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Experimental orthopedics

Distractional bone healing

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Studies concerning osteogenesis as a result of distraction are limited. It has been shown that new bone can be produced by closed epiphyseal distraction or by gradual distraction of osteomized bone ends. It is obvious that the role of collagen is essential in distractional bone healing.

In the present study the mode of bone formation in distractional bone healing was elucidated. Bone distraction by external fixation was performed on growing sheep.

Collagen analysis of the cyanogen bromide peptides on SDS-polyacrylamide gel and histologic studies revealed that prior to bone formation, collagen is formed in the distraction area during the first phase (0–3 weeks) of distractional bone healing. After 3 weeks, most of the organic matrix of the distraction area was composed of type I collagen. The collagen bundles were organized according to the direction of distraction. In the second phase (from 3 weeks on), mineralization of the distraction area started from the osteotomized bone ends. As a result of distraction qualitatively solid bone was formed according to the collagen template.

Distractional bone healing differs from the mechanism of osteogenesis by callus formation or direct bone healing. Collagen organized according to the direction of distraction forms a template for the new bone that is formed as a result of distraction.

Formation of a "double epiphysis" as a result of epiphyseal distraction

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In the present study, epiphyseal distraction of the distal radius was performed on 18 growing sheep. Distraction was continued for 2–3 weeks, and external fixation was removed at the time of consolidation. The animals were given oxytetracycline (OTC) intramuscularly and were killed 4, 5, 6, and 7 weeks, and 2, 3, 4, and 5 months postoperatively. The bone specimens were examined histologically and by microradiography and fluorescence microscopy.

Histologic and OTC studies revealed that in most cases the neometaphysis was composed of normal metaphyseal trabecular bone. In some cases, separate groups of chondrocytes were isolated into the metaphyseal area after the distraction procedure. In 2 cases, a "double epiphysis" was formed in the metaphyseal area. After consolidation of the distraction gap, this zone of chondrocytes passed transversally through the distracted segment and was producing new bone by enchondral ossification in two axial directions 20 weeks after distraction.

Formation of a "double epiphysis" as a result of distraction has not been reported earlier. Two explanations for this phenomenon are available: Uneven separation of the epiphysis could cause migration of the proliferative chondrocytes into the metaphyseal area, and the other source of the chondrocytes could be the perichondrial area, which in some cases was noted to form transversal inclusions towards the distraction area.

Scanning electron microscopy of the tenotomized muscles in rat

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The effect of Achilles tenotomy on rat's calf muscles was studied 1, 2, and 3 weeks after the operation by scanning electron microscope (SEM).

One week after tenotomy a pronounced increase in endomysial, as well as perimysial, connective tissue was observed. The increase was even more pronounced after 2 and 3 weeks. In individual muscle cells, hypercontracted segments and longitudinal splitting could be seen. The normal muscle fiber architecture was destroyed: the muscle cells tended to reverse 360° along their longitudinal axis (spiral formation) obviously after the violent loss of muscle tension following tenotomy.

According to this SEM analysis, Achilles tenotomy had severe deleterious effects on rat calf muscles and their microscopic organization.

Fractures and ligament injuries

Pelvic fractures treated in hospitals in Finland in 1985.

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The epidemiology of pelvic fractures in Finland during 1985 was investigated. All the patients admitted to Finnish acute hospitals for primary treatment of pelvic fractures were selected from the National Board of Health statistics. In 1985, 825 pelvic fractures were treated in hospitals. The female/male ratio was 1.7:1. The mean stay in the hospital was 22 days.

Men under 50 years of age had more pelvic fractures than women of the same age; but in older age-groups, the proportion of females was greater. The age-specific incidence increased with age in both sexes and was greater for women than men at all ages after 65, reaching a maximum incidence of 220 per 100,000 person years in women 80 years or older. About 66 percent of the patients were over 50 years old.

Proximal femoral fractures (PFF) in central Finland, 1982–1986

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Ten percent of the surgical capacity and 7 percent of surgical beds are occupied by PFF in Finland. The incidence of PFF has increased in central Finland from 22 per million inhabitants in 1970 to 90 per million inhabitants in 1986, which is about a 9 percent annual increase.

Totally, 983 PFF were registered in the Medical District of Central Finland (about 250,000 inhabitants) in the years 1982–86.

Seventy-seven percent of the material was female. The mean age was 76 years (females 78, males 73). Two percent of the patients were under 50 , 3 percent between 50 and 60, and 95 percent over 60 years of age. The mean age increased from 74 years to 77 years during the study period. The ratio of cervical to trochanteric fractures changed from 2.0 in 1982 to 1.7 in 1986. Fifteen percent of the fractures were sustained outdoors, 33 percent in institutions, 39 percent at home, and 13 percent elsewhere. The number of secondary operations of PFF decreased from 5.2 percent (1982) and 7.2 percent (1983) to 1.3 percent (1985) and 2.0 percent (1986). During the same time a change of operative policy has taken place from osteosynthesis to hemiprosthesis in most cervical fractures.

An unexpected difference in the incidence of PFF was found between various communities of our medical district.

Infections of open fractures

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Eighty-five open fractures were treated in 1984. Prophylactic intravenous penicillin was given to 72 patients, whereas 9 patients received intravenous cephalosporins and 2 patients received peroral erythromycin. Two patients received no antibiotics.

The total infection rate was 19 percent. For Grades 1 and 2 fractures the infection rate was 7 percent and for Grade 3 fractures 50 percent. Infection occurred in 18 percent of the penicillin-treated patients and in 11 percent of the cephalosporin-treated patients ($P > 0.05$). Patients treated with cephalosporins had more often Grade 3 fractures (67 percent) than patients treated with penicillin (25 percent, $P < 0.001$). Infection occurred in both of the 2 patients that received no prophylactic antibiotic treatment.

A positive initial wound culture, large soft-tissue injury, considerable blood loss, vascular injury, and prolonged operation increased significantly the infection risk, whereas multiple or pathologic fractures, chronic heart failure, diabetes, alcoholism, or minor delays in initiating antibiotic treatment or operation did not increase the risk of infection. Intravenous penicillin was found to be ineffective against the common organisms that cause infections in open fractures, because 65 percent of organisms of the initial wound culture and 94 percent of organisms cultured during infection were resistant to penicillin. For the second generation cephalosporins, the respective figures were 20 and 17 percent.

Biodegradable fixation in the treatment of intra-articular fractures in the elbow joint in adults

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Internal fixation of displaced fractures of the olecranon, humeral capitellum, and radial head is problematic. Migration and subcutaneous prominence of the pins cause discomfort for the patient. In order to avoid these disadvantages, biodegradable fracture fixation implants were developed.

Twenty-six adult patients with intraarticular fractures were treated using polydioxanon- (PDS) coated polyglycolide (PGA) cylindric rods. There were 12 patients with a fracture of the radial head, 10 with a fracture of the olecranon, three with a fracture of the humeral capitellum, and 1 with a fracture of the medial humeral epicondyle. The sizes of the implants were 2.0 and 3.2 mm in diameter and 20–70 mm in length.

The reduction could be maintained in all the cases except in one fracture of the olecranon, in which the fixation failed and a redisplacement occurred. No infections were seen, but a sinus formation of the wound without bacterial growth were observed in 4 patients. The functional result after a follow-up time of 6 months was satisfactory in all the patients.

In conclusion, our impression is that biodegradable fixation can be used in the treatment of displaced intraarticular fractures of the elbow joint.

Healing of epiphyseal fracture after fixation with metallic pins or polyglycolic acid (PGA) pins: An experimental study on growing rabbits.

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Physeal separation of the distal femoral epiphysis was made on the right side of 36, 5-week-old rabbits. After accurate reduction, the fixation of a physeal fracture was made with two transcondylar Kirschner wires or two 1-mm-diameter PGA pins. The follow-up times were 3, 6,12, 24, and 28 weeks. The distal femoral growth plates of both femurs were analyzed by radiographic, microradiographic, histologic, and oxytetracycline fluorescence studies.

The fixation of physeal fracture with Kirschner wires or PGA pins did not cause any growth retardation in growing rabbits. Two PGA pins provided sufficient stability for uneventful healing of a physeal fracture in growing rabbits.

Arthrosis in the unstable knee

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The aim of the study was to examine the relationship between age, overweight, sex, and dynamic and static instability, and the development of posttraumatic arthrosis of the knee after ligamentous injury.

A total of 185 patients with a conservatively treated grade II or III knee ligament injury were reexamined 8 ± 3 years after the injury. The following variables were measured: age, sex, weight-height ratio, dynamic knee instability (Cybex II knee strength dynamometer), static knee instability, and the amount of posttraumatic arthrosis. Standardized clinical, radiographic and knee-strength scoring systems were used.

The radiographic scores did not correlate significantly with patient age, weight-height ratio, or sex. However, they had a significant positive correlation with both dynamic ($r = 0.73$) and static ($r = 0.65$) knee stability.

In conclusion, knee stability after ligamentous injury is the most important factor in prevention of posttraumatic arthrosis. The patient's age, sex, and weight are only of secondary importance.

Outcome of operative treatment of old sternoclavicular dislocation

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Twelve patients were operated on after unsuccessful conservative treatment for complete dislocation of the sternoclavicular joint. There were 8 females and 4 males, and their average age was 29 (13–54) years. The average time between trauma and the operation was 1.5 years. Three operative methods were used: stabilization

by fascial loops, reconstructions with a tendon graft and resection of the sternal end of the clavicle.

The following evaluation score scale was used: subjective result (0–2), strength of abduction (0–2), pain (0–3), dislocation of the medial end of the clavicle (0–2), and the range of the movement of the shoulder joint (0–3). Scores of 10–12 were considered a good result, scores of 7–9 a fair, result, and scores of 6 or less a poor result.

The result was good in 3 patients, 2 of whom were treated with a tendon graft and 1 with fascial loops. The result was fair in 5 patients. Four patients treated by resection of the medial end of the clavicle all showed poor results.

In our opinion resection of the sternal end of the clavicle should not be used in old traumatic dislocation.

Spine

Bracing in adolescent idiopathic scoliosis, results after 2 years' follow-up

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Bracing has been generally accepted in cases where the Cobb angle is between 25° and 45°. The real advantage of the conservative treatment in idiopathic scoliosis is not fully known. Although the primary correction of the curve is often good, there is a tendency for the correction to be lost later on.

In the present study, the Boston brace was used in 132 patients (120 girls and 12 boys) during the years 1979–83. The mean age of the patients when starting the treatment was 15 years. Distribution of the curve patterns was as follows: thoracic 37 percent, thoracolumbar 16 percent, lumbar 17 percent, and double major curves 30 percent of all the curves. Duration of the treatment was 1.4 years and the follow-up time averaged 1.7 years.

The best initial correction and also the best final result was seen in thoracolumbar curves. The average final correction of the whole material was 2°. Progression of the curve more than 5° after the treatment was noted in 14 patients. Three patients were operated on because of progression of the curve. The results of 17 patients with part-time bracing of 12–16 hours a day did not differ statistically from the results of the remainder with a full-time bracing program of 23 hours a day.

We concluded that by bracing, progression of the scoliotic curve can be prevented. Prospective studies are needed to determine whether part-time bracing is comparable with the full-time bracing program.

Lumbar disc degeneration and narrow spinal canal in CT

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CT scanning was carried out in 100 patients with low back pain. A narrow central canal was found in 9 patients. Three interspaces from L_3 to S_1 were studied. In 5 (23/27 discs) the midsagittal diameters of three interspaces were measured and were found to be less than 12 mm. In 4 cases, the $L_{3/4}$ and $L_{4/5}$ levels were below 12 mm and $L_{5/S1}$ above it. Of the levels measured between 10 and 12 mm, 3 out of 9 in $L_{3/4}$, 2 of 9 in $L_{4/5}$, and 2 of 5 in $L_{5/S1}$ could not be deemed narrow by the size of the dural sac and the amount of epidural fat. Degenerative changes causing central and lateral canal stenosis were much more common. A narrow central canal seems to complicate spinal degeneration especially at the $L_{3/4}$ and $L_{4/5}$ levels, whereas it is rare at $L_{5/S1}$. Loss of surplus fat seems a more relevant measure of adaptation to lack of space rather than absolute diametric measures.

Rheumatoid arthritis

Neer arthroplasty of the shoulder in rheumatoid arthritis

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Thirty-eight patients, 32 with seropositive and 6 with seronegative rheumatoid arthritis, underwent Neer II arthroplasty, 3 of them bilaterally. The age at the time of surgery varied from 23 to 68 years.

After an average follow-up time of 2 years, pain relief was excellent, as 40 shoulders were asymptomatic or only occasional slight pain was experienced. Mobility increased in all the patients. Despite restricted mobility and impaired muscle strength, ability to perform some daily activities was reasonable in 21 shoulders, as they scored 16 to 20 points (maximum 20 points). Overall evaluation showed an excellent or satisfactory result in 15 shoulders (scoring from 80 to 100 points, maximum 100 points). Sixteen shoulders were acceptable, scoring from 70 to 79 points, and 10 shoulders were evaluated to be unacceptable. The most frequent radiographic finding at follow-up was proximal subluxation of the humerus: moderate in 13 and severe in 4 cases. Incom-

plete radiolucent lines were present around the glenoid component in 32 percent and around the humeral component in 5 percent.

Early results of cementless total hip replacement in rheumatoid arthritis and related conditions

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Total hip replacement in RA can be problematic because of the acetabular protrusion and general osteoporosis. Therefore, cement fixation of the endoprosthesis in RA has been advocated.

In the present study, preliminary results of 36 cementless total hip replacements are presented. During the years 1984–86, 27 patients (8 men and 19 women) underwent total hip arthroplasty. A bilateral operation was performed on 9 patients. The mean age of the patients was 45 years. Nineteen patients had been under prolonged systemic corticosteroid therapy. The Lord endoprosthesis was used in 30 hips, Biomet in four hips, and PCA in two hips. In all the cases the primary stability of the components was considered adequate. Cancellous bone grafts were used in 26 cases. The mean follow-up time was 13 months. In preoperative radiographic staging according to Larsen, seven hips were evaluated to be Grade V, 16 hips to Grade IV, and 13 hips to Grade III. Acetabular protrusion was noted in 20 hips.

In postoperative evaluation a marked improvement was noted in all the cases. Radiographically, there were no loosenings. In 1 case a 1–2 mm radiolucent line around the femoral stem was noted. However, this patient was asymptomatic. There were two postoperative luxations. Two peroperative fractures of the greater trochanter healed normally.

In conclusion, the cementless total hip endoprosthesis, combined with cancellous bone grafting, is a suitable alternative for the replacement of the rheumatoid hip, especially in the younger patient.

Gold(I) compounds and latent human leukocyte collagenase and gelatinase

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Our results indicate that gold(I) thioglucose and gold(I) sodium thiomalate are potent activators of latent human leukocyte collagenase. No activation of latent collagenase by auranofin was noted. The physicochemical properties of the studied gold(I) compounds in solution may explain their effects on latent human leukocyte collagenase. The latent human leukocyte collagenase can be activated by organomercurial compounds evidently through the action on essential sulfhydryl group(s) of latent collagenase. The gold of gold(I) thioglucose and gold(I) sodium thiomalate can react with S/SH-groups(s) in solution, whereas the gold of auranofin is probably not accessible to the SH-groups in solution. Thus, the sulfhydryl group(s) of latent collagenase may be attacked by gold (I) thioglucose and gold(I) sodium thiomalate, but not by auranofin. Activation of the purified latent 70 kD human leukocyte collagenase was not associated with changes in apparent molecular weight of latent enzyme; in this respect the activation of latent enzyme of these gold(I) compounds resembles that obtained by organomercurials and may suggest involvement of conformational change(s) of the enzyme molecule in the activation process. That gelatinase was not activated by gold (I) compounds, although latent leukocyte gelatinase can be activated with organomercurials and trypsin, may indicate that the effect of gold on leukocyte collagenase is specific.

The role of ligamentous laxity in the natural history of the rheumatoid anterior atlantoaxial subluxation

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Aggressive inflammation is the necessary prerequisite for the genesis of rheumatoid subluxations in the cervical spine. Inflammatory cells secrete mediators of inflammation that destroy the spinal ligaments. The synovial joint between the anterior arch of the atlas and odontoid process and the synovial-lined bursa behind the odontoid process in front of the transverse, alar, and apical ligaments are focuses of inflammation and cause destruction of these ligaments.

While analyzing 210 patients who were treated conservatively for rheumatoid cervical spinal disorders, we found 14 patients with anterior atlantoaxial subluxation without erosion of the atlantoaxial facet joints or the odontoid process. The results of our analysis give evidence that rheumatoid ligamentous laxity without erosion of facet joint surfaces may cause anterior atlantoaxial subluxation.