was not possible to distinguish between involvement of the posteromedial ilium and anterolateral sacrum using conventional radiography, due to overlapping of the bones. CT was clearly able to determine whether disease extended across the sacroiliac joint. Also in fractures of the iliac wings CT readily showed the internal and external surfaces which were difficult to evaluate in plain radiographic examination. It also seems that in acetabular fractures CT can help the surgeon decide whether surgery is necessary. The pathological anatomy of these fractures was not easily demonstrated by conventional radiographs.

SKELETAL METABOLISM

B. E. C. NORDIN

Royal Adelaide Hospital, Adelaide, Australia

Dietary calcium. The main source of calcium in the diet is milk and milk products, and the average intake in western countries is about 1 g. (25 nmol) daily.

Calcium absorption. Calcium is absorbed by active transport and diffusion. The active transport mechanism is saturable and accounts for most of the absorption at low calcium intakes. The higher the calcium intake, the greater the proportion absorbed by diffusion but the lower the proportion absorbed. The main regulator of calcium absorption is vitamin D, the most active metabolite being 1,25 (OH_2) D which is synthesized in the kidney.

Plasma calcium. Plasma calcium concentration in the steady state is the value at which input into the plasma and output from the plasma are equal. Input comprises net calcium absorption and net bone resorption. Output is urinary calcium excretion. The equilibrium value of plasma calcium is a positive function of calcium flow (net absorption plus net resorption) as a positive function of tubular resorption of calcium in the kidney and a negative function of glomerular filtration rate.

Bone turnover. Calcium enters bone by the process of bone formation which proceeds at a rate of 200–400 mg (5–10 nmol) per day in normal subjects. Bone resorption proceeds at the same rate.

Calcium excretion. Urinary calcium excretion is a positive function of plasma calcium concentration and a negative function of glomerular filtration rate and tubular reabsorption.

Disorders of calcium metabolism. In *osteomalacia* there is malabsorption of calcium, a tendency to hypocalcaemia, delayed mineralisation of new bone, secondary hyperparathyroidism, and a very low urine calcium. In *osteoporosis* there is frequently malabsorption of calcium, low bone formation and high bone resorption and a tendency to a high urinary calcium.

Osteomalacia is essentially a disorder of bone mineralisation. *Osteoporosis* is essentially a disorder of bone balance.

THE FINNISH ENDOPROSTHESIS REGISTER

PÄR SLÄTIS & UOLEVI KANKAANPÄÄ

Division of Orthopaedic Surgery and Traumatology, Surgical Hospital, Helsinki University Central Hospital, Helsinki 13, Finland

A nationwide endoprosthesis register was set up in 1980 on behalf of the Finnish Orthopaedic Society. The aim of the register is to maintain a record of endoprosthetic replacement surgery, especially about indications, early and late complications and types of implants used. Hospitals may join the register on a voluntary basis. Details related to every operation in which a joint has been replaced by an implant are reported a) after the operation and b) 1 year after the implantation. Subsequent reports on the results are collected in the case of special complications.

During the first year (1980), a total of 1360 endoprosthetic replacements were reported by 28 hospitals. Of these 984 were total hip replacements and 294 knee replacements. Primary complications were reported in 11.1 per cent of the cases, the commonest being wound haematomas, unsatisfactory positioning of the components, thromboembolism and postoperative luxations.

MULTICENTER INVESTIGATION OF ENDOPROSTHETIC ARTHROPLASTY OF THE KNEE

GÖRAN C. H. BAUER, KAJ KNUTSON & ANDERS LINDSTRAND

Dept. of Orthopaedic Surgery, Lund University Hospital, S-221 85 Lund, Sweden

The Swedish Orthopaedic Society has persuaded all orthopaedic units in Sweden to participate in a prospective investigation of all knee arthroplasties performed since October 1, 1975. 5611 primary operations and 579 reoperations have been reported to a common data base. The reports include pre- and post-operative clinical data and radiographic material, complications encountered, and a follow-up of the patients at 1 and 3 years. Osteoarthrosis accounted for 50%, rheumatoid arthritis for 43 and other conditions such as osteonecrosis, trauma, and tumor for 7% of the material. The response to follow-up has been 91% at 1 year and 73% at 3 years. In osteoarthrosis unicompartment endoprosthesis was used in 50% of cases, and in theumatoid arthritis the majority had bi- and tricompartment endoprostheses. At 1 year, 10% of the operations had had significant complications, one third of which were deep infection and two thirds mechanical. The cumulative risk to date for revision has been 5%, for salvage arthrodesis 1%, and amputation 0.1%. At 3 years the incidence of deep infection and mechanical complications in osteoarthrosis was 1% and 4% in 1114 unicompartmental cases, 1% and 9% in 679 bi- and tricompartmental cases, and 11% and 16% in 125 hinge cases. For rheumatoid arthritis the corresponding figures were 2% and 6% in 1301 bicompartmental cases, and 8% and 6% in 248 hinge cases. The probability of 5 year survival was better than 90% for the uni- and multicompartment prostheses in arthrosis and similar for stem and multicompartment prostheses in rheumatoid arthritis. These data correspond favorably with the survival prognosis of the patients.

The conclusions of this project to date are: That close to nine of 10 arthroplasties are satisfactory for at least 3 years; That the risk for deep infection rises with the complexity of the procedure, and that the psychologic and technical obstacles to an all-inclusive multicenter investigation can be overcome.

TOTAL HIP REPLACEMENT IN JUVENILE CHRONIC ARTHRITIS

LARS LIDGREN, HÅKAN BRATTSTRÖM, LEIF EKELUND, BRYNJÓLFUR MOGENSEN & HELENA SVANTESSON

Department of Orthopaedic Surgery, University Hospital, Lund, Sweden

Fifty total hip replacements in 33 patients with juvenile chronic arthritis were performed during a 10-year period with good pain reduction, increased hip motion but only a moderate increase in walking capacity.

The average age at operation was 26 years and the average follow-up time 77 months.

Six hips (patients) have been reoperated, one for infection, one for suspected infection and four due to mechanical loosening.

Loosening was revealed radiographically in 10 hips at follow-up. Lack of cement cover and varus position was the main reason for loosening of the femoral stem.

Considering the high loosening rate it is probable that at least one revision arthroplasty will be necessary in the future.

THE CHARNLEY VERSUS THE CHRISTIANSEN TOTAL HIP ARTHROPLASTY

A Prospective Comparative Clinical Trial

EINAR SUDMANN, LEIF IVAR HAVELIN, OLE DANKERT LUNDE & MILAN RAIT

Hagavik Orthopaedic Hospital, University of Bergen, Bergen, Norway

From September 1974 to the end of 1976 200 consecutive total hip arthroplasties were done by one surgical team in 46 men and 129 women (mean age 67 years). Every other consecutive patient was operated according to Charnley and every other patient according to Christiansen, 100 arthroplasties of each type, in an operating theatre with vertical downflow of filtered air. All patients received prophylaxis against infection and thrombosis. All operations except two were done under general anaesthesia.

Until February 1, 1982 21 Christiansen hips (19 patients) were operatively revised one or more times; three had a Girdlestone pseudarthrosis, 17 a Charnley total hip and one another Christiansen prosthesis (which now is loose). In addition, in these patients four contralateral Christiansen hips need revision due to loosening. In contrast, only two Charnley hips were revised due to breakage and loosening of the stem respectively. The clinical and radiological results will be reported.

EARLY LOOSENING OF CEMENTED TOTAL HIP PROSTHESES

GUDMUND BLOMGREN, CLAES HIERTON & URBAN LINDGREN

Department of Orthopaedic Surgery, Huddinge Hospital, Huddinge, Sweden

To study factors correlated to early loosening, patient data and radiograms from 237 consecutive total hip replacements were evaluated by means of a computer programme.

The frequency of radiological loosening was 24 per cent. The cementation of the prostheses seemed to be a

crucial factor. Loosening was significantly more frequent when the femoral prosthesis was incompletely surrounded with cement. There was a significantly low incidence of bone cement with a high viscosity in the group of loosened hips while low viscosity cement was highly correlated to loosening. The observations indicated that the more viscous the cement the lower the incidence of loosening. The importance of the design of the prosthesis was illustrated as the CAD-prosthesis was significantly superior to the Charnley-Müller prosthesis. When the experience of the surgeons was compared different factors contributed to loosening. The impact of a single crucial factor, such as deficient cementation, seemed to be greater in operations done by inexperienced surgeons. Since loosening occurred at a considerable rate even after total hip replacements done by experienced surgeons factors such as the cement type and the design of the prosthesis probably have a correspondingly greater influence in these cases.

We wish to underline the importance of a thorough surgical technique and believe that special units for total joint replacement may be a basic requirement in order to achieve optimal results.

LOOSENING OF TOTAL HIP PROSTHESIS. A RADIOLOGICAL AND CLINICAL STUDY

TOR STEINAR RAUGSTAD, ANTTI ALHO, ARTHUR BJERRSAND & ODD SØREIDE

Section of Orthopaedics and Traumatology and Department of Radiology, Haukeland Sykehus, Bergen, Norway

Clinical and radiological data have been studied in 146 patients (mean age 77 years) operated with total hip prosthesis in the period 1973–79. 101 patients received a Christiansen prosthesis (36 with a short stem, and 65 with a long stem), 26 received a Charnley prosthesis, and 19 received a Wagner prosthesis. The X-ray films taken at the follow-up-study (which included a clinical examination by one of the authors) were examined with special emphasis on signs indicating loosening, and were compared with the films taken in the immediate postoperative period.

The mean follow-up time was 40 months (range 11–93 months). The postoperative infection rate was 2.5% (within 3 months) and the total infection rate at the follow-up was 4.1%. Loosening of the prosthetic components was defined as migration of the stem and/or acetabular cup. Migration into varus occurred in 16 of 127 prosthetic stems (12.4%) and distal (axial) migration occurred in 21 of 127 prosthetic stems (16.4%). Migration of the acetabular cup occurred in 8 of the 146 cases (5.5%).

Both migration components (varus and distal) of the femoral stem were significantly related to pain ($P < 0.01$), whereas migration of the acetabular component was not significantly related to pain ($0.5 > P > 0.1$), probably due to the small number of patients with acetabular migration. Cortical bone reaction (sclerosis) was found in 12 cases (9.1%) and was significantly related to pain ($P < 0.05$).

A comparison was made between the Christiansen and the Charnley prosthesis. The different signs of loosening all occurred more often and the frequency of pain was higher in the Christiansen prosthesis than in the Charnley prosthesis, but the differences were not statistically significant.

HEAT TOLERANCE OF BONE TISSUE

TOMAS ALBREKTSSON & ANDERS ERIKSSON

Department of Anatomy, University of Gothenburg, Sweden

At sawing and drilling in bone or at cementation of implants the tissue temperature may often reach or exceed 55°C (Tetsch 1974, Lavelle & Wedgwood 1980). As this temperature coincides with the denaturation point of alkaline phosphatase, many authors seem to be of the opinion that 55°C is the critical heating point for osseous tissues (Rhinelander et al. 1979, Green & Matthews 1981). Because of methodological problems few studies have been aimed at investigating the vascular and cellular responses to heating between 45°C and 55°C.

The titanium chamber, previously described by Albrektsson (1979), comprises a titanium implant which through an optical system allows *in situ* and *in vivo* studies of bone tissue. Eriksson et al. (1982) have described a modification of this chamber which allows simultaneous heating up and vital microscopy of a defined bone tissue compartment while the temperature is measured via a thermocouple inserted in the very bone under observation. The authors heated the bone to *53°C for 1 min* and observed immediate stand-still of blood flow. The blood flow temporarily returned when the temperature was lowered. At the control of the animals 2 days later, permanent flow stand-still had occurred and the hard tissue was dead. Vascular and hard tissue regeneration depended on the healing capacity of surrounding, unburned areas.

The same experimental model has been used in further experimental investigations. Heating to *47°C for 5 min* or *50°C for 1 min* provoked similar responses: The connective tissue elements died and became replaced with new-built bone and fat cells while the vessels, apart from some increase in diameter and blood flow, remained functioning and were not replaced. Whether this observation is indicative of a greater tolerance to heat of endothelial cells compared to bone cells or only reflects a lower temperature in the vessels, cooled by the blood flow, is presently unknown. At *47°C, 1 min* there were no signs of tissue injury.

The present study indicates that bone tissue is more sensitive to heat than has been postulated in other investigations. Using cement-free implants with the aim of a direct bone anchorage, the control of the surgical

trauma in form of preventing unnecessary development of heat may be of crucial importance for clinical success.

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TISSUE REACTION TO WEAR PRODUCTS FROM DELRIN® AND UHMW-POLYETHYLENE

Erik Berg-Mathiesen*, Einar Sudmann**, Urban Lindgren* & Finn Reinholt***

*Department of Orthopaedic Surgery, Huddinge Hospital, Huddinge, Sweden, **Department of Orthopaedic Surgery, Kysthospitalet i Hagavik, 5220-Hagavik, Norway ***Department of Pathology, Huddinge Hospital, Huddinge, Sweden

Aseptic loosening of total hip replacements may result from biomechanical failure or formation of foreign body granulomas. In the latter case wear particles become encapsulated by foreign body giant cells forming a granulomatous tissue around the joint. This tissue invades the bone-cement interface around the prosthetic components leading to loosening of the prosthesis and in particular the acetabular component.

Delrin or Polyoxymethylene – a polyacetal homopolymer – has been found to have slightly inferior wear characteristics under certain conditions compared to UHMW-Polyethylene. This has not been considered to be of significant importance in the Christiansen prosthesis where Delrin has been used since 1970.

We have studied biopsies from connective tissue surrounding loosened Christiansen prostheses. The size of the wear particles and the tendency to granuloma formation has been compared to findings from biopsies obtained from loosened UHMW-polyethylene prostheses. An unusually high loosening rate of Christiansen prostheses may partly depend either on a pronounced foreign body reaction around the joint or on a high friction between metal and Delrin.

THE BACTERIOLOGICAL EFFECT OF A PLASTIC ADHESIVE DRAPE IN A LAMINAR CROSS FLOW OPERATING UNIT

Sven Friberg & Kristina Tåg

Department of Orthopaedic Surgery, University of Umeå, Umeå, Sweden

The bacterial contamination of the wound area was studied during 10 total hip replacement operations. During five (randomized) operations the skin was protected with a sterile plastic adhesive drape. The number of colony forming units (Cfu) in wound washings and on four different locations on the surface around the wound was determined every 15 min.

With the adhesive drape the wound washings (n = 22) contained a total number of 28 Cfu. When no plastic drape was used the total number of Cfu found in the washings (n = 24) was 247. The difference is not significant (P = 0.3). The higher number of Cfu in the experiments without plastic drapes was due to two observations with 35 and 196 Cfu respectively and probably reflects slip-ups in the aseptic technique.

On the four locations of the plastic adhesive drape tested (n = 79) a total number of 4 Cfu was found. On the un-protected skin (n = 100) a total number of 35 Cfu was sampled. The difference is not significant (P = 0.1). However, 32 of the 35 Cfu sampled from the un-protected skin were located on the measuring point closest the anal region. Comparing the results from this location only showed that a significant (P = 0.01) reduction of the contamination occurred when plastic drapes were used.

None of the patients developed a postoperative infection.

The conclusion is that a sterile plastic drape reduces the number of bacteria found on the surface around the wound if the preoperative preparation of the skin is inadequate. In the present situation with a very low degree of remaining bacteria on the skin the effect of the sterile drape on the contamination of the wound is insignificant and presumably of no clinical interest.

CEMENTLESS LORD MADREPORIQUE HIP ARTHROPLASTY. AN ALTERNATIVE FOR YOUNGER PATIENTS

Peter Herberts, Bertil Romanus & Lennart Ahnfelt

Department of Orthopaedic Surgery, East Hospital, Gothenburg, Sweden

Preliminary experiences of 25 arthroplasties of the hip using the Lord prosthesis without cement are presented. The study is prospective and the patients are evaluated pre- and postoperatively according to a standardized formula. We use the method for younger patients where the use of cement must be abandoned. Different pathological conditions were present with in most cases severe destructions of the femoral head. The age of our patients varies between 28 and 55 years. The follow-up is short and varies between 6 months and 2 years. All patients are seen at 6 months and yearly thereafter.

Preliminary results are good and similar to conventional hip arthroplasties. Pain, range of movement and function has been evaluated according to Charnley. We have encountered a number of surgical complications such as fractures of the greater trochanter and fissures of the femoral shaft. The operative technique must be precise and the method involves certain specific pitfalls. However, no serious postoperative complications have

been observed so far and no prosthetic loosening or deep infection has occurred. The method seems to be a promising alternative for younger patients with crippling hip disease. It offers the possibility of a simple exchange of the articulating components in the case of wear, without removing the biologically anchored implants in the acetabulum and proximal femur.

EFFECT OF TOTAL HIP ARTHROPLASTY ON THE SERUM LEVELS OF ESR AND CRP

KARI AALTO, KALEVI ÖSTERMAN & HEIKKI PELTOLA

Aurora Children's Hospital & The Orthopaedic Hospital of the Invalid Foundation, Helsinki, Finland

35 osteoarthritic patients were operated on under flucloxacillin prophylaxis using metal-to-HDP endoprosthesis and acrylic bone cement. ESR and CRP samples were taken preoperatively, during the operation and at intervals up to 2 months postoperatively.

All the patients recovered without any clinical signs of infection. The preoperative ESR value was, on the average, 28 mm/h decreasing to 12 during the operation day. The maximum mean ESR value of 58 was reached on the third postoperative day. Though gradually decreasing the mean ESR value remained elevated, 50 at 3 weeks and 38 at 2 months.

The postoperative CRP values were invariably negative, under 10 mg/l. The operation, however, resulted in elevated CRP levels. The mean CRP value during the operation day was 16 mg/l, and the maximum of 134 was reached 2 days postoperatively. Normalization took place within 21 days without a single exception.

CRP seems not to be affected by osteoarthritis. It seems to be a useful test in assessing the postoperative course of patients with total hip replacement.

DRY ^{99m}Tc-MICROAEROSOL FOR VENTILATION STUDIES OF PULMONARY EMBOLISM AFTER TOTAL HIP REPLACEMENT

HANS O. FREDIN & MÅNS ARBORELIUS, JR.

Departments of Orthopaedic Surgery and Clinical Physiology, Malmö General Hospital, Malmö, Sweden

A new ^{99m}Tc-microaerosol was used for ventilation scintigraphy in combination with ^{99m}Tc perfusion scintigraphy regarding pulmonary embolism (PE). Two hundred patients were studied 10–14 days after surgery.

A blind reevaluation of the scintigrams after more than 2 months gave identical evaluation in more than 90% concerning type of defect and diagnosis of PE. Perfusion defects of triangular shape were more frequent in combination with ventilation mismatch (= PE) than with ventilation match (= not PE) ($P < 0.001$). The incidence of PE was 20%. Arterial blood gases could not discriminate between patients with large PE (two segments or more) and patients without PE. Attacks of sudden chest pain in the postoperative course were more frequent in patients with PE ($P < 0.01$).

The dry ^{99m}Tc-microaerosol provides a low radiation dose, a high resolution and images directly comparable to the perfusion study with the same isotope. These qualities are obvious advantages as compared to ^{133}Xe or other methods earlier applied.

The scintigraphic method presented implies an improvement in the clinical work of diagnosing pulmonary embolism.

RESULTS AFTER EXCHANGE ARTHROPLASTY FOR FAILED TOTAL HIP REPLACEMENT

ERIK BERG MATHIESEN, STAFFAN GRÖNDAL & URBAN LINDGREN

Dept. Orthopaedic Surgery, Karolinska Institute, Huddinge Hospital, Huddinge, Sweden

It is generally agreed that the results from exchange arthroplasty are inferior to what we expect from the primary operations. It has even been claimed that it is unwarranted to replace failed total hips because the results would not be much better than after excision arthroplasty.

We have studied 50 consecutive exchange total hip arthroplasties with a mean follow-up period of 32 months. The results of these operations have been compared to results from 237 primary total hip replacements (T.H.R.). Data collected from patient records and radiographs have been compared by means of a computer programme.

The operation time was longer and bleeding more intensive in secondary operations compared to primary T.H.R. There was no difference in the rate of serious complications. The clinical condition of non-loosened secondary T.H.R. was comparable to what we found in uncomplicated primary hips. Only three of the exchanged prostheses loosened again and were subjected to tertiary surgery whereas in the unselected material of primary total hip replacements the loosening rate was in the range of 20 per cent with a revision rate of about 10 per cent. A low virulent deep infection after the primary total hip replacement did not influence the result of the secondary operation, but one deep infection with *Staph. aureus* subsequently necessitated excision arthroplasty.

An exchange T.H.R. is a more extensive operation than a primary T.H.R. and often requires a diversified set of prostheses and instruments. Frequently bone transplantation to the acetabulum becomes necessary. The results may however be quite comparable to what we see after a primary T.H.R.

REOPERATION OF TOTAL HIP REPLACEMENT A.M. CHARNLEY BY A STANDARDIZED METHOD

JAKOB KJÆR & CLAUS KROMANN-ANDERSEN

Orthopedic Hospital in Aarhus, Denmark

Between February 1969 and April 1981, 2790 total hip replacements were performed in the Orthopedic Hospital, Aarhus. Since April 1979 a standardized procedure has been used in exchange arthroplasties, including 1) radical removal of implants and cement, 2) removal of all infected and necrotic tissue, 3) use of gentamycin-loaded Palacos cement for the new Charnley prosthesis, 4) effective suction drainage and 5) long term treatment with dicloxacillin in infected cases.

In this period of 2 years, 50 hip endoprostheses in 20 male and 29 female patients (median age 61 and 62 years respectively) were exchanged. The median time from the primary operation was 27 months (range 1–110). The reason for reoperation was in 22 cases mechanical loosening or luxation and in 28 cases infection. Because of reinfection one patient underwent the standard operation twice, and in another case the Girdlestone procedure was used.

No major surgical complications and only minor postoperative complications were observed. Until now a clinical follow-up has demonstrated excellent/good results in about 80 per cent and fair/poor results in about 20 per cent of the cases. These preliminary data indicate that our standard procedure gives results that are comparable to those reported by other centers for hip surgery.

ICLH ARTHROPLASTY OF THE KNEE WITH THE "MAGIC PEG"

PETER HERBERTS, IAN GOLDIE*, BO ALTHOFF, B. E. ALBREKTSSON, GUNNAR ANDERSSON & FOLKE KARLSSON

Dept of Orthopaedic Surgery, Östra Hospital, 416 85 Gothenburg; *Dept of Orthopaedic Surgery, Karolinska Hospital, 104 01 Stockholm, Sweden

Cementfree implants have been reintroduced for both hip and knee joints. Freeman et al. have developed a method by which the tibial component of a knee prosthesis can be made to interlock with living cancellous bone. The tibial implant is provided with an area to ensure that it can rest totally on the resected top of the tibia. Two specially designed ultra-high-molecular-weight-polyethylene pegs, integral with the prosthesis itself, are driven into the bone. Their design is such that they provide an immediate interlock with living bone. This modification of the ICLH (Imperial College London Hospital) arthroplasty has been used by us since 1977 and we intend to report our clinical impressions, radiologic findings and the relation of the "magic peg" to the surrounding bone.

The operation has been carried out in 121 patients with a longest follow-up of 4 years and a shortest of 6 months (mean: 3 years). Half of the patients had rheumatoid arthritis, the remainder osteoarthrosis. All patients were examined clinically and radiographically with function test of mobility and weight bearing of the ankle joint. The relation of the "magic peg" to bone was examined in one case.

There was in all patients a general improvement in pain, range of movement, activity level and walking ability, which improved considerably after operation. Valgus-varus deformities were corrected and remained so at the follow-up. Sagittal stability was retained. 80 per cent of the patients were enthusiastic, 15 per cent satisfied and 5 per cent non-committal.

There were complications in 10 per cent including thromboembolism, swollen leg without certified thromboembolic diagnosis, superficial infection in two cases and one deep. The infections healed without any complications to the prosthesis.

Results in this investigation have supported the opinion that prosthetic replacement of the knee joint in both rheumatoid arthritis and osteoarthrosis is a most satisfactory procedure.

MICROMOVEMENT OF THE TIBIAL COMPONENT IN SUCCESSFUL KNEE ARTHROPLASTY, STUDIED BY ROENTGEN STEREOPHOTOGRAMMETRY

LEIF RYD, ANDERS LINDSTRAND & GÖRAN SELVIK

Departments of Orthopaedic Surgery and Diagnostic Radiology, University Hospital in Lund and Department of Anatomy, Lund University, Lund, Sweden

Roentgen stereophotogrammetry was used to study the behaviour of the tibial component of 20 patients with a successful knee arthroplasty.

At the operation 3 or more tantalum markers, 0.8 mm in diameter, are introduced into the tibial component and the tibial metaphysis respectively. Measurements are made of the change of position between these two groups of markers at different time intervals with an accuracy of 0.1° for rotations and 0.1 mm for translations. A post-operative reference examination is always done. We present the first 20 consecutive patients for whom the clinical result was satisfactory after at least a 1-year follow-up period. There are 10 unicompartmental Marmor prostheses and 10 total condylar ones. Since the beginning of 1981 the method has been applied to every knee arthroplasty performed for gonarthrosis at the Lund University Hospital.

Stereophotogrammetrical analysis revealed significant movements in at least one direction in all cases. The mean values for rotations were between 0.5° and 3° for different directions, being smaller for the total condylar prostheses than for the Marmor ones. Translations were more seldom seen. The most consistent movement was

found about the vertical axis, where 8 total condylar prostheses rotated in a "toe-out" fashion, and 7 out of 9 Marmor prostheses rotated with the anterior part away from the centre of the knee. The magnitudes of these movements were 0.5° and 1° respectively.

The movements found here *could* be caused by the soft tissue of the radiolucent zone, which developed in all cases, thereby offering only a semi-rigid bond between the prosthesis and the bone. However, this state of semi-rigidity could only be proven by examinations taken under stress. Work along this line is in progress.

REARTHROPLASTY OF THE KNEE JOINT IN MECHANICAL AND INFECTIOUS FAILURES

ANDERS WIGREN

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

Rearthroplasty or fusion of the knee joint must be performed in severe complications of an arthroplasty. Long-term experiences in this field are so far not available. Since 1977 we have performed 23 rearthroplasties, 4 in osteoarthritis and 19 in rheumatoid arthritis. 15 were done because of a mechanical complication and 8 because of an infectious one. Follow-up is 1–5 years, mean 2 years. In the mechanical complications the primary prosthesis was mostly of the unicondylar type. Most of the infected arthroplasties had a hinge endoprosthesis, and all were in rheumatoid patients.

The cause of mechanical failure was found to be technical errors in the choice of endoprosthesis and/or in the surgical procedure. Settling of prosthetic components and subluxation of the artificial joint were as common as true loosening. 2/15 arthroplasties had an adequate trauma causing the rearthroplasty. 3/8 infected knees had a hematogenous infection. Delay of adequate surgical treatment of the infection led to progressive osteomyelitis, loss of bonestock and severe skin and soft tissue problems around the knee joint. Fractures involving the artificial knee often made a customized endoprosthesis necessary. 21 arthroplasties were converted to spherocentric® knees, one to a GSB-joint and one to a Marmor arthroplasty. Bone cement with antibiotics was always used. The 15 mechanical complications were all successfully reoperated in a one-stage procedure. The 8 infected joints were reoperated in a two-stage procedure and are on permanent antibiotics. The result is satisfactory in 6, one patient has a stiff knee and in one the endoprosthesis has been extracted. All knee joints are without signs of infection.

Conclusion: Rearthroplasty in mechanical complications can be expected to be successful in most cases. Rearthroplasty in infected knees can be performed in selected cases as a two-stage procedure. The condition of the soft tissue over the artificial joint strongly influences the result.

FEATURES RESISTING PRIMARY TREATMENT OF CONGENITAL CLUB FOOT

A Prospective Therapeutic Trial

EINAR SUDMANN & JOHN K. HALD, JR.

Departments of Orthopaedic Surgery and Radiology, University of Tromsø, Tromsø, Norway

The aims of this study were: 1) to see whether the number of relapses of hindfoot deformity in congenital club foot in the first year of life could be reduced by operative treatment, and 2) to try by surgery to pinpoint features of congenital club feet that make them resistant to treatment. Thirty-two patients (47 club feet) born between 1975 and 1978 were divided into two consecutive groups, B and C. Group B (15 patients, 22 club feet) received primary closed treatment, with manipulation and plaster casts for about 4 months, and in 9 feet tenotomy of the heel cord. Day and night splints were used irregularly. In group C (17 patients, 25 club feet) tenotomy of the heel cord and tibialis posterior tendon was done on almost all the patients, followed by immobilization in plaster slabs for about 4 months. No splints were used. The median observation period was about 3½ years in both groups.

The number of relapses of the hindfoot deformity in the first year of life was significantly lower in group C (8 per cent) than in group B (59 per cent), and the need for additional treatment was less for this group. The results indicate that the achilles and the tibialis posterior tendons, and their corresponding muscles, are the main dynamic features that need to be dealt with when treating the hindfoot deformity in congenital club foot.

METATARSAL HEAD RESECTION IN THE TREATMENT OF THE RHEUMATOID FOREFOOT

IAN GOLDIE, BO ALTHOFF, TOMAS BREMELL & LARS IRSTAM

Department of Orthopaedic Surgery, Karolinska sjukhuset, Stockholm, Sweden

Some 70 per cent of patients with rheumatoid arthritis have foot trouble. The initial treatment is generally conservative. However, with time surgery has become more advocated. The most common procedure is resection of the metatarsal heads. It has proved successful in the treatment of splayfoot, tylomas and dislocation of the MTP joints.

In surgery of the forefoot there are five factors to be considered: 1) should the fat pad be excised or replaced to its original position, 2) should the metatarsal heads only be excised or the excision combined with resection of the phalanges, 3) should all metatarsal heads be excised or only e.g. II–V, 4) must the resected metatarsal ends form an even curved arc, and finally 5) are the results of surgery influenced by other factors like functional class, stage of disease, etc.?

Between 1972 and 1980 34 patients with classical rheumatoid arthritis representing 62 feet were operated. Metatarsal resections II–V were done in 27 feet; I–V in 11. In 21 feet additional procedures (e.g. Keller's or Reverdin's op.) were carried out besides metatarsal resections II–V. The results were followed up in 1981 with the longest observation time of 9 years and a shortest of 6 months.

The follow-up was carried out by the rheumatologist of the team. Twenty-two patients were satisfied, 2 were undecided and 8 dissatisfied. Walking ability improved except in the dissatisfied group, where there was a remarkable deterioration. Pain decreased considerably. The use of shoes was not significantly influenced. There was an improvement in stability. The amount of callosities diminished. The fat pad remained in its original position. The muscle power of the toes and their mobility, as well as the ability to stand on toes improved. The metatarsal arc was even in the majority of cases, but this was found to be insignificant in relation to the patient's sensation of discomfort. An uneven arc did not necessarily imply a bad foot function or pain. In patients in whom no procedure had been carried out in the big toe, hallux valgus developed and had to be dealt with later. The result of the operation was worse in patients with deteriorated functional class. Resection of metatarsal heads in the painful rheumatoid forefoot is a recommendable procedure.

PROXIMAL METATARSAL OSTEOTOMY IN HALLUX VALGUS

CARL-AXEL CEDELL & MATS ÅSTRÖM

Department of Orthopaedic Surgery, Central Hospital, Växjö, Sweden

In order to obtain an optimal correction of hallux valgus and to prevent its recurrence the authors have applied a surgical technique which combines a proximal valgus osteotomy of the first metatarsal bone with an excision of the pseudoexostosis and a distal soft tissue plasty at the first metatarsophalangeal joint.

The procedure is based on an etiological theory regarding metatarsus primus varus as the primary cause of the deformity, which is in accordance with the opinion of many other authors. The osteotomy corrects the malposition of the first metatarsal bone thereby reducing the deformity and preventing its recurrence. The soft tissue plasty alleviates secondary contractures that prevent a full correction of the big toe. The postoperative treatment is greatly simplified by immediate weight bearing and a minimal immobilization with a strip of plaster along the medial border of the foot. A series of 43 consecutive patients (46 feet) with a follow-up period of 5–44 months and extracted from a total number of 99 operated cases is presented.

The result was excellent in 78%, good in 11% and poor in 11%. The reason for a less than excellent result was almost always inadequate correction of the deformity, either at the level of the first metatarsal bone, or the big toe, or both.

Our method has proved to be an effective surgical procedure against hallux valgus, even in older patients. It has been used in our department since 1975 and is now predominating in all cases of advanced hallux valgus.

COMPARISON BETWEEN CLAYTON PROCEDURES PERFORMED WITH AND WITHOUT A SILICONE PROSTHESIS IN THE MTP I JOINT

HELGE RØNNINGEN, JENS TEIGLAND & JAN A. PAHLE

Oslo Sanitetsforenings Revmatismesykehus, Oslo, Norway

Clayton has described a radical procedure for correction of the severely damaged forefoot often encountered in patients with rheumatoid arthritis. In our department the procedure has been performed through a transverse plantar approach to the MTP II–V joints. The MTP I joint together with the sesamoids have been resected through a dorsomedial incision. Until 1979 the great toe was temporarily kept in alignment with the first metatarsal bone by means of an axial Kirschner wire. It was intended that this aided alignment should yield a permanently aligned toe after removal of the wire, with less tendency towards valgus deformity and malrotation. From 1979 on, as the silicone prosthesis designed by A. B. Swanson had appeared, the MTP I joint has been replaced by the doublestemmed prosthesis.

In the present study we have compared the results at follow up after arthroplasty (14 feet in 9 patients) to the results after resection and wire fixation (19 feet in 11 patients). Average observation time was 24 and 36 months respectively.

There were few postoperative complications. Five feet in the "wire-group" needed minor revisions. Spontaneous ankylosis had occurred in six feet in the "wire-group", though without hampering the function of the feet. The prosthesis tended to produce a longer toe than did the simple resection. Hence a generous resection of the bone ends should be recommended. The feet were similar as regards flexion power and valgus deformity. The overall results could be assessed as excellent in 20 feet, acceptable (improved, but some pain still remaining) in 12 feet, and poor in 1 foot. All patients could wear normal shoes, though most of them after careful selection or minor modifications. It is concluded that the arthroplasty yields acceptable results, without being superior to the simple resection.

THE STRAIN ON SUTURED ACHILLES TENDONS IN WALKING CAST. AN EMG ANALYSIS

O. J. Fretheim, P. Benum & V. Berg*

Department of Orthopaedic Surgery and Department of Neurology*, Trondheim University Hospital, Norway

The purpose of this study is to evaluate the strain on a sutured Achilles tendon during postoperative weightbearing in a short leg cast.

The regression line of the EMG/torque relationship of the triceps surae muscle in the non-injured leg was investigated during isometric contractions. A linear relationship was found.

The ankle torque provided by the triceps surae of the injured leg in a short leg walking cast was calculated from the EMG activity of the injured leg and the regression line of the non-injured leg. The strain acting on the sutured Achilles tendon was then calculated after measuring the lever arm.

There was no significant difference in calculated strain on the sutured tendon during full, partial or no weightbearing in short leg cast. The actual strain is unlikely to exceed the strength of a sutured Achilles tendon.

The present study gives experimental support to the view that full weightbearing in a short leg cast is worth recommending in the postoperative treatment of Achilles tendon ruptures. The walking cast ought to have a plantar flexion of 20 degrees and weightbearing should not provoke considerable pain.

IMPROVED DIAGNOSIS OF PARTIAL RUPTURE OF THE PATELLAR AND ACHILLES TENDONS

Lars Vedin & Gunnar Westberg

Dept. of Diagnostic Radiology at Danderyd Hospital, Stockholm, Sweden

Over the last 3 years 200 patients with symptoms of traumatic patellar or Achilles tendons disease have been examined with soft tissue high resolution radiography and ultrasonography. In some cases bursography of the deep Achilles bursa was also performed. Fifty of the cases with radiographic and ultrasonographic signs of subcutaneous partial rupture of the tendon, mainly the Achilles tendon, were operated upon and examined by microscopy. In all these cases the diagnosis was confirmed.

An interesting observation was that with very few exceptions the patients with subcutaneous partial rupture of the tendons had clinical symptoms of so-called tendinitis. Our investigation showed that soft tissue radiography and bursography permits diagnosis of subcutaneous partial rupture of the tendons with a very high degree of accuracy. Additional ultrasonographic examination provides a more exact information of the degree and localisation of the rupture.

POSTERIOR FUSION FOR ATLANTO-AXIAL LUXATION IN RHEUMATOID ARTHRITIS

Sven-Erik Larsson & Göran Toolanen

Department of Orthopaedic Surgery, University of Umeå, S-901 85 Umeå, Sweden

About one third of rheumatoid patients with chronic destructive disease show atlanto-axial luxation of more than 3 mm on radiograms taken in flexion. Symptoms are progressive and may necessitate surgical intervention to prevent long tract signs and sometimes sudden death. 34 patients were operated on in 1976–80. Their mean age was 54 (29–72) years. 8 patients had had long-term steroid treatment. 7 were working. Fusion was performed more or less prophylactically in the latter cases. Occipital rhizopathy had 21, long tract symptoms 14, vertigo (brain stem ischemia) 2 and crepitations ("loose head") 4. There were 5 deaths, all more than 1 year after the operation, but no complications due to the treatment. Operation was performed in local anaesthesia. Skull traction was not used. Posterior fusion was performed with cerclage and an iliac bone block. All patients were mobilized the day after the operation with a specially made plastic neck collar used for 3 months. All patients became symptom-free except 3 with spinal tract signs. These had reduced spasticity and numbness. Bony fusion was achieved in 58%, stable fibrous fusion in 28% and remaining instability (>2 mm) in 14%. The results were comparable to those reported from more extensive surgical regimens. Fusion is recommended in cases with forward luxation of 88 mm or more, in downward luxation and in cases with neurological symptoms.

THE SIGNIFICANCE OF DISTALLY POINTING ACROMIOCLAVICULAR OSTEOPHYTES IN RUPTURES OF THE SUPRASPINATUS TENDON

Claes J. Petersson & Carl-Fredrik Gentz

Departments of Orthopaedic Surgery and Radiology, Malmö General Hospital, Malmö, Sweden

The acromioclavicular joint is positioned over the muscle-tendon junction of the supraspinatus muscle. When the arm is abducted the tendon slides below the acromioclavicular joint and the tendon insertion at the major tubercle reaches a position close to the joint in about 90° of abduction.

The purpose of the present investigation was to evaluate, by two different methods, whether distally pointed osteophytes of the acromioclavicular joint have any part in the pathogenesis of supraspinatus tendon ruptures.

In the first part of the investigation 102 shoulder

dissections on cadavers were performed. The supraspinatus tendons were examined and degenerative changes and ruptures of the tendon were registered. The areas of the changes were measured with a ruler. The acromioclavicular joints were excised and scrutinized. Osteophytes on the inferior surface of the acromion or the clavicle were carefully dissected and the size was measured.

Ruptures of the supraspinatus tendon were registered in 13 shoulders and severe degenerative changes with an area greater than 10 × 10 mm in another 15 shoulders. Acromioclavicular osteophytes with a size of 2 mm or more were found in 11 out of the 28 shoulders with ruptures or degeneration and in 3 of the shoulders with a normal supraspinatus tendon. This difference is highly significant.

In the second part of the investigation 47 images of patients with arthrographically verified supraspinatus tendon ruptures and 50 images of patients without shoulder disease were reviewed. The images were standard anterio-posterior projections of the shoulder joint. Distally pointed osteophytes were registered and measured with a ruler.

There were 24 osteophytes with a size of 2 mm or more in the rupture group and 7 osteophytes in the control group. The difference is highly significant.

Our conclusion is that distally pointed osteophytes of the acromioclavicular joint are of importance in the pathogenesis of rupture of the supraspinatus tendon.

SHORTENING OSTEOTOMIES

PAUL LEREIM & NORVALD LANGELAND

Sophies Minde Orthopaedic Hospital, Oslo, Norway

During a period of 11 years from 1970 through 1980, 39 shortening osteotomies in 35 patients were carried out in Sophies Minde Orthopaedic Hospital. Thirty-one of the patients had their operation done because of unequal leg length, and 4 patients were operated bilaterally because of unacceptable body height. Thirty-five of the osteotomies were performed on the femur, the remaining 4 on the proximal tibia and fibula.

On the proximal femur a Z-osteotomy was performed saving the minor trochanter to the proximal fragment. Fixation was achieved by a compression plate. In the group of unequal leg length, the preoperative difference ranged from 2 to 6.2 cm, mean 4.2 cm. In the group of unacceptable body height a shortening of 5.5 cm and 9 cm respectively was achieved in the 2 male patients, and 6.5 cm and 7 cm, respectively, in the female patients.

There were no serious complications. The intended shortening was obtained quite accurately with the present method, and it seems to be safer than epiphyseodesis in the treatment of unequal leg length in young patients.

INCREASED FEMORAL ANTEVERSION AND OSTEOARTHRITIS OF THE HIP JOINT

TERJE TERJESEN, PÅL BENUM, SVEIN ANDA & SVEIN SVENNINGSEN

Department of Orthopaedic Surgery and Department of Radiology, Trondheim University Hospital, Trondheim, Norway

It has long been an axiom that increased femoral anteversion in adults predisposes to osteoarthritis of the hip joint, but such a relationship has never been proved. In order to throw some light upon this controversial matter, a study of the femoral anteversion in a series of 50 patients with "primary" osteoarthritis of the hip and in a control group of 30 individuals without hip disease was carried out.

The anteversion angle (AV-angle) was measured according to the method of Rippstein. The median AV-angle of the hips in osteoarthritic patients was 17.5°, and in the control group 13°. Osteoarthritic patients had a significantly increased AV-angle in relation to the control group ($P = 0.0028$). The greatest AV-angle in hips of the control group was 25°. In 18 hips of osteoarthritic patients an AV-angle greater than 25° was found. In 15 of these hips osteoarthritis was found, and in three hips there was no osteoarthritis.

Our results lead to the conclusion that increased femoral anteversion is a predisposing factor of hip osteoarthritis. This implies that derotational osteotomy in children can be a prophylactic procedure.

EXTRAARTICULAR TRANSPOSITION OF THE LATERAL PART OF THE PATELLAR LIGAMENT AS A STABILIZING PROCEDURE IN ANTEROLATERAL ROTARY INSTABILITY OF THE KNEE

PÅL BENUM

Orthopaedic Department, Trondheim University Hospital, 7000 Trondheim, Norway

A method using the lateral third of the patellar ligament and the adjacent part of the patella as an extraarticular transplant to the lateral femoral condyle has been developed as a stabilizing procedure in anterolateral rotary instability of the knee.

The operation has been performed in 16 patients. Eleven patients have been followed for more than 6 months postoperatively, the longest observation period being 2½ years.

The results are most promising since full rotary stability and good functional results have been obtained in most patients.

The procedure is recommended to be further tested as an alternative method to procedures applying the ileotibial band in the treatment of severe anterolateral rotary instability of the knee.

JOINT LAXITY AND ANATOMY IN DISLOCATION OF THE PATELLA

ANDERS RÜNOW

Dept. of Orthopaedic Surgery, Lund University Hospital, S-221 85 Lund, Sweden

Joint laxity and anatomy of the patellar joint were studied in 104 consecutive patients (37 men and 67 women) treated in 1975–77 for dislocation of the patella. 36 patients had bilateral dislocations.

All probands had other joint disease, joint laxity and/or abnormal anatomy of the patellar joint. 72 probands had two or more of these factors which predispose for dislocation of the patella.

Patellar instability (high dislocation frequency (> 2/year), bilateral dislocations and minor trauma) was correlated with joint laxity and increased ligament/patella ratio (> 1.3). Patellar instability was thus highest in the presence of both factors, lower in the presence of one factor and lowest in the absence of both factors.

Avulsion fracture from the medial margin of the patella and/or osteochondral fracture occurred in 47/140 joints. The incidence of these fractures was inversely related to joint laxity and an increased ligament/patella ratio. Avulsion and osteochondral fractures thus occur predominantly in relatively stable patellar articulations.

CRUCIATE LIGAMENT DEFICIENCY IN CONGENITAL SHORT FEMUR

EVALD JOHANSSON & TOMAS APARISI

Department of Orthopaedic Surgery, Karolinska Hospital, Stockholm, Sweden

Congenital absence of the cruciate ligaments has earlier been described only in connection with severe deformities and/or congenital dislocation of the knee. Instability of the knee joint is reported in a high frequency in cases with congenital short femur or proximal focal femoral deficiency, but the anatomical cause of this instability is not described.

We have found knee joint instability in six cases with slight to moderate congenital shortness of the femur. Arthroscopy was performed in all cases. In three patients both cruciate ligaments were missing. The remaining three patients had a normal posterior but no anterior cruciate ligament. X-ray showed a varying degree of hypoplasia of the intercondylar notch and the tibial spine. The patients are surprisingly little troubled by the instability and no treatment is planned at present.

PARTIAL RUPTURE OF THE PATELLAR TENDON

ASBJØRN MYKKELBOST & ASBJØRN ROAAS

Martina Hansens Hospital, Sandvika, Norway

Rupture of the patellar tendon may be caused by an acute trauma or repetitive maximal loading.

Twenty patients with partial ruptures were operated on. All had pain localized to the apex patellae. Usually the pain started gradually during or after sports activities. Surgical treatment comprised boat excision of scar tissue and/or splitting of the tendon in the fibre direction to obtain revascularization. Mobilization was started on the first day postoperatively. Histological examination was done in 10 cases with the following findings: organized granulation tissue with iron pigment, coiled up arterial bundles with hypertrophical intima and anomalous degenerated collagen fibres.

Seventeen patients were followed up. The reduction of pain during physical exercise was significant. However, some of the patients were not satisfied because they did not obtain better sport results than before the injury! Excision of scar tissue gave better results than only splitting of the tendon. This is compatible with the histological and histochemical development during the regeneration process. Sharp excision may reduce the number of coiled denaturated collagen fibrils, while splitting increases growth of granulation tissue into the tendon.

Partial rupture of the patellar tendon is usually localized to the apex patellae. This area has few cells and reduced vascularization. The rupture is possibly a progressive process. Surgical treatment should be sharp excision of scar tissue.

MOIRÉ TOPOGRAPHY IN SCREENING FOR SCOLIOSIS

TROELS LAULUND, JENS OLE SØJBJERG & ERIK HØRLYCK

Department of Orthopaedic Surgery, Central Hospital, Holstebro, Denmark

The diagnostic reliability of the Moiré topography (MT) as a screening method for structural scoliosis has been clinically evaluated by screening 987 girls at the ages of 10–17 in common schools. The results of the screening have been compared with an independent conventional examination performed by the school doctors.

The study revealed 41 cases of clinically significant scoliosis, which has been defined as lateral deviation of 10 degrees or more measured a.m. Cobb.

The diagnostic sensitivity of the MT has proved to be high (0.997). The method is, however, loaded by many false positive results, as the diagnostic specificity is low (0.29).

The precision of the MT has been evaluated by es-

timating the inter- and intra-observer agreement. Using Kappa statistics indexes of 0.79 and 0.86 were found.

The MT is furthermore well accepted by the patients, and the method is recommended in school screening for structural scoliosis.

Tc-99m MDP SCINTIMETRY IN EVALUATION OF LOCALIZED GROWTH DISTURBANCES

BIRGER BYLANDER, LARS INGVAR HANSSON & YNGVE NAVERSTEN

University Hospital of Lund, Sweden

The aim of this investigation was to correlate Tc-99m MDP scintimetric and roentgen stereophotogrammetric evaluation of growth disturbances in distal femur, proximal and distal tibia.

Material and methods: Longitudinal growth in 7 children with posttraumatic or postoperative growth disturbances were determined using the roentgen stereophotogrammetric method and Tc-99m MDP bone scanning. Twenty-eight growth regions were studied included five provided with staples, one operated with Phemister epiphysiodesis and three with posttraumatic growth disturbances. The qualitative analysis was performed using gamma imaging and quantitatively calculated from computerprocessed gamma camera images using the ROI selection. The radionucleide uptake from medial and lateral aspect of the growth region with growth disturbance was compared with contralateral part of intact growth region and obtained ratios presented.

Results: Deposition of Tc-99m MDP varied with increasing and decreasing growth respectively. A significantly lower disposition of Tc-99m MDP can be visualized at growth retardation or growth arrest. A gradual decrease in radionucleide uptake was observed until maturity. The roentgen stereophotogrammetric method was found superior in growth rate evaluation after fracture and operative procedures compared to the scintimetric technique, which however presented valuable information about growth. The reason is that the first method registers the longitudinal growth process while the latter registers the metabolism in the calcification of cartilage and bone.

Conclusions: 1. The Tc-99m MDP bone scanning procedure is a useful clinical method to evaluate growth conditions. 2. Satisfactory correlation was found between uptake ratios from Tc-99m MDP scanning and the roentgen stereophotogrammetric analysis.

ARTHROSCOPY OF THE SHOULDER JOINT

HELGE LILLEBY

Martina Hansens Hospital, Sandvika, Norway

Arthroscopy of the shoulder joint has been carried out in 30 patients with different shoulder diseases such as "cuff rupture", posttraumatic changes, "snapping shoulder", habitual luxation and postoperative conditions.

The examination has mostly been undertaken under anaesthesia followed by operative treatment permitting verification of the arthroscopic findings, but sometimes only in local anaesthesia. A 5 mm Storz arthroscope has been used through a posterior entry to the joint. Complications were not recorded.

Shoulder arthroscopy seems to be a safe and relatively simple examination which with some experience gives excellent information on intraarticular changes in several shoulder disorders. It is more exact than other conventional examination methods, and may be the only way to arrive at a diagnosis without arthrotomy.

SURGICAL APPROACH TO ORTHOPAEDIC ONCOLOGY

MARIO CAMPANACCI

Istituto Ortopedico Rizzoli, Bologna, Italy

Anatomo-clinical diagnosis of bone tumors has been growing rather complex. For instance, we recognize at least eight varieties of osteosarcoma, and six of chondrosarcoma, each of them bearing important practical consequences both in differential diagnosis and in treatment. Moreover, the correct diagnosis has to be completed by the staging of the tumor. The staging is based upon two figures: the histologic grading and the anatomic location-extension (intra- or extracompartmental). The staging usually requires supplementary tests (isotope scan, CAT scan, angiography, etc.) before the biopsy. The staging is essential in order to plan the surgical treatment. Surgical treatment is also conditioned by the combined radiation therapy and chemotherapy.

Surgical treatment is classified according to the surgical margins, as intralesional, marginal, wide and radical removal of the tumor. Such definitions again are based on the anatomic compartments and are independent of the preservation or ablation of the limb. In fact, you can have a marginal amputation but a radical resection preserving a functional limb. The choice of the surgical procedure is based on the stage of the tumor, on the experience of the surgeon and on the general social-psychological condition of the patient. It should be stressed, however, that the experience of the surgeon should cover hundreds of cases with long-term (at least 10 years) follow-up, which is only possible in rare circumstances.

The Rizzoli Institute, however, in the course of 70 years, has gathered some 3500 primary bone tumors, 1300 metastatic, and 900 pseudotumorous lesions, all treated in the Institute (plus a roughly comparable number of cases seen in consultation). An example of the principal techniques of en bloc resection and reconstruction employed by us in the different anatomic locations is given with demonstrative cases.

HORMONAL RESPONSIVENESS OF A HUMAN CHONDROSARCOMA

Effects of Insulin and Hydrocortisone on DNA and Proteoglycan Synthesis in Vitro

RONNY LORENTZON, SVEN-ERIK LARSSON & LENNART BOQVIST

Departments of Orthopaedic Surgery and Pathology, University of Umeå, S-901 87 Umeå, Sweden

There is now considerable evidence indicating that growth, differentiation and metabolism of cartilage are controlled by several hormones including insulin and adrenal corticosteroids. The hormonal requirements for growth and proteoglycan synthesis of human chondrosarcomas have hitherto not been defined. In this study, the effects of insulin and hydrocortisone on the synthesis of DNA and proteoglycan in monolayer cultures of chondrocytes derived from a human chondrosarcoma were investigated. Insulin stimulated (35S) sulfate incorporation and accumulation of uronic acid in a dose-dependent fashion and was effective at physiologic concentrations. Insulin also significantly stimulated DNA synthesis in a dose-dependent manner and this stimulatory effect was more pronounced than that on (35S) incorporation. The increased accumulation of proteoglycan was significantly correlated to increases in DNA synthesis indicating that cell multiplication was primarily stimulated by insulin and as a result of this more proteoglycan was produced. Hydrocortisone did not effect DNA synthesis but significantly stimulated proteoglycan synthesis. The stimulatory effect of cortisone on proteoglycan synthesis in the chondrosarcoma probably reflects a property of the transformed phenotype of cartilage.

FLOW DNA ANALYSIS OF PRIMARY BONE TUMOURS

ANDRIS KREICBERGS & BERNHARD TRIBUKAIT

Department of Orthopaedic Surgery, Karolinska Hospital, Department of Medical Radiobiology, Karolinska Institute, Stockholm, Sweden

The cellular DNA content of 15 benign and 34 malignant primary bone tumours was analyzed by means of flow cytophotometry.

All benign tumours except one of questionable histologic type exhibited a normal DNA content (diploid), whereas 23 out of 34 malignant tumours showed an abnormal DNA content (aneuploid). Closer analysis revealed that all supposedly highly malignant tumours, i.e. 16 osteosarcomas and one Ewing sarcoma, were aneuploid, while 8 out of 13 chondrosarcomas, 2 paraosteal osteosarcomas, and one out of two adamantinomas were diploid. Interestingly, these diploid malignant tumours represent tumour entities which are known to include variants of low grade malignancy.

The present study clearly shows that flow DNA cytophotometry can be applied to most primary bone tumours despite a substantial content of hard tissue. The results also indicate that DNA determinations as an adjunct to conventional histopathologic assessment may provide objective clinically relevant information with respect to the degree of malignancy. Thus, regardless of histogenetic origin it appears that benign bone tumours as well as malignant bone tumours of low grade malignancy in general are diploid whereas highly malignant bone tumours in general are aneuploid.

DIAGNOSES IN 477 PATIENTS REFERRED FOR SUSPECTED SKELETAL SARCOMA IN SOUTHERN SWEDEN 1973–1979

RONNY LÖVDAHL & BJÖRN M. PERSSON

Dept. of Orthopaedic Surgery, Lund University Hospital, S-221 85 Lund, Sweden

The total number of 477 skeletal tumors or tumorlike conditions referred to the orthopaedic oncology group at the University Hospital in Lund was studied. The group covers a population of 1.35 million in South Sweden.

Patients were referred either for diagnosis (397/477 = 83%), or for therapy (80/477 = 17%) with the diagnosis already known.

Biopsy was made in 369 cases as follows: fine needle (237), drillcylinder (14), incisional (69) or excisional (49). The rest were diagnosed on anamnestic, clinical and radiological grounds and observed more than 2 years. Pain was the major reason for consultation in 350 cases and in 230 it was considered severe. Trauma was recorded in 77 cases (16%) and in 134 a palpable tumor was found.

Final diagnoses	Primarily suspected sarcoma	Primarily known diagnosis	All patients referred
Sarcoma	48	6	54
Carcinoma	45	45	90
Myeloma	23	14	37
Giant cell tumor	11	3	14
Benign tumors	77	2	79
Cysts	56	2	58
Infections	42	1	43
Fractures	12	0	12
Other	83	7	90
Total	397	80	477

Thus, when a bone sarcoma is suspected on clinical and radiological grounds a metastasis or an osteomyelitis is at least as likely and a benign lesion about five times more likely. Location, age, size, etc., are analysed.

OSTEOBLASTIC OSTEOGENIC SARCOMA. AN ULTRASTRUCTURAL AND HISTOCHEMICAL STUDY

ANDRÉ STARK, TOMAS APARISI & JAN L. E. ERICSSON

Department of Orthopaedic Surgery, Karolinska Hospital, Stockholm and Central Laboratory of Clinical Pathology, University Hospital, Uppsala, Sweden

The ultrastructural appearance of the cells of 10 classical osteoblastic osteogenic sarcomas, malignancy grade 3–4, was analyzed and the fine structural localization of the non-specific alkaline phosphatase studied.

Four different cell types were almost always present, i.e. osteoblast-like, fibroblast-like, chondroblast-like, and multinucleated giant cells. The osteoblast-like cells varied greatly in appearance and four different subtypes could be easily identified. The nucleus/plasma ratio and the abundance of cytoplasmic organelles varied highly. In some of these cells the Golgi apparatus was very prominent, indicating a high secretory activity. Nuclear alterations like pseudo-inclusions and nuclear bodies were frequent. Nucleoli were prominent and often multiple. It is possible that the four different subtypes represent osteoblast-like cells of varying degrees of maturation and/or different stages of activity. Alkaline phosphatase was associated with the plasma membrane of the osteoblast-like, fibroblast-like, and multinucleated giant cells.

On the basis of the fine structural appearance and the activity of alkaline phosphatase the osteoblast-like cells appeared to be closely related. The multinucleated giant cells in the tumor did not seem to correspond to osteoclasts, but rather to represent true neoplastic cells.

OSTEOSARCOMA: A PROGNOSTIC EVALUATION

OTTO SNEPPEN & LONE HANSEN

Orthopaedic Hospital, Aarhus, Denmark

A material of 84 cases of osteosarcoma was investigated with regard to the prognosis. All of the cases were followed up for at least 2 years or until they died. All of the histological preparations were reviewed.

The mean delay from the first symptom to the admittance to the Tumour Center was 6 months. The treatment consisted of primary open biopsy followed by amputation through proximal healthy bone in a subsequent seance. Neither irradiation nor chemotherapy were employed in the primary treatment.

The corrected 10-year survival for ordinary osteosarcoma after radical operation (58 cases) was 38%. Statistically the result was the same for osteosarcoma patients admitted to the center in the beginning of the 1960's as for those admitted in the late 1970's.

Thus the result doesn't indicate any increased likelihood of survival for patients with osteosarcomas treated recently when compared with those treated more than a decade ago. The only factor of significant importance for the prognosis was histological type and localisation of the tumour.

DIAGNOSIS AND TREATMENT OF GIANT-CELL TUMOUR OF BONE

ROLF HAGEN

Martina Hansens Hospital, Sandvika, Norway

Twenty patients, 10 female and 10 male, with giant-cell tumour of bone were followed up for a mean period of 8 years. Three patients were nearly 15 years, 10 between 15 and 30, five between 30 and 50 and two between 50 and 65 years. Seven tumours were located in the proximal tibia and five in the distal femur, three in the distal tibia, one in the proximal and two in the distal radius, and one in the thumb and a lumbar spinal process, respectively.

The recurrence rate was 30 per cent, and a malignant course was found in 10 per cent. Patients under the age of 25 years rarely had recurrences. A high recurrence rate was recorded in the knee region and in tumours penetrating the cortex, regardless of tumour size and spontaneous fracture. Histopathological grading was of no prognostic value.

The amputation rate was 25 per cent. Primary en bloc resection combined with autologous bone transplantation and arthrodesis with internal or external fixation are recommended in patients over 25 years. Curettage and bone-grafting are only advocated in certain cases under the age of 25. Radiotherapy alone or combined with curettage is contraindicated in the treatment of osteoclastoma.

FUNCTIONAL RESULTS AFTER EXTENSIVE PROXIMAL HUMERUS REPLACEMENT

LARS-ÅKE BROSTRÖM, ULF NILSONNE, ELISABETH OLSSON & RICHARD WALLENSTEN

Department of Orthopaedic Surgery, Karolinska Hospital, Stockholm, Sweden

In seven patients (five chondrosarcomas, one chondroblastoma, one giant cell tumour) the proximal part of the humerus was resected and replaced with a custom-made isoelastic endoprosthesis. The mean age of the patients was 43 years. Four patients were female. All patients were right-handed and in four patients the operation was performed on the dominant side. The time of follow-up was at least 1 year. No signs of local recurrence were noted. All patients were examined 3, 6 and 12 months postoperatively. Passive range of motion and isometric strength of the shoulder were measured in an isokinetic dynamometer. Extension and rotation range of motion was normal, but flexion and abduction

were reduced to about 50 per cent as compared to the healthy side. Isometric strength of the shoulder was reduced to about one third, whereas hand strength was normal. Six patients were satisfied with the functional results of the operation and reported no or only slight pain at exercise, whereas one patient had more or less constant pain. Five patients returned to their previous occupation. One patient had to be retrained for lighter work and one was sicklisted. The overall result was better for patients operated on the non-dominant side. No major improvement of the functional results observed 6 months postoperatively was noted at subsequent examinations.

FUNCTION AFTER PELVIC TUMOR RESECTION INVOLVING THE ACETABULUM

ANDRÉ STARK, ULF NILSONNE, ANDRIS KREICBERGS & ELISABETH OLSSON

Department of Orthopaedic Surgery, Karolinska Hospital, Stockholm, Sweden

Since 1970 nine patients with primary malignant bone tumors of the pelvis have been treated at the Karolinska Hospital by limb-saving pelvic resection involving the acetabular ring. Seven cases were available for functional analysis. In addition to conventional clinical assessment gait was analyzed objectively by means of an electronic walkway and remaining hip muscle strength tested by means of a Cybex II dynamometer.

Six of the seven patients reported painless gait, but only one patient walked without any support. Maximum walking distance was in general satisfactory. All patients walked with a marked limp and exhibited a positive Trendelenburg sign. Leg length discrepancy was on the average 6 cm. Gait analysis showed reduced weightbearing time for the operated leg in all cases. Isometric muscle tests indicated that hip extension strength generally was less reduced than flexion and abduction. Comparison of weightbearing time and isometric muscle strength disclosed that patients with the best hip extension strength also had a less pronounced reduction of weightbearing time. Radiological examination showed that bony support for the proximal femur was of decisive importance for the functional result.

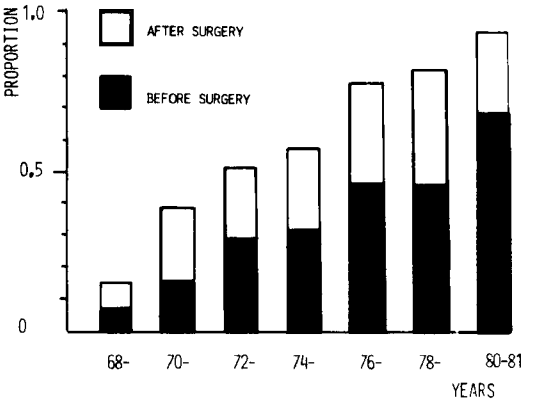
Conclusion: Pelvic resection involving the acetabular ring results in reduced but acceptable gait function. This surgical procedure should therefore be considered a preferable alternative to conventional hemipelvectomy from a functional point of view, provided radicality can be ensured.

PROPORTION OF PATIENTS WITH SARCOMA REFERRED BEFORE AND AFTER SURGERY TO THE ORTHOPAEDIC ONCOLOGY GROUP IN SOUTH SWEDEN 1968–1981

ANDERS RYDHOLM, NILS-OSKAR BERG, RONNY LÖVDAHL, BJÖRN M. PERSSON & MÅNS ÅKERMAN

Depts. of Orthopaedic Surgery, Cytodiagnostics and Pathology, Lund University Hospital, S-221 85 Lund, Sweden

From the Swedish Cancer Registry all cases of nonvisceral soft tissue sarcomas in South Sweden 1968–81 were collected and histopathologically reviewed. Similarly all cases dealt with by the regional orthopaedic oncology group in Lund were studied, the skeletal cases for 1973–79 and the soft tissue sarcomas for 1968–81. An analysis was made of 231 soft tissue sarcomas and 54 bone sarcomas to determine whether the patients had been referred before or after any surgical procedure. A total of 66/231 soft tissue sarcomas and 6/54 bone sarcomas came after surgery, in most cases consisting in marginal excisions or incisional biopsies.



Referral of soft tissue sarcomas.

The steep increase both in total number and in the proportion of untouched soft tissue sarcomas referred is illustrated. This can be attributed to information about treatment programs and to an increased use of fine needle aspiration biopsy in the region. The referral of patients before surgery will most likely increase the cure rate and decrease loss of function after radical surgery.

PREOPERATIVE RADIOTHERAPY OF SOFT TISSUE SARCOMAS. A PILOT STUDY

EVA MÅNSSON, TOMAS APARISI, ULRIK RINGBORG & JAN WILLEMS

Department of Orthopaedic Surgery, Radiumhemmet, and Department of Tumor Pathology, Karolinska Hospital, Stockholm, Sweden

During 1968–1977 27 patients with soft tissue sarcomas received preoperative irradiation followed by surgical treatment. The tumors were localized to the lower extremities in 18 cases, the upper extremities in 3 cases and the trunk in 6 cases. Twenty-one of the tumors measured more than 5 cm in diameter. Both cytological and histological diagnosis were obtained in most cases with fine needle aspiration and incisional biopsies. Malignancy grading according to a 3-grade scale showed Grade I–II in 6 cases and Grade III in 21 cases.

The patients received radiotherapy 200 rad/day with a total dose of 4000 rad. In 2 cases a higher dose was given in combination with cytostatic drugs. The surgical treatment was performed within 5 weeks after radiotherapy in all but 2 cases. In 19 cases a wide excision was performed, compartmental excision in 3 cases, disarticulation in 3 cases, and amputation in 2 cases. Macroscopic and microscopic radiation effects on the tumor were studied.

The follow-up time was 54–167 months. Three patients showed local recurrences. Two of the patients were reoperated on and are living free of disease 29 and 40 months after the reoperation. Nine patients have died from distant metastases. All recurrences appeared within 30 months after diagnosis. The 5-year survival rate was 67 per cent. Whether the low frequency of local recurrences may be attributed to the radiotherapy can not be determined from the present study, but may be worthwhile to evaluate in a controlled prospective study.

MASSIVE ALLOGENIC OR AUTOGENIC JOINT-METAPHYSEAL TRANSPLANTATION IN THE TREATMENT OF BONE MALIGNANCY

ALLAN AHO

Department of Surgery, University of Turku, Turku, Finland

In the treatment of malignant or semimalignant tumours four principal methods are available: reconstruction by autogenic or allogenic transplants or custom-made prostheses, arthrodesis, and ablative surgery (amputation).

In reconstructing diaphyseal or metaphyseal defects involving the joint after radical resection, autogenic transplants are suitable, e.g. in the radiocarpal antebrachial region. An autogenic fibular transplant can be used for reconstruction of the proximal humerus, but the weakness of the transplant is a limiting factor. For that reason, an allogenic massive proximal humerus graft with cartilage surface is a rival alternative. In the lower extremity the size of the defect requires an allogenic transplant or prosthesis.

All these alternatives have been used in our clinic in the treatment of (semi-) malignant bone tumours (giant cell tumour, chondrofibrosarcoma, aneurysmal bone cyst, osteosarcoma), but during the past few years the use of allogenic grafts has progressively increased. Human bank bone has been preserved according to the Russian (Imamaliev-Volkov) method at –70° to –30°C. AO-plates have been used for anchoring the transplant to the host bone. CT-scan is of great importance in establishing the cortical penetration of the tumour. The cell-mediated immune response to the allografts has been very slight. The results are good. The longest observation time for allografting is 9 years; one patient with a metal prosthesis is alive 12 years after resection of a chondrosarcoma in the femur.

CONGENITAL DISLOCATION OF THE HIP JOINT: FOLLOW-UP OF LATE-DIAGNOSIS CASES

KURT PALMÉN

Varberg, Sweden

The work on early diagnosis of CDH is based on the assumption that early treatment gives the best results. Earlier experiences have shown the very good results achieved when treating preluxation in newborns.

In order to study the results of treatment of late-diagnosis CDH, the 52 cases among children born in 1976 and treated at the Swedish orthopaedic departments have been followed up in 1981.

42 of these cases (76%) had been diagnosed between 1–6 months of age, 6 between 7–12 months and only 4 after 1 year of age.

Only 21% had had dislocation, the rest subluxation or dysplasia.

At the follow-up 69% had completely normal hip joints and another 8% showed slight dysplasia changes. In 2 cases pelvic osteotomy had been made. 10 cases had avascular necrosis of the femoral head and neck.

The study showed the importance of early treatment and of traction treatment and tenotomy before reduction. No case thus treated before the age of 6 months displayed avascular necrosis.

CONGENITAL DISLOCATION OF THE HIP IN SOUTHEAST NORWAY, LATE DIAGNOSIS

INGJALD BJERKREIM & JETTE JOHANSEN

Sophies Minde Orthopaedic Hospital, University of Oslo, Oslo, Norway

A survey of 363 late detected cases of congenital dislocation of the hip born in the years 1975–79 is presented. The incidence of late cases in southeast Norway was calculated at 4.4 per 1000 live births. All cases had been examined at birth without discovering any hip affections. Later on the welfare clinics or the relatives became aware of the hip situation. Children with anomalies, children who were delivered by Caesarean section and children who were born in abnormal position (breech, foot or face) had a routine CDH-screening by an orthopaedic specialist at 4 or 5 months of age.

In the survey 78% were females. 5.2% were delivered in breech position and 5.2% by Caesarean section. 9.9% had bilateral affection. 8.8% of the total number had luxation and 11.5% had subluxation. Compared to this the number of dysplasias without dislocation was alarmingly high. Without this last group the rate of late diagnosis of CDH would be more equal to the rate in other countries.

HABITUAL DISLOCATION OF THE HIP IN CHILDREN

Åke Hjelmstedt & Bo Sahlstedt

Departments of Orthopaedic Surgery and Diagnostic Radiology, University Hospital, Uppsala, Sweden

Habitual dislocation in children is an uncommon condition. The diagnosis is sometimes difficult to establish in an early state. It is, however, the decision about the right treatment that causes the orthopaedic surgeons concern as there are rather few reports in the literature to guide the doctor. Hip joint laxity in connection with Ehlers-Danlos syndrome, morbus Down or general joint laxity is a contributing factor in many cases. In some cases there are no signs of laxity in any other joint than the affected hip.

Four cases of habitual dislocation have been followed clinically and radiologically up to 11–15 years of age. One case was examined by EMG and by cineradiography when voluntarily provoking dislocation of the right hip. To the experience of these cases are added the reports of 18 cases from the literature.

From this study it is obvious that habitual dislocation in connection with Ehlers-Danlos syndrome should be regarded as a special entity with a very early onset and pronounced resistance to therapy.

The clinical and radiological course seems on the other hand to be about the same for habitual dislocation in cases of morbus Down, of general laxity of other origin and in cases without general joint laxity.

Often the habitual dislocation will cease spontaneously in the course of time. Conservative treatment with immobilization in plaster or with braces or splints is of no avail.

The patients should be followed clinically. Operative treatment is indicated if a) the dislocations become a real problem for the patient, b) the radiograms show an increasing acetabular dysplasia and c) the dislocations have not ceased at the age of 11–12 years.

The pathology of these hips will be described as well as the operative procedures based on this knowledge.

SHELF OPERATION IN THE TREATMENT OF DYSPLASIA OF THE HIP WITH SPECIAL REFERENCE TO THE AGE GROUP ABOVE 40 YEARS

Per Siewers & Bernhard Paus

Martina Hansens Hospital, Sandvika, Norway

Fifty-seven hips were operated 3–30 years earlier. At the time of operation 14 were more than 40 years old, 43 less.

At follow-up 9 of the first group were completely satisfied, against 23 of the second. The observation time was equal in the two groups with a mean of 12 years. More than half of all patients with more than 10 years observation time were symptomfree.

Duration of symptoms before operation, subluxation or dysplasia of the hip, and length of observation time seemed of little if any importance to the patients' evaluation of the present situation.

In 29 hips the shelf was placed on a level with the acetabular rim; in 18 cases the patients were completely satisfied. Of 28 hips with the shelf a little higher, 14 patients were satisfied.

Fifty-one hips had no roentgenological signs of osteoarthritis at the time of operation. Of 26 with the shelf on a level with the acetabular rim 21 still had no signs at follow-up, against 17 of 25 where the shelf was placed higher.

The number of hips is not large but seems to indicate that shelf operation can be recommended also in patients more than 40 years old. The shelf gives somewhat better results if placed on a level with the acetabular rim than if placed higher.

LATE CONGENITAL DISLOCATION OF THE HIP – REDUCTION AND TREATMENT BY ABDUCTION SPLINT

Olof Ahlgren & Sven Friberg

Department of Orthopaedic Surgery, University of Umeå, Umeå, Sweden

Twelve children with late unilateral unreducible dislocations of the hip were diagnosed during the years 1977–81. After diagnosis the children were placed in splints holding the hip joints in flexion and abduction (frog position). The hip joints were not fixed in forced abduction, but left so that the child had freedom to move the joint when kicking. The children were then seen with 1-week intervals. The dislocated hips all showed a successive increase in abduction in the flexed

position. The splints were accordingly tightened into increased abduction. Thus all hips were reduced after 2–4 weeks of treatment.

After reduction the hip joints were continuously treated in the frog position until the radiographic examination showed a normalization of the acetabular dysplasia. A normalization of the acetabular angle was achieved in all children treated.

GROWTH PATTERN AFTER ANKLE FRACTURES IN CHILDREN

JOHAN KÄRRHOLM, LARS INGVAR HANSSON & GÖRAN SELVIK

Dept. of Orthopaedic Surgery, University Hospital, Lund, Sweden

In a prospective study of ankle fractures in children the posttraumatic growth pattern was registered with roentgen stereophotogrammetric technique. Fifty-three fractures were classified anatomically according to Salter-Harris and traumatologically according to Gerner-Schmidt.

Information about the growth could be obtained within 3 months after fracture and the growth pattern was found stationary within 6–8 months.

The posttraumatic growth pattern could be separated into five types: symmetrical growth, initial growth stimulation of varying length, initial and temporary growth retardation, initial and progressive growth retardation, and initial and permanent growth arrest.

Growth arrest and progressive growth retardation was found after Salter-Harris type III–IV as well as after type I–II injuries. The traumatological classification improved the possibilities to predict the prognosis of ankle fractures but factors such as age at injury, displacement, and treatment were also of prognostic importance.

MICROVASCULAR SURGERY IN ORTHOPAEDICS: CLINICAL EXAMPLES

SIMO VILKKI

Department of Hand Surgery, The Orthopaedic Hospital of the Invalid Foundation, Helsinki, Finland

Free composed tissue transfer with microvascular anastomoses gives additional possibilities in the treatment of many orthopaedic problems.

The skin coverage of fractured bones may sometimes need radical repair before fracture healing is possible. The treatment of an open joint is a challenge which cannot be solved properly without microvascular tissue transfer in some special situations. Chronic osteomyelitis with poorly healing skin or ulcers is often an important indication for microsurgical reconstruction. The vascularised bone transfer has shown superiority in the treatment of bone defects and difficult pseudarthroses.

In hand surgery toe to hand transfer has made it possible to reconstruct the thumb or some fingers after amputation injury if primary replantation surgery is not possible.

Experiences gained in the reconstructive cases are presented.

THE MICROSURGICAL REPAIR OF N. ISCHIADICUS

SIMO VILKKI

Department of Hand Surgery, The Orthopaedic Hospital of the Invalid Foundation, Helsinki, Finland

The lesions of N. ischiadicus are due to a direct trauma or an injury associated with fractures or a luxation in the femur. Sometimes a tumor of neurogenic origin is seen in this major nerve of the lower extremity.

In traumatic cases a suspicion or established clinical diagnosis of the ischiadic nerve injury should be followed by primary exploration and nerve repair to achieve best results.

However, this important nerve can be reconstructed in delayed cases by microsurgical methods using Millesi-type free nerve grafting with satisfactory results in sensory and motor recovery.

A material of 10 cases is presented.

AMPUTATION INJURY: REPLANTATION OR PRIMARY AMPUTATION – COMPARISON OF THE RESULTS

SIMO VILKKI & HARRY GÖRANSSON

Department of Hand Surgery, The Orthopaedic Hospital of the Invalid Foundation, Helsinki, Finland

Two patient groups with amputation injuries in the upper extremity were treated differently, although all patients could have been suitable candidates for replantation surgery according to the severity of the injury.

A comparison of the groups was made analyzing the influence of the treatment on the length of hospitalization and need for secondary treatment. Also the working capability, remaining symptoms and overall satisfaction of the patients were studied in both groups.

According to the study, the results are better in the replantation group compared to the patients treated with conventional primary amputation.

INCREASED INCIDENCE OF AMPUTATIONS AND THE FACTORS AGE, DIABETES AND SMOKING

EINAR LIEDBERG & BJÖRN M. PERSSON

Department of Orthopaedic Surgery, Lund University Hospital, Lund, Sweden

The number of amputations in Malmöhus county with just over 500 000 inhabitants had increased from 14 to 161 per year during the years 1910–79. This increase could not be explained only by the rising number of elderly. Compared to the age related incidence the number of amputations had increased 4 times. Age, diabetes mellitus and sex distribution of ischemic amputees was studied and compared to other, mainly Scandinavian, reports during the last 30 years. The proportion of diabetic amputees and of males (0.54) seemed unchanged, but the proportion of amputees at least 80 years old had increased from about 0.19 to 0.38.

A prospective analysis was therefore made to assess the influence of diabetes and smoking habits. 176 lower limb amputees in Lund 1979–81 were examined and classified as non-smokers, ex-smokers, light smokers and heavy smokers. These figures were compared to corresponding figures among age-correlated controls and to a group of hip fracture patients. The material was split into men and women and into non-diabetics and diabetics. Smokers had a much lower mean age at amputation. Out of 176 amputees only 15 were neither diabetics, smokers nor 80 years or more. The population study proves a correlation between smoking and amputation for ischemia.

PROXIMAL AMPUTATION OF THE UPPER LIMB

S. BLÅDER, B. GUNTERBERG & G. MARKHEDE

Department of Orthopaedic Surgery II, Sahlgren's Hospital, Gothenburg, Sweden

During a 10-year period 38 patients underwent a proximal amputation of the upper limb in the Department of Orthopaedic Surgery II, Sahlgren Hospital, Gothenburg. Thirty-five patients were amputated because of a tumor. In 27 patients a forequarter amputation was made, in two a humeroscapular disarticulation, and in nine an amputation through the humerus. The observed 5-year survival was 23 per cent in the patients with a malignant tumor.

Seventeen living patients were questioned concerning prosthetic use and social and psychologic factors. Only three patients used a functional (mechanical) prosthesis and only five used a cosmetic prosthesis. The other nine patients rejected the use of a prosthesis. Half of the patients had the same occupation postoperatively as preoperatively. Activities of daily living did not constitute any major problem. One of four housewives needed daily help. One patient seemed to have suffered obvious psychologic damage.

MEASUREMENT OF MAXIMUM END WEIGHT-BEARING AND A CLINICAL CLASSIFICATION OF LOWER LIMB AMPUTATION STUMPS

BJÖRN M. PERSSON & EINAR LIEDBERG

Dept. of Orthopaedic Surgery, Lund University Hospital, Lund, Sweden

Total contact sockets distribute more or less weight on the stump end. Its tolerance to bear weight on the naked end was measured with a scale and the values were correlated to body-weight, sex, indication, level, shape, stump pain, phantom pain, etc. One hundred and thirty-five stumps were classified utilizing the ISPO form and 102 were measured in 69 individuals. Men had a mean tolerance above 15 kg but women less than 10. Joint disarticulation stumps had several times higher tolerance than transmedullar amputations. Diabetics tolerated more than nondiabetics and patients with phantom pain more than patients with stump pain. There was a positive correlation to body-weight and within each category of stumps a wide range of end weight-bearing tolerance. Among all below knee amputees the maximum end weight-bearing was between 3 and 79 per cent of body-weight. It is suggested that end weight-bearing measurements should be used to analyse pain and to make the total contact sockets individually so that this tolerance is taken into account. The patient should be able to bear his full weight with the prosthesis on and the end weight-bearing should be utilized carefully. Skin damage should be classified according to its causes and corrections based on systematic examination of the involved factors.

THROUGH-KNEE AND SYME'S TWO-STAGE AMPUTATIONS GIVE A NEW PROFILE

ACKE JERNBERGER & DAGNY TRYGGÖ

Department of Orthopaedic Surgery, Centrallasarettet, Norrköping, Sweden

In 1977 through-knee (TK) and Syme's two-stage amputation were introduced as an alternative procedure to above-knee (AK) and below-knee (BK) amputations respectively to give a better walking capacity to some patients, where healing could be expected on a lower level. On the other hand it was important to ensure that TK and Syme's amputation were not chosen at the expense of BK or transmetatarsal amputation respectively.

At the department of orthopaedic surgery of Norrköping all amputations from a district of 140 000 inhabitants are performed. During the years 1971–81, a total of 639 amputations, including all levels from

transmetatarsal to AK, was carried out on patients for vascular disease. In 1971–76, 271 amputations were divided into 26 (9%) transmetatarsal amputations, 159 (59%) BK and 86 (32%) AK, while in 1977–81, 368 amputations were divided into 32 (9%) transmetatarsal, 28 (8%) Syme's amputations, 154 (42%) BK, 82 (22%) TK and 72 (19%) AK amputations.

The results of the first 30 TK and 25 Syme's amputations have been followed up for 1.5–3.5 years and 1–5 years respectively and have been examined for instance with regard to survival, frequency of reamputation, prosthetic limb fitting and walking capacity.

With an amputation frequency of 52 patients/100 000 inhabitants AK amputations have been reduced from 32% to 19%, and in 8% Syme's amputation has been performed instead of BK while the frequency of the transmetatarsal amputations has been constant.

In this way a reasonable number of patients has got the benefit of an endbearing stump after TK or Syme's amputation which among other advantages means that they can crawl or walk some steps without prosthesis.

HEALING IN BELOW-KNEE AND ABOVE-KNEE AMPUTATIONS DETERMINED BY SKIN PERFUSION PRESSURE MEASURED BY PHOTOELECTRIC TECHNIQUE

JØRGEN OVESEN & MIKAEL STØCKEL

Department of Orthopedic Surgery and Clinical Physiologic Department, Aalborg Sygehus, Aalborg, Denmark

During a period of 14 months 57 amputations of the lower extremity, 40 below-knee and 17 above-knee were performed. A newly introduced standardized photoelectric technique for measurement of the local skin perfusion pressure (SPP) was used preoperatively and the result served as a guidance in the selection of proper amputation level. An overall healing rate of 89 per cent was found with 70 per cent of the amputations being below-knee. The healing rates for individual SPP-levels were identical to those obtained with the cumbersome isotope washout technique. The standardized photoelectric technique is simple and rapid and gives only negligible discomfort to the patient allowing repeated measurements on different levels of the leg.

BLOOD SUPPLY MEASUREMENT BY LASER DOPPLER TECHNIQUE IN SEVERE ARTERIAL INSUFFICIENCY

ACKE JERNBERGER, DAGNY TRYGGÖ & TORSTEN TENLAND

Department of Orthopaedic Surgery, Norrköping, Department of Medical Engineering, University of Linköping, Sweden

As the laser Doppler flowmeter technique became a non-invasive method to evaluate the cutaneous blood flow, we adapted it for simultaneous measurement of the peripheral blood pressure to be able to calculate the ischemic index in dysvascular patients and to predict healing of ulcers or surgical procedures.

The light changes its frequency when reflected in moving red cells in the superficial layer of the skin. Red light from a 2 mW He-Ne-laser is via an optical fiber brought to illuminate the skin. A portion of the backscattered light is via optical fibers led to two photodetectors. The electrical signals from the photodetectors contain information about the blood flow.

The flowmeter is used to determine the flow characteristics before, during and after occlusion of the arteries by a blood pressure cuff on a desired level of the extremity. The flow values are recorded and the curve shows pulse related variations superimposed on a slower curve with about 5 periods/min caused by the regulation of the cutaneous blood flow. Other characteristics are initial or delayed drop of the flow value to zero on occlusion of the arteries, incomplete occlusion caused by too rigid arteries, initial or delayed start of the blood flow when the cuff pressure is decreased and following hyperemic reaction. The pressure at which the blood flow starts after occlusion of the arteries has been accepted as the peripheral blood pressure at the level of the cuff.

The method has been used for a year with reliable results and its high sensitivity for low flow values is demonstrated by the clinical course and the curves taken from two cases where ultrasound could not register any circulation and arteriography showed no functioning main artery in the lower extremities.

Lots of factors influence the blood flow and much work is to be done to correlate the flowmeter curves to physiological and pathological conditions of the skin. The flow values differ much from one skin region to another mainly because of the great difference in vascular bed geometry, and a large number of factors can influence the skin blood flow. However, besides an easily handled method to measure the peripheral blood pressure the flowmeter curves can give other valuable information.

FACTORS INFLUENCING OUT-PATIENT ATTENDANCE IN ORTHOPAEDIC SURGERY

LARS INGVAR HANSSON

Department of Orthopaedic Surgery, University of Lund, S-221 85 Lund, Sweden

Diagnostic data about in-patient visits in orthopaedic surgery has since many years been documented and analysed in contrast to diagnostic data about out-patient attendance.

In 1971 the registration of diagnostic data about out-patient attendance at the orthopaedic department in Lund started. In 1976 the registration was completed

with corresponding data from the orthopaedic units of the local hospitals in Landskrona, Trelleborg and Ystad.

The following data is registered at every visit and analysed by computor: identification of patient, residency, type of visit (acute/non-acute), date of visit, physician, referral, first or repeated visit, diagnosis code according to a revised and completed edition (WHO).

The number of visits per year has been about 15 000 of acute type and 25 000 of non-acute at the department of orthopaedic surgery in Lund.

The diagnostic data has been used to analyse the pattern of visits of orthopaedic patients in relation to diagnosis and residency, effect of changes in orthopaedic service (often changes based on findings from this investigation), collection of material for production control and for research.

Factors affecting the out-patient attendance have been analysed. The most significant factor is diagnosis. The distance to the orthopaedic clinic is important as well as the efficiency of the medical service of the districts and of the general practitioners. Orthopaedic surgeons working in the medical service of the districts and in the local hospitals result in marked reduction of the number of visits to the central hospital and most probably in a better medical service to the orthopaedic patients.

DEMAND FOR SURGERY IN FEMORO-TIBIAL ARTHROSIS IN THE 1980'S

BJÖRN TJÖRNSTRAND, LEIF RYD & GÖRAN BAUER

Dept. of Orthopaedic Surgery, Lund University Hospital, S-221 85 Lund, Sweden

Introduction. The course of untreated femoro-tibial arthrosis (gonarthrosis) is usually progressive, and many patients are forced into social isolation by increasingly unstable, painful knees. Over the last 15 years first osteotomy and then endoprosthetic arthroplasty have proven increasingly reliable by stopping the natural course of the disease and providing stable, painless knees. As both methods have now passed the experimental stage we have attempted to calculate what resources surgery for gonarthrosis will require in the future.

Material and methods. During 1970–80 721 operations for gonarthrosis were performed in our department which serves a population of 196 000. During the early years only tibial osteotomies were performed but arthroplasties have increased to 2/3 of all operations, equally divided between uni- and multicompartment devices. On the basis of previously known and new data on the incidence and prevalence of symptomatic gonarthrosis, the pool of cases needing surgery during the period 1980–90 was calculated.

Results. In 1970 the pool contained 520 knees. If none of these knees had been operated upon the pool would contain 570 knees in 1980 and 600 knees in 1990. However, our surgical activity has decreased the pool to 120 knees 1981, and it would be empty by 1984 if we could continue at the same activity level utilizing annually 1000 hospital days or 3.5% of our total resources. From then on the annual recruitment to the pool plus an estimated 15% need for reoperations would require only 2% of our resources. In a balanced system of this nature the majority of the operations would be osteotomy for early stages of medial type arthrosis with unicompartment arthroplasties reserved for lateral type or more advanced stages of the condition, and multicompartment arthroplasties predominantly in salvage situations.

Conclusion. A conscious effort to develop methods for diagnosis and therapy for gonarthrosis has resulted in near balance of demand and supply. The waiting list will soon be eliminated, and the majority of cases will have an early stage of the condition, suitable for osteotomy whereas, in the past, the cases were referred so late that arthroplasty was usually the method of choice. The experience gained here can easily be translated to other populations and emphasize the importance of close collaboration between primary care and orthopaedic units.

LOW BACK PAIN IN 40–47-YEAR-OLD MEN: A RETROSPECTIVE CROSS-SECTIONAL STUDY

HANS-OLOF SVENSSON & GUNNAR B. J. ANDERSSON

Department of Orthopaedic Surgery I, Sahlgren Hospital, Gothenburg, Sweden

The frequency of LBP was studied in a random sample of 940, 40–47-year-old, men. In addition the need for medical services because of LBP, and the relationship of LBP to some socio-economic factors, work history, working conditions, other diseases than LBP and to cardio-vascular risk factors were also investigated.

The life-time incidence of LBP was 61%, the prevalence 31%. 60% had LBP only, 40% had sciatica. The disability prevented work in 3.6% of the participants and 4% had been sicklisted more than 3 months because of LBP in 1975–77. 40% had consulted a physician, 3.5% had been hospitalized, and 0.8% had been operated on because of their LBP. Men with LBP had significant functional impairment.

The LBP-men had an increased previous sickness absence, a lower sickness benefit, and were more often blue collar workers. A covariance analysis showed that two of the socio-economic variables had a direct association with LBP viz. foreign citizenship and an increased number of sickness absence days.

Ten variables related to work history and working conditions were found to be correlated to LBP; less overtime work, diminished work satisfaction, decreased potential to influence the work situation, lesser demand on concentration, monotonous work, physically heavy work, a high degree of lifting, a lesser degree of sitting, and a greater degree of standing and walking at work.

Three variables were directly associated with LBP viz. less overtime work, monotonous work and a high degree of lifting.

In the study of other diseases and cardio-vascular risk-factors nine variables were correlated to LBP; chest pain, calf pain and breathlessness on exertion, smoking, physical activity at work and during leisure time, worry and tension, fatigue at the end of the work day and perception of stress. In the covariance analysis four variables maintained a direct association with LBP, viz. calf pain on exertion, smoking, a high physical activity at work and a frequent feeling of worry and tension.

AN EPIDEMIOLOGICAL STUDY ON PATIENTS WITH LOW-BACK PAIN AND SCIATICA

JARL-ERIK MICHELSSON

Division of Orthopaedic Surgery and Traumatology, Helsinki University Central Hospital, Finland

The aim of this study was to investigate the symptoms and signs of out-patients with low back pain and sciatica, and to correlate them with, e.g. age, sex, weight, occupational factors, sports activities, and radiological changes of the spine.

The 1463 patients were investigated in various parts of Finland by 80 physicians.

The main symptomatic diagnoses and their frequencies were Lumbago acuta 49%, Syndroma ischiadicum 23%, Lumbosacralgia chronica 20%, Insufficientia ileosacralis 3%, and Stenosis canalis spinalis 1%.

The pain began in most of the patients gradually, in 16% on lifting, in 3 % on falling and in 68% without any apparent abnormal spinal loading. Most of the patients had suffered from back pain previously, and the first attack occurred on the average at 31 years of age. In 56% the back pain lasted for 2 weeks or less and only in 4% longer than 12 weeks. The patient's weight was not related to the symptoms.

ULTRASOUND IN SCIATICA

LILLEMOR FORSBERG & ANDERS WALLÖE

Departments of Radiology and Orthopaedic Surgery, Lund University Hospital, Lund, Sweden

Investigation of the sagittal diameter of the spinal canal by ultrasound has shown a relative stenosis in patients with sciatica. This relative stenosis could be expected to influence the results after disc operations.

In a four-year period 158 patients were operated on for herniated lumbar discs in our department. Out of these 115 had both positive myelogram and positive findings at operation. At a follow-up 2–6 years later 20 patients still had pain. Ten of these and a comparable group of 12 patients who had recovered uneventfully were selected for an ultrasound investigation. The spinal canal was examined using "B-scan" ultrasound apparatus.

The 12 patients who had recovered well after the operation were easy to examine and had a broader spinal diameter than the 10 patients who still suffered from pain. In the first group only 5 out of 120 possible sites could not be visualized as compared to 34 out of 100 possible sites in the latter group (12 patients examined from left and right side at five levels, respectively 10 patients). The non-visualized levels in the latter group showed skeletal changes in plain film examinations such as arthrosis of the intervertebral joints or marked reduction of the disc space. In this small material it was found that patients getting well after disc operations had a broader spinal diameter than those still suffering from pain. It is hoped that a preoperative ultrasound investigation could guide the surgeon when and how to perform spinal surgery in the future.

HIP DISORDERS WITH SYMPTOMS IN THE KNEE AND LOW-BACK PAIN

HOLGER GLASTRUP

Amtssygehuset, Stege, Denmark

Dysplasia in the hip-joint with a flat acetabulum, edged caput and deficient articulation between caput and acetabulum is common among white people contrary to other races as demonstrated by A. P. Skirving (1).

Misinterpreted cases with such dysplasia are presented. Apart from anamnestic, objective and radiological findings in dysplasia coxae, alleged pains in the back and knees, which do not give objective and radiological clues, must be examined for hip disorders.

Unsuccessful treatment of back and knee symptoms should also give rise to a suspicion of hip disorders.

If possible, surgical treatment should be adopted as the only causal treatment. However, far from all hip-joint dysplasias can be treated surgically with our present technique and knowledge.

Reference:
Skirving, A. P. (1981) The centre-edge angle of Wiberg in adult Africans and Caucasians. *J. Bone Joint Surg.* **63**, 567–568.

SEMI-RIGID FIXATION IN THE TREATMENT OF FRACTURES

B. MC KIBBIN

The Welsh National School of Medicine, Department of Traumatic and Orthopaedic Surgery, Cardiff, Great Britain

Fractures healing in the natural state do so through the medium of external bridging callus. This callus forms quickly and often provides sufficient stability for the limb for it to be used for normal purposes long before

final remodelling and disappearance of the fracture line have taken place. Rigid external fixation on the other hand leads to suppression of external callus and healing must await the rather prolonged remodelling process occurring directly between the fracture ends. This leads to prolonged dependency of the patient on his implant, presents difficulties in timing the removal of the plate and if there is undue delay may lead to subsequent pathological fractures due to stress protection osteopenia.

In this paper it will be suggested that secure internal fixation is not necessarily synonymous with rigid fixation and that an ideal implant is one which will permit unrestricted use of the limb without inhibiting the formation of external callus. The results are described using a semi-rigid plate of carbon reinforced epoxy resin for treatment of fractures of the tibia, femur and forearm following preliminary animal studies.

The results suggest that rapid healing by external callus is possible with this method leading to restoration of normal function earlier than with rigid metal plates. Additional benefits include the avoidance of stress protection and easier salvage in the case of deep infection. There are also advantages when used in connection with osteo porotic bone and in dealing with certain types of non-union.

THE BONE-NAILING SURGEON G.B.G. KÜNTSCHER AND THE FINNS: A HISTORICAL REVIEW OF THE WARTIME COLLABORATION AND THE CONSEQUENCES 1942–1981

RALF V. LINDHOLM

Department of Surgery, University of Oulu, Finland

The Medical Services of the German and Finnish armies established combined military hospitals in Kemi in 1941–44. In 1943–44 the German Hospital was headed by Gerhard Küntscher, later regarded as "a giant of surgery" and the most famous Kieler bone surgeon of recent times. Co-operation between Küntscher and leading Finnish surgeons spread knowledge of marrow nailing and instituted their application in Finland before the end of World War II. Continued collaboration in the post-war period gave rise to a further activation of clinical practice and research. The main purpose of this work has been to provide osteosynthesis people and historians with a basic outline of a rare episode in the continuous approach towards the solid fusion of broken bones.

The descriptive documentation of the items related to the medical, occupational and social occurrences is based on valid sources. The clinical implications are mainly based upon the author's monograph "Küntscher bone nailing in Finland. A review of reports from the period 1943–1976" (Acta Univ. Oulu. Ser. D Med. No. 42 Chirurgica no. 7 Oulu 1979).

The greatest reciprocity between Küntscher and the Finns can doubtless be recognized at the level of everyday collaboration and the practice of surgery and in humanitarian and social compatibility. The heads of the middle-rank and minor surgical hospitals, obviously more familiar with the everyday requirements of accident surgery, acted with more confidence than the highhanded, academic surgeons, who reacted with reluctance. Provincial surgeons took the lead in clinical practice and research both with the early V-profile nail and with the later clover-leaf-sectioned nail plus the reaming procedure. Anyhow, Finnish medical societies contributed to the spreading of information on marrow nailing among the English speaking world.

OPERATIVE TREATMENT OF PROXIMAL HUMERAL FRACTURES

JAN-MAGNUS BJÖRKENHEIM, PEKKA PAAVOLAINEN & PÄR SLÄTIS

Division of Orthopedic Surgery and Traumatology, Surgical Hospital, Helsinki University Central Hospital, Helsinki 13, Finland

The results after operative treatment of 41 severe proximal fractures of the humerus were analyzed. The fractures were grouped according to the Neer classification. The aim of treatment was accurate reduction and stable fracture fixation with screws or screws and a plate.

In 31 patients re-examined more than 1 year postoperatively, the over-all results were excellent or satisfactory in 74.2 per cent of the cases, according to the Neer functional score. In type III fractures 93.3 per cent of the patients had an excellent or satisfactory result, in type IV fractures 63.3 per cent, and in type VI 50.0 per cent respectively. The only patient with type V fracture had an unsatisfactory result.

The most common technical error was too high positioning of the AO plate and unreduced varus deformity of the head of the humerus. High position of the AO plate also caused postoperative restriction in the movements of the glenohumeral joint because of impingement under the acromion during abduction. Aseptic necrosis of the humeral head was not observed.

Of the patients of working age all but one returned to their postoperative occupation within an average time of 3.5 months.

FRACTURES OF THE SHAFT OF THE TIBIA TREATED CONSERVATIVELY WITH FUNCTIONAL BRACING

A. PAUS, E. GJENGEDAL & L. ROLFSEN

Department of Orthopaedic Surgery, Åker Hospital, Oslo, Norway

Functional bracing has been the main treatment for tibial fractures in our Department since June 1979.

Sixty-four patients have completed their treatment, and the results are satisfactory.

A period of 33 days was the average time for the primary treatment of the fracture. When soft tissues allowed, a fracture brace was produced and treatment with functional bracing started. Generally we use Orthoplast in a tight below-the-knee brace, with straps to open and a plastic heel cap. The brace allows mobility of both ankle and knee joints. Full weight bearing was encouraged within 3–4 weeks after treatment with the fracture brace was started.

There were 23 females and 41 males with a mean age of 46.5 years. One patient developed a redislocation after removing his fracture brace before his treatment was completed. A second patient had an injury 2 months after completed treatment and got a refracture of the tibia. She was successfully treated with conservative functional bracing the second time as well.

All fractures healed, some with delayed union, average time of healing 135 days. After completed treatment, joint and muscle function were good, and subsequent physiotherapy was only required in a few cases.

FRACTURES OF THE SHAFT OF THE HUMERUS TREATED CONSERVATIVELY WITH FUNCTIONAL BRACING

E. Gjengedal, A. Paus & L. Rolfsen

Department of Orthopaedic Surgery, Åker Hospital, Oslo, Norway

Functional bracing as treatment for fractures of the humerus was started in June 1979. The results are satisfactory, and functional bracing is our choice of treatment for these fractures. Twenty-five patients have completed their treatment. Primary treatment with plaster of Paris, traction or other immobilisation was routinely used. Twenty-five days was the average time before a fracture brace was produced. Generally we use Orthoplast as a tight brace on the upper arm, with straps to open. For distal fractures we use a brace with elbow joint and brace on the forearm as well. The fracture brace allows mobility of both shoulder and elbow joints. Joint exercises are encouraged as soon as pain allows.

The fractures healed in 10 weeks on the average. After treatment, muscle and joint function was good in the majority of patients. One patient refused primary surgery for a dislocated, angulated supracondylar fracture, and treatment with a below-the-elbow fracture brace was started. She developed pseudarthrosis and accepted surgical treatment at a later stage.

HOFFMANN'S EXTERNAL FIXATION FOR UNSTABLE COLLES' FRACTURES

Ulf Jonsson & Göran Olbe

Department of Orthopaedic Surgery, Danderyd Hospital, Stockholm, Sweden

Since 3 years we have routinely used Hoffmann's external fixation when Colles' fracture redislocates to such an extent that rereduction is indicated. This occurred in about 5 per cent of all treated fractures.

Two self-drilling Ø 3 mm half-pins were placed through the base of the second metacarpal and two pins in the radius a few cm proximal to the fracture site. The four pins were connected with one bar and the fixation was kept for 6 weeks.

42 patients (mean age 58 years) with a follow-up of at least 1 year have been reexamined. All fractures healed in 6 weeks. In five early cases there was pin loosening but without any signs of infection. Concerning the functional end results the patients were divided into four groups. According to Frykman's classification about 75 per cent of the patients were judged as "excellent" or "good". This means that the final functional results of our most unstable fractures are almost as good as the results in large studies of unselected Colles' fracture. The anatomical end results were judged from X-rays and compared with the mean of uninjured wrists. The results in the present study are compared with those in an earlier one, where transfixation with plaster over Kirschner wires was carried out.

According to our opinion the results are good enough to justify Hoffmann's external fixation as a routine when a redislocated Colles' fracture needs reduction.

COLLES FRACTURE: FUNCTIONAL BRACING IN SUPINATION VERSUS LOW DORSAL CAST

Cody Bünger, Kjell Sölund & Peter Rasmussen

Dept. of Orthop. Surg. Sönderborg, Denmark

A PVC/Hexcelite® brace for reuse was developed by the authors. In a randomized clinical trial functional bracing in supination was compared to conventional treatment with dorsal casting and a postreduction Cotton-Loder position of the hand. 150 patients were included in the study.

The anatomical result was assessed by radiographs of both wrists. The degree of shortening, dorsal angulation, radial angulation as well as the dorsal and radial shifts were evaluated on postreduction radiographs and after fracture healing.

The functional result was based on an evaluation of residual deformity, joint motion, grip strength, complications and subjective evaluation after 7 weeks, 3 months and 6 months.

The final anatomical result was significantly better in functional bracing. However, the overall functional result was only slightly better after functional bracing. In

both groups of patients the range of movements and the grip strength improved significantly from the 7th week to the 3rd month and from the 3rd month to the 6th month.

Functional bracing in supination may represent an improvement in the treatment of unstable Colles' fractures in patients who are able to utilize the mobility of the brace during the early stages of treatment.

INTRAMUSCULAR TISSUE PRESSURE IN PATIENTS WITH FUNCTIONAL FRACTURE ORTHOSIS

Ove J. Fasting, Einar Stranden & Lorenz Rolfsen

Dept. of Orthopaedic Surg. and Dept. of Vascular Surg., Åker Hospital, Oslo, Norway

Functional bracing of leg fractures allows early weightbearing and one factor responsible for the stability can be the hydraulic effect of the soft tissue enclosed in the rigid cylinder. The present investigation was performed to study the interstitial fluid pressure in the muscle enclosed by the brace.

The pressure was recorded in 13 patients with a wick-in-needle technique. The needle was placed in the posterior muscular compartment through a hole in the brace. Simultaneously the pressure was recorded in a foot vein.

In all the postures examined the interstitial fluid pressure was significantly increased. The mean pressure was in the supine position 15 mmHg, standing with the limb dependent 48 mmHg, standing with weightbearing 50 mmHg, and walking 33 mmHg.

The interstitial fluid tissue pressure found in this investigation may be of importance in the maintenance of stability of the fracture and to some extent prevent dislocation and shortening. The pressure has, however, to be balanced between the pressure necessary to give adequate support and the pressure that may cause disturbance in the blood circulation with complications such as oedema, decubitus, compartment syndrome and even peripheral gangrene.

CHILDREN'S ANKLE FRACTURES. CLASSIFICATION AND EPIDEMIOLOGY

Lars Danielsson & Lennart Landin

Department of Orthopaedic Surgery, Malmö General Hospital, Malmö, Sweden

In an investigation of childhood and adolescence fractures (age groups 0–16 years) occurring in Malmö during 1950, –55, –60, –65, –70 and 1975–1979 a total number of 8682 were found. Four per cent or 373 were ankle fractures which were classified according to their roentgenological appearance.

Avulsion fractures of the tip of the lateral malleolus were most frequent, followed by fractures involving the distal fibular physis. Triplane- and Tillaux-fractures were the third and fourth most common fracture groups which constitutes a higher frequency than could be expected from previous reports.

The frequency in the whole series was equal in boys and girls but Tillaux-fractures were more common in girls ($0.01 > P > 0.001$). There was no statistically significant difference between the sexes in the other fracture groups.

In the whole material fractures were observed to occur more often in the right ankle ($0.01 > P > 0.005$).

Most injuries were caused by low energy trauma. A foot caught in a bicycle wheel resulted more often in an epiphyseal fracture of the lateral malleolus than any other type of fracture. Otherwise no other etiological factor caused a significant number of cases in any fracture group.

There was a seasonal variation with twice as many fractures during April and September as compared with July and December when the lowest frequency was observed.

The incidence showed a steady increase during growth which ceased after the early teens due to a lower incidence among girls in the age groups 15–16 years.

A significantly increased incidence of ankle fractures was recorded during the 30 years covered by this study.

OPERATIVE TREATMENT OF ANKLE FRACTURES. A FOLLOW-UP STUDY OF 345 OPERATIVELY TREATED ANKLE FRACTURES

Ulf Lindsjö

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

In an unselected prospectively planned series of 611 ankle fractures 25% were of the AO (Weber) type A, 56% type B and 13% type C; 4% were impact fractures. 345 fractures (57%) were operated on according to the principles of AO ("ASIF").

The postoperative treatment consisted of a few days of early joint motion exercises 2–3 days after the operation and then walking with full weight-bearing in a below knee PTB (Sarmiento) plaster bandage. 327 fractures (95%) were followed up 1–6 years after the operation. The range of motion was measured as loaded dorsal extension (normal value 33°) and loaded plantar flexion (normal value 48°). The clinical results were "excellent" or "good" for 81% of the dislocation fractures, 38% of the impact fractures and for two of the six combined shaft/ankle fractures. Post-traumatic arthritis developed in 14% of the dislocation fractures and 50% of the impact fractures.

There was a strong correlation between the degree of arthritis and poor clinical results. The clinical and radiographic results from use of the AO ("ASIF") method were better than those of conservative treatment or earlier operative methods. According to an AID analysis the most important factors for the final

outcome were 1) type of fracture, 2) the result of operative reduction and 3) the patient's sex. The surgeon is only able to influence the second factor. Thus the best way for attaining good results seems to be accurate open reduction and rigid internal fixation.

EXTERNAL FIXATION AS A DIAGNOSTIC AID IN CHRONIC PELVIC INSTABILITY (CPI)

GERT WALHEIM & SVEN OLERUD

Department of Orthopaedic Surgery, Karolinska Hospital, Stockholm, Sweden

The symptomatology of CPI (also called Pelvic Insufficiency or Pelvic Girdle Relaxation), with pain emanating from the pelvic joints, may be atypical and be interpreted as low-back pain, sciatica or hip disorders. Stabilization of the pelvis in patients with suspected CPI can be expected to relieve true pelvic joint pain, whereas pain emanating from the back or hip will not be affected. A correct diagnosis is important, since certain disabling cases of CPI may require surgical treatment with arthrodesis of one or several pelvic joints.

In 11 patients with pain in the sacro-iliac joints, in the majority of cases combined with pain in the symphyseal and/or inguinal region, sciatica, and limping, a Hoffmann frame was applied for a period of about 5 days. The device was mounted as a trapezoid compression frame according to Slätis and Karaharju. The patients were able to move about freely and were in fact encouraged to test the device outdoors and at home.

Prior to removal of the frame the patients' symptoms were re-examined. Partial or complete relief of the subjective symptoms was noted in 80 per cent. A good effect of the external fixation treatment was in more than 70 per cent of the cases also verified by clinical examination including six different tests. Gait analysis on an electronic walkway was used for objective assessment of the clinically observed improvement with regard to limping.

This study indicates that temporary external fixation of the pelvis is a valuable aid in verfifying a suspected diagnosis of CPI.

HIP ARTHROPLASTY WITH EXTENDED FEMORAL COMPONENT AS A SALVAGE PROCEDURE IN CASES OF FEMORAL FRACTURE AND/OR POOR BONE STOCK

SVEN OLERUD & GÖRAN KARLSTRÖM

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

In nine cases a conventional hip arthroplasty has been combined with intramedullary nailing after reaming. In the first three cases a Charnley prosthesis and an AO i.m. nail were used, in one case combined with double osteotomy of the femur and rearthrodesis of the knee joint. However, in one of these cases the femoral component of the prosthesis rotated in the i.m. nail, which resulted in dislocation of the hip joint. In the remaining six cases a Müller straight stem prosthesis was combined with an original Küntscher nail.

The early results have been very promising with one superficial infection as the only complication.

The indications for this extension of the femoral component have been previous failed arthroplasty with poor bone stock (one case), fracture or delayed union of the femur and severe disease of the adjacent hip joint (five cases), failed resection arthroplasty with poor bone stock (two cases), and pseudarthrosis of the femoral neck combined with severe varus deformity of the femur, partially due to previous knee arthrodesis (one case).

The advantages of this combined procedure over the use of long-stem and proximal femoral replacement devices are better fracture fixation – especially of diaphyseal fractures – and the possibility to preserve hip abductors.

MECHANICAL AND VASCULAR COMPLICATIONS AFTER FEMORAL NECK FRACTURE – COMPARISON BETWEEN TWO TYPES OF OSTEOSYNTHESIS

BJÖRN STRÖMQVIST, LEIF CEDER, LARS INGVAR HANSSON, JOHN PALMER & KARL-GÖRAN THORNGREN

Depts. of Orthopaedic Surgery and Radiation Physics, University Hospital in Lund, Sweden

Deficient isotope uptake in the femoral head after femoral neck fracture means high risk for complications such as redislocation, pseudarthrosis or segmental collapse. Several cases with preoperatively intact and postoperatively deficient metabolism have been noted after osteosynthesis with a 4-flanged nail (Rydell). An alternative method of osteosynthesis has been developed, two round hook-pins with a device for atraumatic insertion (Hansson).

Since January 1, 1981, all patients with femoral neck fracture at the University Hospital in Lund have been operated on with one of these two methods randomly. Within 2 weeks from operation Tc-MDP scintimetry has been performed and femoral head activity on the fractured side below 90% of that on the intact side has been considered insufficient. The follow-up has included regular clinical and radiographic examinations and registrations of all complications requiring reoperation to date.

159 patients were operated on, 68 with the 4-flanged nail – Rydell (group A) and 87 with the two hook-pins – Hansson (group B). 46 fractures were undisplaced and 109 displaced. The preoperative blood circulation, assessed by tetracycline staining, showed no significant difference between the groups.

Definite femoral head defects in the patients with

displaced fractures appeared in 29 out of 44 patients in group A and in 17 out of 51 in group B. This difference is statistically significant ($P < 0.01$).

To date 11 reoperations have been performed, 10 in group A and one in group B.

Conclusion: It seems possible to reduce the complication rate after femoral neck fracture with a less traumatizing technique of osteosynthesis.

FOREARM BONE MINERAL CONTENT IN CHILDREN WITH FRACTURES

LENNART LANDIN & BO NILSSON

Department of Orthopedic Surgery, Malmö General Hospital, 214 01 Malmö, Sweden

The aim of this study was to compare the bone mineral content in children who had sustained fracture with that of normal healthy children. Included in the study were altogether 90 children, 33 girls and 57 boys, in the age group 4–16, who had recently sustained a fracture of the upper or the lower limb.

The bone mineral content in the shafts of the forearms was measured with gamma absorptiometry and compared with that of 131 healthy children of the same age range.

The bone mineral content was decreased by approximately 10 per cent in boys who had sustained fracture as compared with healthy controls ($P < 0.01$). This, however, could be demonstrated only in those boys in whom the fracture was caused by a minor or moderate trauma whereas in those with high energy trauma there was no difference as compared with the controls. In girls there was a similar difference although less pronounced.

These findings suggest that endogenous factors – a less than average bone mass – may contribute to the production of fractures also in children and that therefore not only environmental factors are responsible.

SCINTIGRAPHIC STUDIES OF NECROSIS OF THE FEMORAL HEAD AND PSEUDARTHROSIS FOLLOWING FEMORAL NECK FRACTURE

KARL AKKE ALBERTS, MATS DAHLBOM & JAMES HINDMARSH

Department of Orthopaedic Surgery, Södersjukhuset, Stockholm, Sweden

Pseudarthrosis is the most common complication following femoral neck fractures and often causes such severe symptoms that reoperation will be required.

Whereas most scintigraphic studies are exclusively focused on problems associated with necrosis of the femoral head, the aim of the present investigation has been to study patients with radiologically verified complications following femoral neck fractures with regard not only to segmental necrosis of the femoral head, but also to pseudarthrosis.

A series of 53 patients was examined radiologically and by bone scintigraphy. Technetium$_{99}$ methylenediphosphonate was used as the tracer and the scintigrams were computer processed to allow quantitative measurement of radioactivity in the femoral head and over the fracture site.

Results: Two main groups can be distinguished, on the one hand patients with pseudarthrosis demonstrating enhanced activity in the femoral head and over the fracture line, on the other hand those with reduced activity over the femoral head and enhanced activity over the fracture line. Enhanced activity in the femoral head was most common in patients with initially poor reduction or manifest redisplacement of the fracture, whereas reduced activity in the femoral head was demonstrated by patients with healing disturbances in spite of satisfactory reduction of the fracture.

Conclusion: This study suggests that pseudarthrosis may be caused by mechanical factors (poor reduction or manifest redisplacement) as well as by vascular disturbances due to injuries involving both metaphyseal and retinacular arteries.

TREATMENT OF NONUNIONS WITH ELECTRICITY

T. AHL, G. ANDERSSON, P. HERBERTS & R. KALÉN

Department of Orthopaedic Surgery, Danderyd Hospital, Stockholm. Sahlgrenska & Östra Hospital, Gothenburg, Sweden

Many investigators have dèmonstrated that application of electrical current to bone stimulates osteogenesis in the vicinity of the cathode, given the appropriate current.

Since the beginning of the 1970s an increasing amount of nonunions are being treated with electricity in the USA as well as in Europe.

In the autumn of 1980 we started a study on nonunions treated with electricity at Sahlgrenska Hospital and Östra Hospital in Gothenburg and at Danderyd Hospital in Stockholm.

Only fractures that were not clinically healed within a minimum of 6 months and that had not shown any further signs of healing on X-ray during the last 3-month period were included.

We have followed Brighton's technique for electrical stimulation. This consists of 3–4 teflon coated Kirschner-wires percutaneously inserted into the nonunion area, working as cathodes. The anode is placed on the skin. A small portable battery delivers a constant direct current of 20 μAmp/cathode.

So far we have treated 22 patients. The first 17 of them have been evaluated and are included in this study.

The bones involved were the tibia in 10 patients, the scaphoideum in two, the femur in one and the humerus

in three patients. One unsuccessful fusion of the ankle was also included.

Of the 17 patients studied eight achieved solid bone union. Minor complications such as broken and dislocated Kirschner-wires and superficial skin irritation were observed in six cases. Deep bone infection occurred in one patient.

We consider electrical stimulation of nonunions a promising and interesting complement to conventional surgical therapy.

FRACTURE INCIDENCE OF DISTAL RADIUS AND PROXIMAL FEMUR FOR PATIENTS IN A MENTAL HOSPITAL COMPARED TO THE GENERAL POPULATION

LEIF CEDER, LARS INGVAR HANSSON, KLAS SVENSSON* & KARL-GÖRAN THORNGREN

Departments of Orthopaedic Surgery and Statistics*, University of Lund, S-221 85 Lund, Sweden

The incidence of fractures of the proximal femur has been reported to increase during the last decades. The aim of this study was to find our if fractures of the distal radius also have increased and to see if the pattern of fracture incidence for the distal radius and proximal femur in a mental hospital was different from that in a general population.

Fractures of the distal radius and of the proximal femur from the primary area of Lund and from the local mental hospital (St Lars) in Lund were recorded in 1972. This material was compared to the findings in Malmö from fractures of the distal radius 1953–57 and from hip fractures in Malmö 1951–60.

A statistically significant increase in the incidence of fractures of the distal radius was found in the general population in Southern Sweden during the last decades. Concerning fractures of the proximal femur, an increase of the incidence of trochanteric fractures was observed only in women.

In male patients from a mental hospital the rate of distal radius fractures was the same as in the general population but the rate of proximal femur fractures was about 12 times higher. In female patients from the same mental hospital the rate of distal radius fractures was increased three times and that of proximal femur fractures about seven times. This difference may not only be explained as an increased skeletal fragility in mental, institutionalized patients but may also suggest poorer protective mechanisms against falls. Undiagnosed cardiovascular or neurological diseases, e.g. intermittent cardiac arrhythmia or transient cerebral ischaemic attacks, may cause the fall. Early diagnosis and treatment of such disease may reduce the number of fractures of the proximal femur.

BONE REGENERATION

MARSHALL R. URIST

Bone Research Laboratory, Los Angeles, CA, USA

Since the 19th century, the standard experimental procedure for investigation of bone regeneration has been the skull trephine defect in adult rodents, dogs and nonhuman primates. A trephine defect in the rat skull, 0.8 cm in diameter, does not spontaneously heal in the lifetime of the animal. When the defect is filled with 5 mg BMP, the skull is completely regenerated within a few weeks. The defect heals, not only by bony ingrowth from the trephine rim, but by proliferation and differentiation of perivascular mesenchymal type cells of the *dura* into woven bone. The new bone is remodelled, simultaneously colonized by blood-borne bone marrow derived stem cells and thereby the normal structure of the cranial diploe is restored. Comparable control defects, filled with autologous bone, one or another preparation of bank bone, ceramic materials, etc., were incompletely regenerated.

A chemosterilized autolyzed, antigen-extracted allogenic (AAA) bone is useful to sustain the BMP activity in human bone. The bone is collected under sterile conditions, but the cells and transplantation antigens are chemically extracted in sequence in the presence of NEM and pCMB. These sulphydryl group enzyme inhibitors stabilize BMP and at the same time serve as antimicrobial agents. AAA bone is used for patients with large bone defects from old infections, injury, malignancy, and congenital malformations. AAA is indicated when massive autologous bone grafts are unjustified as for example for intertransverse process or scoliosis fusions, and repair of large aneurysmal or other bone cysts, and various bone defects in young individuals. For bridging large bone defects in aged individuals AAA bone can be used as a composite graft with autologous cancellous bone.

BONE GROWTH STIMULATION BY BIOSYNTHETIC METHIONYL HUMAN GROWTH HORMONE

K.-G. THORNGREN, A. SKOTTNER-LUNDIN, A. FORSMAN, E. LÖVBERG, K. FHÖLENHAG & L. FRYKLUND

Dept. of Orthopaedic Surgery, Lund University Hospital and Peptide Hormone Dept., Kabi Vitrum AB, Stockholm, Sweden

Due to shortage of human growth hormone (HGH) hypopituitary children in many countries lack treatment for impaired bone growth. This shortage has also hampered more thorough trials of HGH in other conditions with delayed bone formation. Today it is possible to make biosynthetic HGH by gene modification techniques. This gives potential possibilities to achieve amounts of HGH available for new indications. The bone growth stimulating effects of the biosynthetic

HGH have first to be evaluated experimentally. The present study compares the effect of biosynthetic HGH with conventional HGH (extracted from human pituitaries) on the longitudinal bone formation process.

The gene for human pituitary growth hormone has been inserted into the plasmid pBR 322 in *E. coli* K12 by recombinant DNA techniques. The biosynthetic methionyl HGH has been purified by conventional biochemical procedures. Tetracycline was used as intravital marker for bioassay of the longitudinal bone growth in hypophysectomized rats. With radioactive sulphate in the same animals the in vivo sulphation of costal cartilage and cartilage from growth plates was performed. Also the body-weight was registered.

The biosynthetic HGH stimulated the longitudinal bone growth in a similar manner as the conventional preparation of HGH. A dose-dependent effect on the longitudinal bone growth was obtained. The effect was linear in the dose interval 10–145 mIU/day and was equal or even somewhat better than that of conventional HGH. The effects on body-weight gain and sulphate uptake into cartilage showed the same general pattern.

COMPARISON BETWEEN THE EFFECTS OF THE ACTIVE VITAMIN D_2 AND D_3 METABOLITES IN RATS

GÖRAN SJÖDÉN*, URBAN LINDGREN* & HECTOR DELUCA**

*Department of Orthopaedic Surgery, Huddinge Hospital, Huddinge, Sweden; **Department of Biochemistry, University of Wisconsin, Madison, WI, USA

In clinical praxis vitamin D_2 has generally been used as a substitution for the physiological form called D_3. Very little is known about the different effects between the active metabolite of the two compounds. We have found certain differences between the effect of 1-alpha-hydroxy D_2 and 1-alpha-hydroxy D_3 in the rat. These are not different in quality but the effectiveness seems to differ on different receptors.

Adult, weaning or rachitic male rats have been used as experimental animals. Bone mass, intestinal calcium transport, urinary excretion of calcium and phosphate, fecal calcium as well as serum levels of calcium, phosphate, 1.25 $(OH)_2 D_3$ and 1.25 $(OH)_2 D_2$ have been measured.

The preliminary results indicate that the disappearance of 1.25 $(OH)_2 D_2$ from serum is slower compared to 1.25 $(OH)_2 D_3$. The effect on bone is slightly less with the D_2 metabolite whereas the depression of parathyroid function seems to be greater with the D_2 compared to the D_3 metabolite.

As a therapeutic agent it is now possible to make the active vitamin D_2 *or* D_3 metabolite available. The pharmacologic differences between the active metabolites may be of interest in the clinical situation.

INFLUENCE OF VITAMIN 25 OHD_3 AND 1,25 $(OH)_2 D_3$ ON BONE GROWTH AND REMODELLING IN THE RAT

K.-G. THORNGREN, O. JOHNELL & L. I. HANSSON

Depts. of Orthopaedic Surgery, Lund University Hospital and Malmö General Hospital, University of Lund, Sweden

The effects of vitamin D on bone resorption are definitely established whereas the effects on actual new bone formation are still under discussion. To study the *in vivo* effects on bone formation in standardized bone growth and remodelling systems, a moderate supplement of vitamin D metabolites was given adolescent rats on a standard diet. Comparison with other hormones previously shown to stimulate the bone formation in these systems is thereby facilitated.

Female rats (10 animals per group) were given one daily s.c. injection of 1.5 μg/kg 25 OHD_3 or 0.04 μg/kg 1,25 $(OH)_2 D_3$ for 20 days (75–94 days of age). Controls were given 0.5 ml solvent. Tetracycline was used as intravital marker to determine the longitudinal bone growth of the proximal tibia, as well as the apposition and resorption of cortical bone in the femur diaphysis. The osteoclasts were counted in the metaphysis and diaphysis of the ribs.

Vitamin 1,25 $(OH)_2 D_3$ resulted in retardation ($P < 0.05$) of the accumulated longitudinal bone growth. A similar but insignificant tendency was found for 25 OHD_3. The body-weight and the periosteal and endosteal bone formation at various levels along the femoral shaft were unchanged compared to the controls. The total cortical width was somewhat lower in the distal femur for 1,25 $(OH)_2 D_3$. In the proximal femur the 25 OHD_3 resulted in a somewhat thicker cortical bone. Most levels along the femur, however, showed no differences. The osteoclast count showed an increased number ($P < 0.05$) in the cortex of the rib in the rats given 1,25 $(OH)_2 D_3$. Compared to growth hormone, which is the major bone growth stimulating agent, the influence on bone formation of the vitamin D metabolites was minor and predominantly negative.

HEMODYNAMICS AND GROWTH DISTURBANCES OF THE JUVENILE KNEE IN EXPERIMENTAL ARTHRITIS

C. BÜNGER, J. HJERMIND, E. H. BÜNGER & J. BÜLOW

Orthopedic Hospital and Institute of Experimental Clinical Research, University of Aarhus, Denmark

An experimental model in puppies was developed to study the pathogenesis of growth disturbances in juvenile degenerative arthritis of the knee.

Unilateral arthritis was induced by weekly instillation of Carraghenin solution into the knee joint of 24 dogs. After implantation of Tantalum markers the growth of both knees in each dog was followed for 3 months on

serial radiographs. In 12 dogs simultaneous pressure measurements were then taken from the knee joint cavity, the juxta-articular epiphyses and the distal femoral metaphysis during control conditions and various degrees of knee joint tamponade. In 12 other dogs the regional blood flow rates were determined by radioactive microsphere technique. Using four different isotopes the influences of induced arthritis on the local blood perfusion of the knee and the regional blood perfusion of the limb were assessed in various degrees of knee joint tamponade.

The induced arthritis resulted in epiphyseal overgrowth and decreased endochondral ossification of the distal femoral growth plate. The intra-articular pressure and the intraosseous pressure of the distal femoral epiphysis was significantly elevated. Regional blood flow was significantly increased in the knee joint capsule, menisci and in the femur proximal to the epiphysis of the knee, while the juxta-articular bone blood flow was unchanged or moderately decreased. The intraosseous pressure response and regional blood changes during increasing intra-articular pressure suggested increased resistance in the draining veins of the juxta-articular bones in the arthritic knees.

The observed changes of hemodynamics and subsequent increase of vascular volume of the juxta-articular bones may be of major importance in the pathogenesis of the growth disturbances observed.

LONGITUDINAL GROWTH OF A RABBIT TIBIA AFTER EXPERIMENTAL ALTERATION OF ITS LENGTH

KALEVI ÖSTERMAN & KARI AALTO

The Orthopaedic Hospital of the Invalid Foundation, Helsinki, Finland

The epiphysial growth after experimental lengthening or shortening of a rabbit tibia was studied by making a shortening osteotomy (mean 10.1 mm) in 16 animals or a one-stage lengthening operation (mean 8.4 mm) in 16 animals. The osteotomy was stabilized using an external fixation device.

It appeared that, compared with the intact opposite tibia, both after shortening and lengthening procedures a stimulation of longitudinal growth of 1.0 per cent was observed. No epiphysial compensation of the longitudinal growth after alteration of the length of the bone was observed.

QUANTITATIVE AND QUALITATIVE EVALUATION OF BONE INGROWTH IN A POROUS FIBER METAL IMPLANT

HELGE RØNNINGEN, LUDVIG FJELD SOLHEIM, NORVALD LANGELAND & JORGE O. GALANTE

Institute for Surgical Research, Rikshospitalet, Oslo, Norway

Previous results based on histological evaluation have indicated that bone ingrowth in a porous implant follows a pattern very similar to the healing of a fracture or bone defect. In the present study we have pursued this idea in an animal model and by means of chemical evaluation.

The implants used were porous T-6A1-4V implants of Drs. Rostoker and Galant's design, manufactured as cylinders sized 4.8 × 10.0 mm (d × h). Nineteen adult cats were used. A hole (∅ = 4.8 mm) was drilled in both trochanteric regions. Implants were placed in the left side holes while right side holes were left to heal undisturbed. The animals were sacrificed at 4, 12 and 26 week intervals. 85-Strontium had been administered 24 hrs before sacrifice to label the bone mineral. Tissue that had grown into the pores and into the empty drill-holes was analyzed together with a slice of the right tibia from each animal.

The average amounts of tissue ingrowth were: 32.6 mg (4 wks), 49.8 mg (12 wks) and 52.8 mg (26 wks). For each sample the contents of hydroxyproline (HYP), calcium (Ca) and phosphous (P) were analyzed. The mineralization (Ca/HYP) of the bone within the pores lagged a little behind those of the holes and tibias, but at 26 weeks the bone was fully mineralized. In the implants the Ca/P-ratio increased from 1.00 at 4 weeks to 1.2 at 26 weeks, compared to a stable 1.3 – ratio in the holes and tibias. A regression analysis of Ca on HYP was performed for each time interval. No significant differences were found when the slope of the regression line for the implants was compared with that for the holes, at any time interval. This means that a gain in HYP was followed by an equal gain in Ca for both the implants and holes.

It is concluded that bone ingrowth and defect healing are very similar events.

ELECTRICAL STIMULATION OF OSTEOGENESIS: STUDIES OF THE CATHODE EFFECT ON NON-FRACTURED RABBIT FEMUR

CLAES J. PETERSSON, NILS GUNNAR HOLMER* & OLOF JOHNELL

Departments of Orthopaedic Surgery and Biomedical Engineering*, Malmö General Hospital, Malmö, Sweden

The aim of the present investigation was to evaluate the effect of cathodal direct current stimulation on rabbit femur.

Three series of experiments have been performed A, B and C. Adult white rabbits with an average weight of 3900 were used. A drill hole of 1.0 mm penetrating into the medullary cavity was made in the frontal cortex of the right and the left femur of each animal. The uninsulated stainless steel tip of a pace-maker cable was introduced into the hole on each side and secured with a stitch. The cable of the right side served as the cathode

of a subcutaneously placed isolated electrical stimulator, controlled by a transistor, and constantly delivering 20 micro-ampère direct current irrespective of resistance. The anode was placed subcutaneously at a distance of about 10 cm from the cathode. The cable on the left side served as a control and was not connected with a stimulator.

In series A and B the osteogenic effect was determined with histomorphometry according to the method described by Merz and Schenk. No difference in osteogenic response between the stimulated and unstimulated sides was found. In series C the femora were divided into proportional parts. The difference in cortical thickness, bone volume, ash-weight and activity of ^{85}Sr was determined.

A non-significant increase in new bone formation in the cathodal region of the stimulated right femora was found.

Our conclusion is that if there is any effect of electrical direct cathodal current stimulation on new bone formation in the rabbit femur it is indeed very small.

EFFECT OF ELECTROGALVANIC ELEMENTS ON NON-FRACTURED BONE

Olof Johnell & Claes Petersson

Department of Orthopaedic Surgery, Malmö General Hospital, Malmö, Sweden

To evaluate the effect of electrogalvanic elements on rat bone we have placed an element consisting of silver and platina on the right rat femur and on the left femur only a Sham operation was performed on 10 rats. In two other groups of rats pure silver rods and pure platina rods were placed on the right femur and a Sham operation on the left femur. The animals were killed after 6 weeks and 3 months, histological sections were made on half of the rats, the other half was given Sr^{85} prior to death and the ashweight of the femora was measured. After 6 weeks there was a difference both in histological appearance, increased uptake of Sr^{85} and ashweight in the femora with the silver-platina elements compared with pure silver and platina rods, but after 3 months there was no difference between the electrogalvanic element and the pure metal rods. This could indicate an initial effect on bone of these elements.

RECOVERY OF DIAPHYSEAL BONE STRENGTH AFTER RIGID INTERNAL PLATE FIXATION

Jaakko Joukainen, Pekka Paavolainen, Pär Slätis & Teddy Holmström

Division of Orthopaedic Surgery and Traumatology, Surgical Hospital, Helsinki University Central Hospital, Helsinki, Finland

Porotic transformation of diaphyseal cortical bone was induced by attaching a four hole stainless steel ASIF plate onto the tibio-fibular bone of rabbits.

The plates were removed 24 weeks after the operation. Recovery was followed radiographically and by testing the bone specimens in a torsiometer 0, 6, 12, 18, 24 and 26 weeks after removal of the plate.

On removal of the plate the strength of the plated bones was only 72 per cent of that in paired controls. Full recovery of torsional strength was achieved 18 weeks after removal of the implant.

Cortical porosity and reactive periosteal new bone formation observed on plate removal diminished in the radiographs during the first 18 weeks but were still visible at the end of the experiment.

TORSIONAL BEHAVIOR OF RAT FEMORA

Arne Ekeland, Lars B. Engesaeter & Norvald Langeland

Institute for Surgical Research, Rikshospitalet and Sophies Minde Orthopaedic Hospital, University of Oslo, Norway

Torsional properties of cortical rat bone have been studied in 135 male, Wistar rats, aged 3–36 weeks. The right femora of the growing animals were dissected free of soft tissues, and loaded until failure in torsion.

The strength of the femora, the ultimate torsional moment, increased with increasing animal age. So did also the torsional stiffness of the femora. In contrast, the femoral deformation at failure, the ultimate torsional angle, remained almost constant throughout the study.

The strength and stiffness of bone as a material, the ultimate torsional stress and the modulus of rigidity, increased and plateaued at 14 weeks of age and a body weight of about 350 g.

In conclusion, the strength and the stiffness of rat femora tested in torsion increase with age and growth of the animals, whereas the deformation at failure remains constant. Femoral diaphyseal bone as a material reaches adult strength and stiffness, and thus seems to mature, when the rats are about 14 weeks old.

STRESS PROTECTION OF PLATE FIXATION AND EXTERNAL FIXATION. AN IN VITRO INVESTIGATION ON INTACT HUMAN AND RABBIT TIBIAE

Terje Terjesen & Pål Benum

Department of Orthopaedic Surgery, Trondheim University Hospital, Trondheim, Norway

Application of rigid metal plates on intact bone leads to bone loss and reduced bone strength, because of the stiffening effect by the plate on the plated bone segment (stress-protection).

The object of this study was to find out the extent of the stiffness increase in intact human and rabbit tibiae due to metal plates or external fixation. Intact bones were tested *in vitro* in the elastic range in three-point bending, before and after application of a plate or external fixation. The deformation was measured by a linear voltage differential transformer (LVDT) only in the tibial segment where the plate or external fixation was placed.

In the human specimens a median bone stiffness increase of 31 per cent was obtained after fixation with a tibial plate (140 × 12 × 4 mm) and of 43.8 per cent with a femoral plate (140 × 16 × 5 mm), compared to 10.2 per cent with the Vidal-Adrey double frame external fixation device. In rabbit tibiae a median stiffness increase of 31.9 per cent was found after application of a thin plate (45 × 5 × 1 mm).

Conclusions:

1. A considerably greater stiffness increase was obtained by metal plates than by external fixation.
2. The stiffness increase in rabbit tibiae with the thin plate corresponded well to that obtained in human tibiae with a tibial plate. In previous reports of *in vivo* plate fixation on intact rabbit tibiae more rigid plates have been used, which seem to be overdimensioned.

THE COMPRESSION PATTERN IN FEMORAL NECK OSTEOTOMIES: AN EXPERIMENTAL STUDY

PETER A. FRANDSEN & TOMMY MADSEN

Department of Orthopaedic Surgery O, Odense University Hospital, Odense, Denmark

Medial fractures of the femoral neck can be treated by sliding-screw-plate (SSP) osteosynthesis, but it is still unsolved whether or not it is an advantage to apply compression on the SSP. A firm contact between the surfaces of a fracture is an advantage. However, exaggerated compression implies the possibility of losing the fixation of the head of the femur. This problem has been elucidated in an experimental study.

An SSP was implanted centrally in the femoral neck and head after a subcapital osteotomy was performed. The experiments were carried out in 20 autopsied bones from 10 females between 60 years and 85 years. At the site of the osteotomy a specially constructed strain gauge transducer transmitted the compression force to a calibrated Y-t writer. The compression screw was tightened intermittently, but the compression force at the osteotomy was measured continuously.

The results showed a diaphasic curve with a maximum compression force varying from 324 N to 1638 N. The median of the compression force was 981 N, and at the first and the third quartile 711 N and 1172 N, respectively. When the maximum compression force was reached, any attempt to apply further compression resulted in a rapid fall in pressure at the site of the osteotomy.

In relation to osteosynthesis of medial fractures of the femoral neck, the clinical implication is: 1) in normal cancellous bone the compression screw can quite safely be applied in the SSP osteosynthesis, and 2) in soft (osteoporotic) bone the compression screw in an SSP osteosynthesis should be used with extreme caution – if it should be used at all.

PROPRIOCEPTIVE NERVE ENDINGS AND BONE REPAIR

H. ARO, E. EEROLA & A. J. AHO

Department of Surgery, University of Turku, Turku, Finland

The basic mechanisms behind the successful treatment of tibial fractures with early functional bracing remain to be established. Pain is probably not the only afferent signal from the fracture site which prevents damaging loading during the formation of a stabilizing callus. In addition, it is still unknown why arthrodeses fail to unite and long bone fractures heal poorly in patients with abnormalities in proprioceptive functions (e.g. in tabes dorsalis). The present experiments suggest that periosteal proprioceptive nerve endings act as mechanoreceptors of long bones and co-ordinate the healing and remodelling processes.

Histological examinations of the rat tibio-fibular bone showed that there is a plexus of encapsulated nerve endings (Pacinian corpuscles) in the periosteum of the fibula at the distal tibio-fibular junction. Encapsulated nerve receptors are sensitive to mechanical deformations (pressure and tension) and the location of the receptors in the rat tibio-fibular bone suggests that they could monitor the degree of the bending of the tibio-fibular bone during weight-bearing (Aro et al., *Clin. Orthop.*, in press.). We excised the receptors or prevented the bending of the receptor area by the application of a rigid intramedullary nail into the tibia during fracture healing.

Rigid fixation of fractured legs caused the development of nonunion in the associated fibular fracture with marked osteolytic resorption of the fibular fragments. Flexible fixation without stress protection of the receptor area secured concurrent healing of both bones in legs with an intact innervation, whereas some of the associated fibular fractures failed to unite in legs with motor denervation (sciatic lesion). In legs with isolated fibular fractures the local excision of the nerve receptors without motor denervation caused atrophy of bone fragments, although most of the fractures united before adverse remodelling changes. Motor denervation (sciatic lesion) did not affect the remodelling of united fibular fractures.

HEALING OF EXPERIMENTAL FRACTURES OF THE TIBIA AFTER SPINAL CORD TRANSSECTION

H. Aro, E. Eerola, R. Penttinen & A. J. Aho

Departments of Surgery, Medical Microbiology, and Medical Chemistry, University of Turku, Turku, Finland

Rapid consolidation of extremity fractures is exceptionally important for spinal cord injured patients, because they are susceptible to a variety of complications during the management of fractures in their anaesthetic extremities. The present experiments indicate that the healing power of long bones is not depressed in denervated limbs. By contrast, spinal cord trauma seems to accelerate callus formation in fractures of paralyzed limbs.

Experimental tibial fractures in rats were fixed with an intramedullary nail. The spinal cord of experimental rats was transsected at the level of the upper lumbar region of the spinal column. The healing of fractures was monitored by biomechanical measurements, chemical determinations, histoplanimetrical analysis and by X-ray studies up to 2 months.

Results of the biomechanical and radiological evaluations have been reported previously (Aro et al., *Clin. Orthop.* 1981: **155**, 211–217). Tensile strengths of fractures in paraplegic rats were significantly higher than those of non-weight-bearing control rats (with experimental hip luxations) at the early phase of healing. In addition, the mass and size of external calluses formed in fractures of the paraplegic rats were greater than those of weight-bearing and non-weight-bearing control rats at the early phase of healing. Endochondral ossification, evaluated by quantitative histoplanimetrical analysis of the amounts of various callus tissue components, was also enhanced in fractures with spinal cord transsection. Chemical analysis showed an increased concentration of organic matrix components in calluses of the paraplegic rats at the early phase of healing, whereas at the mineralization phase the chemical composition of calluses was similar in paraplegic rats and in non-weight-bearing controls. The mineralization of organic matrix was only slightly delayed in the paraplegic rats. Radiologically, bony calluses of paraplegic rats were osteoporotic probably because of a failure to transform woven new bone to mature compact bone.

CARBON FIBRE IN THE CERVICAL SPINE – AN EXPERIMENTAL STUDY AND A CLINICAL REPORT OF THE FIRST CASE

Bo Levander & Håkan Molander

Department of Orthopaedic Surgery, Eksjö-Nässjö Hospital, Eksjö and Karolinska Institute, Stockholm, Sweden

Flexible carbon fibre implants have been used as tendon and ligament substitutes in clinical practice since the middle of 1970 (Jenkins 1977, *J. Bone Jt Surg.* **59B:** 501).

Snapping of the wire is a well known post operative complication in the upper cervical spine surgery (Brattström & Granholm 1973, *Orthopäder* **2:** 118–120).

This study is a preliminary report of carbon fibre implants in the upper cervical spine in a series of rabbits and the first clinical case, an occipito-cervical fusion in rheumatoid arthritis, is also presented.

The flexible carbon fibre was looped around the second cervical vertebra and tightened to the occiput. This fixation was stable throughout the observation period and the implant was well tolerated by the animals. In dissected specimens from the rabbits there was fibrous tissue around the implant but no evidence of foreign body reaction.

The clinical case, an atlanto-axial dislocation with spinal cord compression, was operated upon with internal occipito-axial transfixation by bone cement, bone chips and carbon fibre. The surgical procedure is further described in the paper.

REGENERATION OF PERIPHERAL NERVE THROUGH A POLYGLACTIN TUBE

Håkan Molander, Ove Engkvist, Jarl Hägglund, Yngve Olsson, Erik Torebjörk & Ingvar Eriksson

Dept. of Surgical Research II, Dept. of Plastic Surgery, Dept. of Neurophysiology and the Neuropathological Laboratory, University Hospital of Uppsala, Sweden

A resorbable synthetic material, polyglactin 910 (Vicryl®), was used as a mesh-tube to bridge defects (7–9 mm in length) in sectioned rabbit tibial nerve. In the controls a transplant or a Silicon tube bridged an equal defect. The observation time was 1–36 weeks.

The main methods used were histology, fibre spectrum analysis and EMG-registrations from the gastrocnemius muscle.

Coincident with the absorption of the mesh-tube a new sheath was formed which enclosed numerous minute fascicles of regenerating axons. After 8 weeks no remnants of the polyglactin tube were seen. The polyglactin tube influenced the direction taken by the regenerating axons and guided them into the distal segment. The tube also reduced the formation of neuroma and the growth of scar tissue from surrounding structures.

EMG-registrations showed signs of regenerating axons 10 weeks after surgery and after 24 weeks no further improvement was seen. The amplitude then was about 80% of the normal value.

The polyglactin tube seemed to offer a suitable milieu for regenerating axons. The EMG-registrations and the fibre analysis showed a pattern similar to the transplant group. On the other hand, the dense Silicone sheath did

not seem usable. In the Silicone group the axons crossed the defect to a lesser extent and the EMG curve showed no similarities to the normal one throughout the observation time.

BIOMECHANICAL AND CHEMICAL CHANGES IN THE PLANTARIS LONGUS TENDON IN THE RABBIT AFTER INDOMETHACIN TREATMENT

CARL ANDERS CARLSTEDT & TORSTEN WREDMARK

Department of Orthopaedic Surgery, Huddinge Hospital, Huddinge, Sweden

The use of nonstereoidal antirheumatic drugs such as Indomethacin is very common in the treatment of partial and total ruptures in tendons and muscles. Very little is known about the influence of Indomethacin on the healing process of tendon and muscle lesions. In studying this the influence of Indomethacin on the intact tendon is of interest.

Adult male New Zealand-white rabbits weighing approximately 2½ kilo were given Indomethacin 10 mg/kg/day orally in two doses. After the observation period of 4 and 8 weeks the rabbits were sacrificed and the tendons were dissected and mounted in a modified MTS-test apparatus. The tensile strength and maximal breaking strength were registered. Thereafter the tested tendons were analysed on the content of adult and immature collagen with high pressure liquid chromatography. Tritium labeled proline was given 15 hours i.v. before sacrifice. The tritium activity was determined in the different collagen fractions of the tendon.

We found that in rabbits treated with Indomethacin tensile strength of the plantaris longus tendon was significantly lower than in the non treated animals. There was no change of the total collagen content nor of the different collagen fractions. The speed of the collagen synthesis was not changed.

Indomethacin treatment seems to influence the biomechanical properties of intact tendons although no changes in the collagen fraction contents chould be observed. The mechanism of the Indomethacin effect needs further investigation.

THE IMMEDIATE STRENGTH OF SUTURED ACHILLES TENDON RUPTURES. AN EXPERIMENTAL IN VITRO INVESTIGATION

O. J. FRETHEIM & P. BENUM

Department of Orthopaedic Surgery, Trondheim University Hospital, Norway

The strength of the sutured Achilles tendon is of primary importance when the postoperative treatment is to be chosen.

Experimental ruptures on cadaver Achilles tendons were sutured with three different suture techniques and various suture materials. The tensile strength of the sutured tendons was investigated in a "low speed tensometer".

Sutures with the original Bunnel technique were stronger than sutures with a modified Bunnel technique where the knot is positioned at the rupture level. The double right angled suture of Kleinert was considerably weaker than both Bunnel sutures. This was mainly because the Kleinert suture cut through the tendon.

Mean strength of suture with the original Bunnel technique was for Supramid No. 3 24.5 kp, Ethibond No. 3 22.7 kp, Supramid No. 2 20.9 kp and Ethibond No. 2 only 13.9 kp.

The original Bunnel suture with the knot in the midline at the proximal end of the criss cross stitch gives the strongest tendon suture of the techniques investigated. The Ethibond No. 2 is significantly weaker than the other three sutures. It is probably safer to use one of the stronger sutures if for instance the patient postoperatively is allowed to walk with full weightbearing in a short leg cast.

ECTOPIC CARTILAGE AND BONE FORMATION FOLLOWING PASSIVE EXERCISING OF IMMOBILIZED LIMBS OF RABBITS

JARL-ERIK MICHELSSON & WOLFGANG RAUSCHNING

Department of Orthopaedics and Traumatology, University Central Hospital, Helsinki, Finland; Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

Sufficient immobilization of adult rabbit limbs leads to progressive stiffening, thickening and development of osteoarthritis.

In order to prevent these changes in the joints the immobilized limbs were passively exercised temporarily during or after the immobilization period of 5 weeks.

The daily careful exercise of 5 min had no preventive effect and vigorous manipulation led regularly within a few days to severe necrosis of some muscles and within 3–5 weeks to progressive ectopic cartilage and bone formation in these muscles and para-articularly. The changes were related to the frequency and intensity of the passive exercising.

These experiments show that ectopic cartilage and bone formation whose pathogenesis is unknown may develop as a result of vigorous exercising of immobilized tissues. It seems that immobilized joints must be exercised very carefully.

LOCAL ADMINISTRATION OF DIPHOSPHONATE PREVENTS ECTOPIC BONE FORMATION

LEIF AHRENGART & URBAN LINDGREN

Department of Orthopaedic Surgery, Huddinge Hospital, Huddinge, Sweden

Ectopic bone formation causing joint stiffness constitutes an unsolved problem in orthopaedic surgery. The resection of ectopic bone is frequently followed by formation of new bone. Systemic treatment with EHDP (sodium ethane-1-hydroxy-1-1-diphosphonate) has been advocated but the effect is dubious.

Adult male New Zealand rabbits were used for the study. Bone cement was mixed with EHDP and 30 mm pins with a diameter of 2 mm were made. We found that such a pin with a concentration of 0.43 g of EHDP/ml of bone cement was the smallest dose, capable of causing local impairment of bone healing for 6 weeks postoperatively. Pins containing 0.4 g EHDP/ml of bone cement were then used in an attempt to prevent ectopic bone formation in the quadriceps muscle of rabbits. Ectopic bone was created by immobilization of the knee and intermittent manipulation every 2 or 3 days. The femur on one side was approached surgically and a cement pin either with or without EHDP was fixed to the femur with a suture. The ectopic bone formation was studied roentgenologically at 2 and 4 weeks postoperatively and histological studies were done on specimens taken at 4 weeks postoperatively.

We found that bone cement containing EHDP was capable of preventing major ectopic bone formation in all cases whereas all rabbits with a pin containing no EHDP had major ectopic bone formation.

Local administration of diphosphonate may be a useful method of preventing ectopic bone formation also in man. New studies have then to be performed in order to determine the correct concentrations tolerated and its effects on ectopic bone formation.

HETEROTOPIC OSSIFICATION IN RATS – INHIBITION BY A DIPHOSPHONATE AND PROSTAGLANDIN SYNTHESIS INHIBITORS

OLLE NILSSON, HENRIK BAUER, SAM LINDHOLM & HANS TÖRNKVIST

Department of Orthopaedic Surgery, Huddinge Hospital, Stockholm, Sweden

Diphosphonates and prostaglandin synthesis inhibitors (PGSI) have been reported to have a profound effect on bone metabolism – both on bone formation and resorption. Ethane-1-hydroxy-1-1-diphosphonate (EHDP) prevents heterotopic ossification in paraplegics and after hip arthroplasty. PGSI (indomethacin and ibuprofen) delay healing of experimental fractures.

The Urist model of inducing bone and cartilage formation, by implanting HCl demineralized pieces of cortical bone matrix in muscle pouches of rats, provides the possibility of studying new bone formation in adult animals. After implantation of the bone matrix the animals were treated with varying doses of EHDP, indomethacin and ibuprofen. The effect on bone formation of these drugs was quantified by ^{45}Ca incorporation and ash content of the implants.

EHDP and the PGSI gave a highly significant, dose dependent, reduction of bone formation. ^{45}Ca uptake increased almost immediately upon withdrawal of EHDP administration, supporting earlier observations that diphosphonates do not primarily inhibit matrix production, but only interfere with the mineralization of osteoid.

Conclusions: EHDP and prostaglandin synthesis inhibitors prevent heterotopic ossification in rats. The experimental model employed permits quantification of these effects, and provides the possibility of elucidating where in the sequence bone induction, osteoid formation, mineralization, and resorption these drugs have their effect.

INHIBITION OF PARTIAL CLOSURE OF EPIPHYSEAL PLATE IN RABBITS BY INDOMETHACIN

EINAR SUDMANN, OTTO SCHNELL HUSBY & GISLE BANG

Hagavik Orthopaedic Hospital and Department of Oral Pathology and Forensic Odontology, School of Dentistry, University of Bergen, Norway

The efficiency of indomethacin (10 mg/kg/day) in inhibiting recurrent partial closure of epiphyseal plate was tested in rabbits. An epiphysiodesis was done laterally in the distal left femoral epiphyseal plate in 19 adolescent rabbits. This produced a valgus deformity in 14 of them. The bone bridge was then removed operatively and the rabbits were treated with either indomethacin or vehicle for 21 days postoperatively. Indomethacin plasma levels were about 180 ng/ml. The valgus deformity improved in indomethacin-treated rabbits, whereas it became worse in the controls (P = 0.004).

EFFECTS OF ACETYLSALICYLIC ACID AND NAPROXEN ON BONE METABOLISM IN YOUNG RATS

LUDVIG FJELD SOLHEIM, HELGE RØNNINGEN & NORVALD LANGELAND

Institute for Surgical Research, Rikshospitalet, Oslo, Norway

The influence of acetylsalicylic acid and naproxen on the biomechanical and biochemical properties of intact femora in rats has been studied. The serum concentrations of the drugs were comparable with the therapeutic anti-inflammatory levels in humans.

After 9 and 18 days of medication the femora were subjected to epiphyseal and metaphyseal bending tests and to diaphyseal torsional test. The metabolism of minerals and collagen has been evaluated utilizing strontium-85 and 14C-proline as tracers.

After 9 days the acetylsalicyclic acid treated rats had significantly increased bending strength of the distal epiphyseal plate and increased torsional strength of the

femoral diaphysis. After 18 days the epiphyseal and metaphyseal bending strengths were significantly reduced. Naproxen did not influence the mechanical parameters significantly. After 18 days the dry weight and content of collagen were significantly reduced in the femora of the acetylsalicylic acid treated rats. The rate of mineralization and the rate of collagen synthesis were also significantly reduced after 18 days. The femora of the naproxen treated rats showed a reduced rate of mineralization after 18 days.

The findings indicate an inhibitory effect of acetylsalisylic acid on bone metabolism.

BONE FORMATION OF COMPOSITE GRAFTS OF DEMINERALIZED BONE MATRIX AND BONE MARROW IN THE RABBIT EVALUATED BY TECHNETIUM RADIONUCLIDE BONE IMAGING

K.-G. Thorngren, J. Wittbjer, B. Nosslin, B. Palmer & M. Rohlin

Dept. of Orthopaedic Surgery, Lund University Hospital, Maxillo-facial Center and Depts. of Nuclear Medicine and Plastic Surgery, Malmö General Hospital and Dept. of Oral Radiology, University of Lund, Sweden

The osteogenetic potentials of autologous bone marrow as well as of demineralized diaphyseal compact bone are well documented. The interpretation of marrow influence in osteogenesis of a decalcified bone transplant differs however. The aim of this investigation was to find out to what extent fresh autologous bone marrow would contribute to the osteogenesis of a decalcified bone transplant and thus accelerate the healing process in a bone defect.

Twenty adult male rabbits were operated on with bilateral resection of a 12 mm piece of the middle part of the radius. No postoperative fixation was necessary due to the stabilizing effect of the ulna. Both pieces were decalcified and at a second operation 3 days later the decalcified pieces of bone were replaced in the radial defects on both sides. To one implant autogenous fresh marrow cells were administered. The bone marrow was obtained by aspiration from the femoral medullary cavity through a drill hole. At 14 and 28 days postoperatively the bone formation activity was registered by scintigraphy, radiography and autoradiography in 11 and 9 rabbits, respectively. The defect retransplanted with the composite graft had at 14 days a significantly higher ($P < 0.01$) bone formation rate compared to the control defect. At 28 days no differences were found between the sides. Thus, added bone marrow seems to have an initial effect on the osteogenesis while in a later phase no differences in bone formation or total amount of formed bone were seen between the bone matrix alone and the composite graft.

PENETRATION OF DICLOXACILLIN INTO BONE AND TISSUE CAGE FLUID IN RABBIT

Sven-Erik Larsson & Stig E. Holm

Departments of Orthopaedic Surgery and Clinical Bacteriology, University of Umeå, Umeå, Sweden

A single intravenous dose of ^{3}H-labelled dicloxacillin (^{3}H-activity 1.5 μC/mg dicloxacillin) 5 mg/kg body weight was given to 4-kg rabbit. Six weeks earlier, two cylindrical steel net cages (2 × 2 cm) had been implanted subcutaneously in the back to deliver extracellular tissue cage fluid (TCF). The animal was killed 6 hours after the antibiotic administration and the concentrations in serum, TCF, bone, fat and muscle tissues were determined with biological and radiological methods. The concentrations of dicloxacillin in extracellular fluid (TCF) after 1, 2 and 4 h were 0.36, 1.1 and 1.3 μg/ml. The increase was slow and continued after the serum level had fallen below the concentration in TCF. The total concentration of antibiotic in bone after 4 hours reached 0.72 μg/g spongious bone and 0.56 μg/g cortical bone. The amount of antibiotic being extractable with distilled water corresponded to 0.24 μg/g bone both for spongious and cortical bone; i.e. 34 and 43 per cent of the total concentrations. The concentrations of unextractable dicloxacillin were 0.48 μg/g in spongious bone and 0.32 μg/g in cortical bone. The serum level had fallen to 0.29 μg/g after 4 h. With regard to the small volumes of blood and extracellular fluid in bone, the findings indicate that relatively high concentrations of dicloxacillin can be obtained in bone 4 h after intravenous administration. The amount of antibiotic in bone was considerably higher than in fat and muscle.

HEALING OF EXPERIMENTAL OSTEOTOMIES TREATED WITH EXTERNAL FIXATION

Kari Aalto, Pär Slätis, Erkki Karaharju & Teddy Holmström

Division of Orthopaedic Surgery and Traumatology, Surgical Hospital, Helsinki University Central Hospital, Helsinki, Finland

In rabbits, a transverse osteotomy of the midshaft of the tibia was stabilized with a Rezaian-Karaharju miniframe. The animals were killed at intervals from 1 to 36 weeks. The bones were tested with a torsiometer, and samples of the osteotomy line were analyzed histologically.

All the osteotomies healed within 3 weeks by the formation of periosteal and endosteal callus and by primary bone healing. The biomechanical strength of the bones approached that of the control bones at 3 weeks, reached peak values at 6 weeks, thereafter decreasing below control values. Weakening of the bone

was due to progressive enlarging of the medullary cavity and moderate porotic transformation of the cortical bone.

Good fracture alignment and preserved axial cyclic load on the externally stabilized bone seem to provide favourable conditions for undisturbed fracture healing.

BONE REACTIONS AFTER INTRAMEDULLARY NAILING: RADIOGRAPHIC AND BIOMECHANICAL ASPECTS

ESKO KAARTINEN, TIMO SILVENNOINEN & PEKKA PAAVOLAINEN

Division of Orthopaedic Surgery and Traumatology, Surgical Hospital, Helsinki University Central Hospital, Helsinki, Finland

The effects of stable intramedullary nailing on nonosteotomized and osteotomized rabbit tibiofibular bones were analyzed radiographically and torsiometrically 3–24 weeks after the operation. Marked cortical atrophy was seen both in nonosteotomized and in osteotomized bones at 24 weeks suggesting a stress protective effect of the nail. Periosteal callus formation was moderate. Remodelling of the callus was demonstrated from 9 weeks on. A sleeve of bone surrounding the entire nail was seen in both groups at 12 weeks. The osteotomy line was invisible in all cases at 24 weeks. Resorption was usually observed in the osteotomy area.

The biomechanical strength of the nonosteotomized bones was somewhat lower than that of control bones at 3 and 6 weeks after the operation, obviously due to reaming of the medullary canal. The increase in the strength of the osteotomized bones reached its maximum at 6 weeks, thereafter decreasing markedly up to 24 weeks. The biomechanical strength of the nailed osteotomized bones remained on a subnormal level throughout the experiment.

The results suggest that stable intramedullary nailing has a stress protection effect on bone and its consequences are seen radiographically in the form of marked cortical atrophy, and biomechanically in the form of weakening of the torsional strength of the bone.

QUANTITATIVE MORPHOLOGICAL ASSESSMENT OF PARATHYROID ACTIVITY

HANS-OLOV LARSSON, RONNY LORENTZON & LENNART BOQVIST

Departments of Orthopaedic Surgery and Pathology, University of Umeå, Umeå, Sweden

Despite considerable progress during the last few years concerning the knowledge of the synthesis and release of parathyroid hormone, there are divergent opinions about the ultrastructural characteristics of the active parathyroid cell. The acute (1 h and 6 h) morphologic response of parathyroid glands incubated in media containing low (0.5 mM), normal (1.25 mM) and high (3.0 mM) calcium concentration was investigated by quantitative stereologic methods and image analysis. The cell membrane surface was not significantly changed by high or low calcium indicating unchanged cell membrane tortuosity. The volume density and absolute volume of the endoplasmic reticulum were equal in the three groups of calcium concentration indicating an unchanged synthesis of the precursors of parathyroid hormone during this early stage of stimulation or inhibition. The volume of the Golgi complex and the associated presecretory granules was significantly reduced in suppressed glands compared to stimulated glands. This reduction was most marked for the presecretory granules. The findings indicate that alterations in Golgi complex and presecretory granules occur rapidly in parathyroid glands in response to functional suppression. Acute suppression seems to be associated with an increased degradation, or a decreased formation of hormone-containing presecretory granules.

MOBILITY PATTERNS AFTER EXPERIMENTAL ANKLE LIGAMENT LESIONS

OVE RASMUSSEN & CLAUS KROMANN-ANDERSEN

Laboratory of Biomechanics, Orthopaedic Hospital, Århus, Denmark

In 32 osteoligamentous ankle preparations lesions of the ligaments were produced by forced motion in various directions, and the resultant instability was elucidated by means of tracing mobility patterns. These visualize rotatory mobility in two planes simultaneously, so that either internal and external rotation or adduction and abduction is graphically registered at any degree of dorsal and plantar flexion when the talus is submitted to a given torque – in this investigation 1.5 Nm.

In some cases we found avulsion fractures of the malleoli instead of ligament ruptures, but the ligaments which by traction produced these fractures could easily be identified.

Internal rotation primarily resulted in rupture of the anterior talofibular ligament and of the anterior short fibres of the posterior talofibular ligament.

External rotation predominantly caused rupture of the anterior deep part of the deltoid ligament and, at a later stage, of the deep fibres of the posterior part. The superficial layer was the last one to rupture on external rotation.

Adduction primarily resulted in rupture of the calcaneofibular ligament, often accompanied by rupture of the anterior talofibular ligament when the ankle was plantar flexed, and when dorsiflexed of the posterior talofibular ligament.

Abduction first caused rupture of the superficial part of the deltoid ligament.

In no case could we produce rupture of the anterior and posterior tibiofibular ligaments or of the syndesmosis. This indicates that these structures will only rupture during weight bearing.

Lesions of the anterior and posterior talofibular ligaments may be found together with an intact calcaneofibular ligament.

As in external rotation traumas the superficial part of the deltoid ligament is the last one to rupture, the finding at surgical exploration of an intact superficial ligament does not ascertain that the deep ligamentous structures are undamaged.

FUNCTIONAL AND TOMOGRAPHIC ANATOMY OF THE SPINE STUDIED BY CRYOMICROTOMY

W. Rauschning, K. Bergström, S. Olerud, P. Pech & B. Sahlstedt

University Hospital, Uppsala, Sweden

To elucidate the undistorted functional anatomy of the neurovascular spinal soft tissues in relation to the supporting skeleton, intact fresh cadaver spines were placed in various functional positions of flexion, extension, rotation, also including axial loading, and were deep frozen *in situ*. Following examination of the specimens by conventional or computed tomography, the undecalcified specimens were serially sectioned through on a heavy-duty cryomicrotome.

Macrophotography of the surface of the specimen at increments following the feed of the tomograph rendered anatomical images in natural colours and with high resolution of anatomical details.

In certain postures narrowing of the spinal canal due to bulging of the intervertebral disc and the ligamentum flavum were observed as well as encroachment of osteoarthritic facet joints upon the nerve roots in the lateral canals and intervertebral foramina.

The exact coincidence of the sectional anatomy with the tomograms is valuable in the interpretation of tomograms and CT scans. This study also emphasizes the need for a functional radiographic assessment of spinal disorders.

EXPERIMENTAL EPIPHYSEAL DISTRACTION IN SHEEP AND PIGS

Jari Peltonen, Erkki Karaharju, Ilkka Alitalo & Harri Heliö

Department of Orthopaedics and Traumatology, University Central Hospital and College of Veterinary Medicine Department of Surgery, Helsinki, Finland

A transepiphyseal distraction was applied to 17 pigs and 6 sheep of growing age. A special external fixation distractor device was used. By gradual distraction (1–1.5 mm/day), a fracture between the epiphysis and metaphysis of the distal radius was induced.

The time of distraction varied from 2 to 3 weeks. The lengthening of the bone was measured from the radiographs. The limb lengthening varied from 3 to 20 mm. After the distraction was completed, the fixator was left in place in order to stabilize the fracture between the epiphysis and metaphysis. The consolidation of the fracture was observed radiographically by weekly X-ray pictures.

In pigs the separation area between the epiphysis and metaphysis healed rapidly. 2–3 weeks after the distraction was finished, a marked callus formation was noticed. In sheep the consolidation developed more slowly. The first signs of ossification were observed radiologically about 2 weeks after the distraction was completed. Thereafter the ossification developed gradually towards the center of the zone of separation.

Two weeks before sacrifice, the animals were given 50 mg/kg tetracycline i.m. The epiphyseal and metaphyseal areas were photographed in ultra-violet light and examined histologically.

As complications, a moderate infection rate occurred in pigs, which in some cases limited the distraction time. However, this was no problem in sheep, which tolerated the distractor apparatus for several weeks without any infection.

EXPERIMENTAL STUDY OF CONGENITAL DISLOCATION OF THE HIP

Stefan Asplund, Åke Hjelmstedt & Wolfgang Rauschning

Department of Orthopaedic Surgery, University Hospital, Uppsala, Sweden

The aims of these biomechanical experiments have been to evolve models for provoking hip dysplasias and dislocations in young rabbits and methods for visualization and measurement of the deformations.

In an *in vivo* series the legs of 7–12 days old rabbits were immobilized with straight knees and flexed hips for 3 h. Dislocations of varying degree occurred in 90% if the hips were kept in inward rotation or neutral position and in 50% if in outward rotation. At the end of the experiment the animals were killed and immediately deep frozen in liquid nitrogen. The hips were then examined by serial cryosectioning. Measurements of the dislocations were made on photographs of the sections.

In vitro experiments were performed on leg-pelvis specimens of 7–11 days old rabbits in a special device where a constant, submaximal load of 0.3–4.1 N was applied on femur for 3 hours. The femur was displaced rapidly at the beginning of the test, but the rate of displacement then progressively decreased. At the end of the experiment the specimens were frozen to −20°C and studied by serial cryosectioning.

The degree of dislocation varied in both series but

pairing samples of about the same deformation allowed comparison. The study showed that the *in vitro* method brought about the same kind of dysplasia and dislocation as in the *in vivo* method. In the *in vitro* method, however, the magnitude and direction of the deforming force is known which makes this method superior to the *in vivo* method in short time experiments.

Our study confirms earlier results of *in vitro* experiments on human hips, i.e. (1) that hip dislocations can be provoked by fairly moderate forces, (2) that the degree of deformation depends not only on the force used but also on the duration of loading, (3) that no macroscopic damage to capsule or ligaments was observed despite the dislocation, (4) that the provoked dysplasia resembled that observed in CDH, and (5) that our techniques have proved satisfactory for provoking and examining dysplasia of the hip.

LUMBO-SACRAL AGENESIS (TYPE IV RENSHAW)

T. Hierton, G. Holmgren & L. Marsh

University Hospital, Uppsala, Een & Holmgren Orthopaedic Co., Uppsala, Sweden

POSTER-review of treatment in a patient followed from the age of 5 to 23 years.

Clinical findings: typical Buddha-like torso, gibbus, spinopelvic instability, marked shortening in sitting compared to lying position, contractures of both hips, 90° flexion contractures of both knees with webbing, fixed clubfeet without motor function and neurogenic bladder, ability to creep – but not to stand, not to walk.

Radiological findings: aplasia of sacrum and lumbar spine below L 2. Narrow pelvis. Right hip dislocated.

Several difficulties had to be overcome to achieve an upright stance, a limited walking capacity as well as a comfortable sitting with the orthotic-prosthetic equipment on. The prosthetic-orthotic management, training and surgical procedures were performed in graduated stages according to dominating problems and goals set up. (T. Hierton & G. Holmgren: Agenesis of lumbosacral vertebrae. Surgical and prosthetic management, *Prosthet. Int.* **3**: 24–28, 1967.) The flexion necessary for sitting takes place between the spine and the pelvis. In 1982 the orthotic-prosthetic connection was equipped with a pair of joints, which the patient manually unlocks – when taking a sitting position – to compensate for the telescoping of her torso.

A 16-mm film is available showing the stages of management.

EXPERIMENTAL ARTHRITIS OF THE JUVENILE KNEE

C. Bünger, J. Hjermind, S. Harving & J. C. Djurhuus

Orthopedic Hospital and Institute of Experimental Clinical Research, University of Aarhus, Denmark

An animal model for the study of hemodynamics in juvenile arthritis is presented. Unilateral arthritis was induced by weekly instillation of 2 ml 1% solution of the mucopolysaccharide Carraghenin ® into one knee of 8 week old puppies for 3 months.

The arthritis was documented on serial radiographs; histological investigation of synovial membranes; histomorphometry of epiphyseal bone.

A multichannel constant perfusion system was used for simultaneous measurements of intraosseous and intra-articular pressures. Tissue blood flow investigation was performed by tracer-microspheres technique with reference sampling using 15 microspheres 4.5 × 10^6/batch. Central hemodynamic control included cardiac output, mean arterial pressure, core temperature, blood gasses and central venous pressure.

THE INFLUENCE OF THE HIP JOINT POSITION ON THE INTRAOSSEOUS PRESSURES IN THE JUXTAARTICULAR BONES

U. Lucht, B. Krebs, P. K. Paulsen & J. C. Djurhuus

Department of Orthopaedic Surgery, Århus Municipal Hospital and Institute of Experimental Clinical Research, University of Aarhus, Århus, Denmark

In six mongrel dogs (11 hips) the intraosseous pressure was measured in the femoral head and acetabulum with the hip joint in different positions. The start position for the measurements was 90° flexion, where the pressure level was low and stable.

In the femoral head a significant pressure increase ($P < 0.01$) occurred in maximum extension, maximum flexion, maximum adduction, 90° external rotation, 45° internal rotation and maximum internal rotation. The pressure in the acetabulum rose significantly ($P < 0.01$) in maximum flexion, 45° internal rotation and maximum internal rotation while the pressure increase was significant at the 5% level at maximum extension and maximum adduction.

The pressure increase is suggested to be caused by changed haemodynamic conditions in the juxtaarticular bones provoked by an inhibition of the venous drainage from the bones. A complete obstruction of the venous drainage was not observed as the intraosseous pressure did not reach the level of the arterial pressure.

RADIOLOGIC ASSESSMENT OF JOINT CHANGES IN PATIENTS WITH HEMOPHILIA

JULIUS SOREFF* & GABRIELLA AXDORPH**

*Dept. of Orthopaedic Surgery and **Dept of Diagnostic Radiology, Karolinska Hospital, Stockholm, Sweden

The criteria for assessment of the degree of joint involvement in patients with hemophilia should always include the radiologic changes resulting from chronic joint bleeding. The attempts at grading hemophilic arthropathy presented in the literature are based on a mixture of clinical and radiologic signs or on a complicated score system which is timeconsuming and laborious.

The grading system used by the authors for some time past in assessing radiographic changes in hemophilic arthropathy has proved to be both effectual and practical and to facilitate clinical evaluation as well as communications between radiologist and clinician. The radiologic assessment is based on the following criteria:

Grade 1: Increased density of the synovia and capsule associated with widening of the epiphysis and/or erosion of the cartilage at the joint margin.

Grade 2: Narrowing of the joint space, increased trabeculation or irregularity of the subchondral bone, and subchondral cysts. Slight signs of joint deformity such as varus or valgus angulation. Slight joint incongruity.

Grade 3: Marked cartilage destruction, marked deformities such as varus or valgus angulation or subluxation, marked rotational deformity and joint incongruity.

Grade 4: Advanced joint destruction with severe deformities, subchondral bone destruction, and total destruction of the cartilage.

The system is recommended for general use.

AVASCULAR NECROSIS OF THE FEMORAL HEAD IN RENAL RECIPIENTS

JUHANI HAAJANEN, ERKKI KARAHARJU & JUHANI AHONEN

University Central Hospital, Helsinki, Finland

The assessment of 1011 renal transplantations carried out on 860 patients during the period from January 1966 to December 1980 in the University Central Hospital Helsinki, revealed avascular necrosis of the femoral head in 18 patients (2.1 per cent). 3–18 months after renal allotransplantation 18 recipients (11 male, 7 female) developed avascular necrosis in 26 femoral heads: 8 bilateral, 10 unilateral.

13 hips (50 per cent) were treated nonoperatively by avoidance of weight-bearing on the affected joint. 13 hips were treated operatively: one with intertrochanteric osteotomy, 7 underwent femoral head arthroplasty (Thompson) as primary procedure, two of which had to be changed to total hip replacement because of unendurable pains in the hip due to migration of the prosthesis into the acetabulum. In 5 hips total hip replacement was performed as primary surgical procedure.

The observation period after renal transplantation ranged from 1.0 to 14 years with a mean of 7.5 years. During this period three patients with avascular necrosis of the femoral head died. Out of the surviving 15 patients, three became fully painfree, six felt occasionally slight pains in the hip, five declared moderate discomfort. One patient only, treated conservatively, complained about severe pain in the hip during walking and in this particular case an operation may be necessary. Eight recipients of 18 with aseptic necrosis of the femoral head experienced discomfort and showed radiological signs of aseptic necrosis also in other joints, such as the knee, shoulder and ankle. Eleven recipients (75 per cent) considered themselves still capable of work.

In our opinion the conservative treatment involving avoidance of weight-bearing on the affected hipjoint may be recommended as primary treatment. In cases of severe disability, however, total hip replacement should be the treatment of choice.

REOPERATION OF TOTAL HIP ARTHROPLASTIES. A REVIEW OF 21 CASES

GUSTAF NEANDER

Department of Orthopaedic Surgery, Danderyds Hospital, Stockholm, Sweden

During the period 1978–80 we performed 481 total hip arthroplasties at the Department of Orthopaedic Surgery, Danderyds Hospital. Of these 21 were reoperations after previous total hip arthroplasties. All new prostheses were at reoperation fixed with gentamicin containing cement. The patients were followed for 1–4 years after reoperation.

The indication for reoperation was in eight cases deep infection, six cases mechanical loosening without infection, five cases femoral stem fracture and in two cases recurrent dislocation.

The mean interval between the primary operation and the reoperation was: in the cases with infection 3.8 years (range 1–9 years); mechanical loosening 5.1 years (1–11 years); femoral stem fracture 3.6 years (2–5 years); and recurrent dislocation 0.5 years (2–7 months).

The results, so far, from these reoperations are as follows: In six of the eight cases reoperated due to infection there is no sign of infection, the other two are still infected. All those with mechanical loosening at reoperation are without problems. Of the five cases with femoral stem fracture one has fractured again 1.5 years after reoperation, the other four are without problems. One of the two cases with recurrent dislocation has been infected, causing a second operation after which there is no sign of infection.

THE COLD FOOT SYMPTOM IN SCIATICA: A THERMOGRAPHIC STUDY

R. V. LINDHOLM, T. MYLLYLÄ & J. SARVARANTA

Department of Physiology and Department of Surgery, University of Oulu, Oulu, Finland

Sciatica is known to be frequently associated with complaints of "coldness" of the foot. Basically, the temperature of the skin reflects the flow regulated by the neuroeffectors of the small arteries and arterioles. The aim of this study has been to elucidate the vasomotor situation in the lower extremities in association with lumbar root syndromes.

Thermograms on polaroid films were obtained by the use of an AGA Thermovision Mode 680 infrared system device.

174 patients with sciatica were subdivided into four groups with increasing certainty of mechanical spinal nerve root compression according to the clinical, radiological and surgical findings.

The results revealed a significant correlation between decreased temperature of the distal part of the affected limb and the probability of spinal nerve root compression. The highest order of preponderance for "coldness' was related to the group of patients whose symptoms were confirmed surgically as those of a herniated disc. The non-dermatomic patterns of the temperature chart do not permit any conclusions regarding the level of the disc herniation. The follow-up thermograms of 30 patients, on the average 29.4 months postoperatively showed correlation between normalization of the temperature and the relief of symptoms.

As an objective manifestation of vasomotor dysfunction the findings add motivation to the subsequent search for its pathogenetic reasons. Hypothetically the "cold foot" symptom in sciatica may be a case of derangement of the anterograde axoplasmic transport of vasodilatatory messages to the smooth muscular layers of the skin vessels concerned with vasoregulation.

COMPUTED TOMOGRAPHY IN MALIGNANT BONE TUMOURS

ERKKI M. LAASONEN & ERKKI O. KARAHARJU

Department of Orthopaedics and Traumatology, Helsinki University Central Hospital, Helsinki, Finland

Suspected malignancies of the bone were studied with plain radiographs, angiography and computed tomography (CT) (Tomoscan 300/Philips). The strategy used in CT is presented, as well as preliminary results of 29 patients.

Slices of 6 or 9 mm were used and the healthy side was included for comparison, except in cases of upper extremity tumours, in which an enlargement technique of the tumour side was used. After a contrast injection of 100 cc, the three or four most informative slices were rescanned within 2–5 min.

Main interest was attached to the intraosseous extension of the tumour, to guide the biopsy site and to help in the treatment plans. The soft-tissue extension and invasion of vital adjacent structures proved to be very significant in selected cases. The CT has an important rôle in defining the histological diagnosis, especially when the relative attenuation values very soon after contrast injection are included into the analysis.

PRIMARY OPERATIVE TREATMENT OF CLUBFOOT

SOINI RYÖPPY & HEIKKI SAIRANEN

Department of Surgery, University Children's Hospital, Helsinki, Finland

Operative reduction as the primary treatment for resistant clubfoot was adopted as routine treatment at this clinic in 1959; the method being revised in 1974.

The material consists of 64 successive patients with 89 rigid clubfeet treated between 1974–79. A tailor-made soft tissue operation without any preceding conservative treatment was performed as soon as other postnatal problems were excluded; mean age at operation being 12 days. The position was maintained by plaster and splints until walking age. The patients were examined clinically and radiologically 1.1–7 years post-operatively. A computer analysis of the data was made.

The criteria for clinical evaluation were those of Main et al. (*J. Bone Joint Surg.* **59**-B, 337, 1977) while for radiological evaluation, those of Main & Crider (*J. Bone Joint Surg.* **60**-B, 536, 1978) were used.

The clinical result at follow-up examination was excellent in 60 (67%), good in 23 (26%) and poor in 6 feet (7%). Plantar angle was normal in 86 feet, talocalcaneal angle in 30 feet and posterior displacement of the fibula in 73 feet.

It is concluded that these results are better than those of the previously used methods. The method cannot, however, be recommended for general use without reservation. The absolute implications for good results are safe neonatal anaesthesia and experience in surgery and postoperative immobilisation of neonates.

ROENTGEN STEREOPHOTOGRAMMETRIC ANALYSIS OF LOOSENING AND MIGRATION OF HIP PROSTHESIS

LARS INGVAR HANSSON, BENGT MJÖBERG & GÖRAN SELVIK

Departments of Orthopaedic Surgery and Anatomy, University of Lund, Sweden

Pain following total hip arthroplasty presents a diagnostic problem. Conventional radiography provides lit-

tle information about loosening and migration. Roentgen stereophotogrammetric analysis (RSA) is able to show loosening and migration with great accuracy.

Material: RSA has been performed on 19 cases with osteoarthrosis of the hip with 22 operated hips according to Charnley, Brunswik, Lubinus and Christiansen during 1970–81. There was pain in weight-bearing in 18 hips, pain in rest in 1 hip and 3 hips were symptomfree.

Method: Under local anaesthesia 3–5 tantalum balls (diameter 0.8 mm) were implanted into os ilium and trochanter major respectively. The roentgen stereophotogrammetric investigation was made with the hip weight-bearing and unloaded. The movements between the pelvis and the acetabular socket, the head of the femoral prosthesis and the femur were calculated. The error of the method was estimated to 0.3–0.5 mm.

Results: Out of 3 hips without symptoms there was migration of the acetabular socket in 1 hip and loosening of the femoral prosthesis in 1 hip.

Out of 19 hips with pain there was loosening of acetabular socket in 6 hips and migration of acetabular socket in 1 hip. There was neither loosening nor migration of the acetabular socket in 7 hips.

Loosening of the femoral prosthesis was found in 6 hips. There was migration of femoral prosthesis in 2 hips but neither loosening nor migration of the femoral prosthesis in 9 hips.

In conclusion, RSA is a valuable method to register loosening and migration following total hip arthroplasty.

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

GUNNAR ORDEBERG, LARS INGVAR HANSSON & STAFFAN SANDSTRÖM

Departments of Orthopaedic Surgery and Diagnostic Radiology, Lund University Hospital, Lund, Sweden

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

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

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

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

PROXIMAL HUMERUS RESECTED FOR OSTEOSARCOMA AND REPLACED BY PROXIMAL HALF OF FIBULA WITH MICROVASCULAR ANASTOMOSES

BJÖRN M. PERSSON, JAN HOLMBERG, LARS KOLMERT, ANDERS RYDHOLM, JAN WIESLANDER & MAGNUS ÅBERG

Dept. of Orthopaedic Surgery, Lund University Hospital, Lund and Depts of Plastic Surgery and Hand Surgery, Malmö General Hospital, Malmö, Sweden

Autotransplantation of fibula to replace upper humerus is a well known method and in replacement of distal radius even microvascular technique has been reported (Pho 1981). To move fibula with its head is more laborious and seems not to have been shown for upper humerus with vascular anastomoses. During the last year in Lund we have used upper fibula after humeral resections in four patients with sarcoma. In the last case, an 18-year-old man with a low grade osteosarcoma, 18 cm of upper fibula was autotransplanted with microvascular technique in order to promote healing and to reduce resorption and fracture tendency. Radiograms and scintigrams will be shown.

TRAUMATIC ATLANTOAXIAL LUXATION WITH A DISLOCATED RUPTURED CRUCIFORM LIGAMENT. FUSION BY ARTHRODESIS OF BOTH LATERAL ATLANTOAXIAL JOINTS

BO LEVANDER

Department of Orthopaedic Surgery, Eksjö-Nässjö Hospital, Eksjö, Sweden

A case report of an unreducible C1–C2 dislocation with cord compression. The patient was operated upon by the extra-pharyngeal approach. The surgical procedure is further described in the paper.

A preoperative assessment of the radiological, EMG and evoked somatosensory potentials was made and a similar series of assessments were carried out after the operation.