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The development of a numerical model of the conduction of force in the meniscus-femur-tibia complex

A. Sauren, G. Schreppers and A. Huson

Technical University Eindhoven, Eindhoven,
the Netherlands

The study presented concerns an investigation of the conduction of load in the knee joint via contact between tibia and femur. A distinction is to be made between the direct contact between the articular surfaces and the indirect contact via the menisci and the articular fluid. In a simple rotation symmetrical schematization the femoral component is represented by a cylinder with a spherical base, the tibial component by a cylinder with a concave, convex or flat top and the meniscus by an exactly fitting ring between the components. In the model, frictionless relative movement is possible between the two articular surfaces and between the meniscus and the articular surfaces.

The schematization is worked out via the finite element method. In models without articular cartilage, the geometry of the tibial plateau was found distinctly to influence the fraction of the total load that was conducted via the meniscus. As soon as the articular surfaces were fitted with a soft layer of cartilage, this dependence on the tibial geometry disappeared virtually completely. In addition, the contribution of the meniscus in the conduction of the load increased considerably. This contribution increased further after increase of the rigidity of the meniscus in the direction of the circumference.

Finally, simulations were carried out with a model in which the articular cavity was filled with fluid and in which cartilage and meniscus were schematized as a solid/fluid mixture. During performance of stepwise change of the load, the fluid was found to conduct most of the load in the first instance, while in time this role was taken over by the meniscus.

Changes of the lumbar intervertebral disk under the influence of the nonautomatized percutaneous discectomy—a biomechanical study

W. H. M. Castro and P. Brinckmann

Department of Orthopedics, University Clinic, Münster, GFR

Introduction: Although numerous publications have appeared in the literature concerning the clinical results of the percutaneous invasive methods of treatment of patients with a nucleus pulposus hernia, in-vitro studies aimed at simulation and investigation of the effects of these operations are still largely lacking.

Material and method: In a biomechanical study, 20 MRI tomographically normal motion segments of the lumbar spine were examined. After removal of the musculature and posterior elements, 1.0 g, 2.0 g, and 3.0 g nuclear tissue was removed from the intervertebral disk of each segment, while the segment was loaded axially with 500 N. At the start of each standardized examination of a motion segment, and after removal of each gram of nuclear tissue, the intradiscal pressure, the height of the motion segment and, using a special measuring setup, the discal outline were measured under an axial load of 1000 N. With the aid of these computer-reproduced images of the discal outline the change of the radial bulging could subsequently be registered. All data were then analysed statistically using the Friedman test.

Results: Per gram of nuclear tissue the height of the intervertebral disk decreased by an average of 0.77 mm. The intradiscal pressure also decreased significantly: from the mean starting value of 9.01 bar to a mean end value of 2.72 bar. The difference between 1.0 g and 3.0 g also was significant (average 2.60 bar after 1.0 g and 1.30 bar after 3.0 g). Also the radial bulging increased by an average of 0.22 mm per gram of nuclear tissue removed.

Discussion: On the basis of these findings the pathogenesis of the radicular pain symptoms caused by a nucleus pulposus hernia are discussed in some detail, and doubt is expressed whether the mechanical component (pressure of the intervertebral disk on the nerve root) is solely responsible for the occurrence of these symptoms. The study, namely, clearly shows that the radial bulging increases while the clinical results of percutaneous invasive interventions constitute an improvement of these radicular symptoms in 70 to 80% of the patients.

A three-dimensional biomechanical model of the shoulder mechanism—implications for diagnosis and treatment

F. C. T. van der Helm and G. M. Pronk

Technical University Delft, Delft, the Netherlands

The shoulder mechanism, consisting of the thorax, clavicle, scapula and humerus, is one of the most complex musculoskeletal systems of the human body. Roughly one-third of the rotations of the humerus are due to rotations of the scapula and clavicle. Owing to its position in relation to the thorax, the scapula performs compulsory rotations. This makes the shoulder girdle a closed chain, and this has far-reaching consequences for the muscular functions. It appears that very little insight into the mechanical functioning of the shoulder exists.

A computer model of the shoulder mechanism was developed in which are represented 16 muscles, three extracapsular ligaments, three joints and the scapulothoracic sliding surface. The morphological data for the model derive from an extensive cadaver study. A special measuring instrument, the palpator, renders it possible to measure the three-dimensional positions of scapula and humerus. Model simulations of humeral abduction and anteflexion were carried out. With the aid of the model the function of shoulder muscles can be analysed. For an adequate analysis of the glenohumeral joint the moments of the scapula during abduction and anteflexion have to be included in the model. As prime movers may be regarded the major muscles with large moment arms. Furthermore, a number of smaller muscles with small moment arms, such as the rotator cuff muscles and the rhomboid muscle, provide the necessary antagonistic muscular activity to position the glenohumeral joint and the scapula, respectively, in such a way that the anterior serratus muscle finds a fulcrum to use the scapula as a lever to exert large moments. Rotations in the acromioclavicular joint are minimized by the conoid ligament.

It is concluded that the model can be used in many ways, for instance to improve the diagnosis, to search for the causes of shoulder complaints and to improve treatment techniques.

The morphology of the muscles round the hip joint in thigh amputees studied with MR scans

S. M. H. J. Jaegers and H. J. de Jongh

Department of Anatomy and Embryology, State University, Groningen, the Netherlands

The morphology of the muscles round the hip joint was studied in 15 thigh amputees. From the hip through the knee transverse MR scans were made at intervals of 5.5 mm. From each scan, the muscular and osseous structures were copied and then reconstructed three-dimensionally using a computer program. Of each outline the surface was calculated in order to determine the volume of the muscular and osseous structures.

The morphology changes substantially after a thigh amputation. The previously biarticular muscles are atrophied by 40–60% and the intact muscles on the amputated side by 0–30%. The degree of atrophy of the m. gluteus medius, minimus and iliopsoas increases with decreasing stump length. The geometry of the amputated muscles is also changed. For instance, on the intact side the sartorius muscle runs in an S curve; in nearly all amputees the sartorius muscle runs vertically from origin to insertion. This is the consequence of the fact that the muscles are fixed in a new position in relation to the femur. The altered course has consequences for the functions of these muscles. In seven amputees the semitendinosus muscle was not fixed. This also applies to the part of the great adductor muscle that has its insertion at the medial condyle of the femur. These muscles are no longer capable of functioning and are degenerated into fat.

In amputees in whom the muscles are not fixed, the femur shows an abduction and/or flexion position. In this position of the femur, the flexors and abductors of the hip are shortened and because of the length-force relationship the moment of the force of these muscles in the hip has decreased.

Polyethylene wear in relation to the alignment in the PCA total knee prosthesis

N. J. A. Tulp and R. Huiskes

Department of Orthopedics, University Hospital, Nijmegen, the Netherlands

Although the alignment is one of the factors believed to exert influence on the wear of polyethylene in the total knee prosthesis (TKP), this has never been documented adequately. In a clinical study it was found that poor alignment is involved in approximately 50% of the cases.

In this in-vitro study a PCA modular TKP was exposed to 150,000 cycles in a knee movement simulator.

The test was carried out five times: once with a central load on the knee and the other times with the axis of the load 1 or 2 cm medially or laterally of the center of the prosthesis. Before and after every test the surface of the polyethylene insert was scanned and the surface roughness measured. Using a pressure-sensitive film, the contact surfaces were registered before and after every test.

At all these tests only little wear was found. The impression of the surface increased from 0.05 mm with a central load to 0.36 mm with the load axis 2 cm laterally. Loading the prosthesis 1 cm medially or laterally resulted in maximal impressions of 0.13 mm and 0.16 mm, respectively.

Increases of the contact surface by up to 28% were measured. The surface roughness decreased in all tests with a wide standard deviation and without any clear relationship with the position of the load axis.

From this study a relationship between polyethylene wear and alignment can be derived. With the load axis 1 cm from the center of the prosthesis the increase of the wear is still acceptable.

The weight-bearing capacity of the femur in relation to the positioning of a gamma nail

H. Lacroix, H. Arwert, C. J. Snijders and W. P. J. Fontijne

Departments of Orthopedics and Biomedical Physics,
Erasmus University, Rotterdam, the Netherlands

Intramedullary fixation using a gamma nail appears to constitute an improvement in the treatment of proximal femoral fractures. However, like other implants, the gamma nail, also, has disadvantages.

One of the postoperative complications is development of fractures round the distal locking. This might be due to incorrect insertion technique of the locking or to the drilling of an additional hole passing behind the nail, which is not unusual in practice. The positioning of a locking with two screws in that part of the femur may in itself be a cause of the development of fractures.

Prompted by clinical practice, we have carried out loading tests with 24 cadaver femurs of persons aged 65 and older. After insertion of a gamma nail the femur was fixed distally while the proximal femur was exposed to torsion. The tests were carried out on a computer-controlled ZwickR tensile testing machine with an additional torsion apparatus. The following comparisons were made:

I. gamma nail with, during the positioning of the distal locking, a small hole made in the femur with an awl (according to the official operation technique) to prevent slipping of the drill during the drilling of the screw hole;

II. gamma nail with intentional drilling of one extra hole passing behind the nail at the site of the distal locking.

In each test setup the control group consisted of the contralateral femur of the same cadaver in which a gamma nail was positioned correctly with two locking screws. It was found that using the awl in test I caused a fissure in every femur. This reduced the mean resistance to torsion of the femur by 58%.

With test II, the mean resistance to torsion decreased by 36% in the group with one extra drilling hole. It is concluded that the recommended technique for positioning of the locking with the gamma nail should be modified to prevent complications such as spiral fractures.

was to develop a method of calculating the magnification factor of a radiograph so that after correction with this magnification factor measured distances can be compared.

Material and method: The basic element is the head of a hip prosthesis, represented spherically in every radiograph. Radiographs were made of a femoral head prosthesis varying in diameter (22, 28, 32 mm) in a fixed setup, so that the magnification factor of these radiographs is exactly the same. Using an 8 bit CCD camera (1024x1024 pixels, 256 grey values), all radiographs were converted into digital information and stored in the computer (1 image = 1 Megabyte). By means of image processing programs, points on the outline of the head are established automatically via grey value analysis. Subsequently, on the basis of the co-ordinates of 200 points and with the aid of mathematical computer programs, an ellipse is determined the smallest diameter of which corresponds to the true diameter of the head. The calculated diameter in mm is then compared with the true diameter. Analyses were also made of the influence of the fact that the roentgen rays are not aimed straight at the head (resulting in an ellipse-shaped image) and of the influence of the position of the points on the outline.

Results: In 20 triple measurements (ellipse reconstructions) a mean variation of 0.20% was found, while the maximal variation amounted to 0.49%. A significant increase in deviation was found when the outline points were distributed over 50% of the outline of the head instead of over 75% or maximally. The maximal deviation with use of the ellipse reconstruction is 0.49% (circle calculation: 0.77%) and the mean deviation 0.16% (0.49%). The difference between use of the ellipse reconstruction and circle calculation is significant ($p < 0.05$).

Conclusions: Use of digitalized radiographs and of semi-automatic image analysis techniques make it possible with great accuracy and reliability to calculate the magnification factor of a radiograph of a hip prosthesis.

Use of ellipse reconstruction affords a significantly higher accuracy than use of the circle calculation, provided the points of the outline are distributed over at least 75% of the outline of the head.

Accurate determination of magnification factors in AP radiographs of the pelvis of patients with a hip prosthesis

R. H. Jansen, L. van Erning, J. van Horn, R. Huiskes and T. J. J. H. Slooff

Department of Orthopedics, University Hospital, Nijmegen, the Netherlands

Introduction: Measuring migration of hip prosthesis components is one of the most reliable parameters supporting the diagnosis of 'loosening'. For accurate comparison of serial radiographs of one patient the difference in magnification of the radiographs is an inconvenience. The purpose of this study

Total hip arthroplasty in dysplastic acetabula—the effect of an acetabular roof reconstruction on the conduction of force

H. M. Schüller, M. Dalstra, R. Huiskes and R. Marti

Departments of Orthopedics, University Hospitals of
Amsterdam and Nijmegen, the Netherlands

Introduction: During a total hip arthroplasty (THP) in patients with a dysplastic acetabulum use is frequently made of a so called acetabular roof plasty. In the present study the following questions were raised: What is the mechanical role of the superolateral rim of the acetabulum in a THP? What is the effect of an acetabular roof plasty if this superolateral cover is absent?

Method: Use was made of a three-dimensional finite element model of the pelvis with cemented into it at the anatomical site a polyethylene cup of 32 mm, into which 0, 6, 12 or 18 mm dysplasia was introduced. The model was exposed to the hip reaction force and to the muscular force resultants of all significant muscles acting on the pelvis, both during the one-legged stance phase, of which the magnitude and direction are known from recent literature.

Results: When the cup is fully covered, the main part of force conduction occurs through the superolateral rim of the acetabulum. With increasing dysplasia this force conduction shifts to a postero-superolateral direction and in the direction of the pubic bone. The Von Mises tensions in the cement layer and the pelvic spongy bone increase significantly (by up to 100%) even with slight dysplasia (6 mm); as the dysplasia increases further, the tensions in the subchondral and cortical bone also increase substantially. In the cement-bone interface, in which in the non-dysplastic situation the rotation component of the shearing stress predominates, the tilt component becomes the major shearing stress and increases by up to 300%. An acetabular roof reduces the tensions to values comparable with those of non-dysplastic hips. From the mechanical point of view bone is more attractive than cement as material for this acetabular roof plasty, because with a cement roof the standard tensions at the site of the interface with the supra-acetabular ilium are mostly tensile forces, whereas reconstruction of bone gives pressure forces here. Conclusion. If a polyethylene cup of a THP is not completely covered, substantial increase of tensions in materials and interfaces is calculated. An acetabular roof plasty for which, from the mechanical point of view as well, bone is more suitable than cement, may reduce these tensions to values as calculated for non-dysplastic hips.

Porous polymers for repair and replacement of the meniscus

J. Klompmaker, H. W. B. Jansen, R. P. H. Veth,
J. H. de Groot and A. J. Pennings

Biomaterials Research Center, State University, Groningen,
the Netherlands

Introduction: The greater part of the meniscus is avascular so that most meniscal lesions do not heal. Treatment of an injured meniscus by complete or partial resection always leads to arthrosis of the articular cartilage. The purpose of this study was to determine whether porous polymers are suitable for the repair of injured menisci and replacement of complete menisci.

Methods: In the dog, longitudinal meniscal lesions in the avascular part of the meniscus were connected with the vascularized periphery by means of a second defect at right angles to the former one. Subsequently a porous plastic (polyurethane or caprolacton) was sutured into the second defect. In control animals, the defect was left empty. In a number of dogs the complete meniscus was replaced by a prosthesis made of poly-

urethane. The optimal structure of the implant was tested by implantation of polyurethane with four different pore sizes in the rabbit. The vascular pattern of the menisci was determined by injecting the vessels with ink, the collagen composition of the ingrowing tissue was determined by means of biochemistry and antibodies.

Results: Both macro- and microscopically two-thirds of all longitudinal lesions healed due to stimulation of the vascularization of the meniscus. In these cases the underlying cartilage was normal until a maximum of one year after the operation. Dislocation of the implant or infection of the knee caused failure of the meniscus to heal. In contrast to control defects, healing with fibrocartilaginous tissue was seen in the polymer group. After a maximal follow-up of 4 months, the prosthesis was found to be incorporated well. Here, also, ingrowth of fibrous cartilage was observed. The structure and composition of the implant proved to have great influence both on the rate of ingrowth and on the differentiation of the ingrowing tissue.

Conclusion: Repair of meniscal lesions and replacement of complete menisci is possible with the aid of porous polymers. Regarding morphology and composition the regeneration tissue strongly resembles normal meniscal tissue.

The unsuccessful perichondrium transplantation—biology and etiology

S. K. Bulstra, R. Kuijer, Ph. Bouwmeester, K. Beckers and A. J. van der Linden

Department of Orthopedics, University Hospital, Maastricht,
the Netherlands

Transplantations of perichondrium have been carried out since 1986 for repair of cartilaginous defects in the knee. Initially, the range of indications was broad: transplantations were carried out in one or two isolated defects while chondropathy in other parts of the knee was not regarded as a contraindication. After exclusion of patients in whom a perichondrium transplantation had been combined with some other intervention (e.g. cleansing, cruciate ligament reconstruction), 60 patients could be followed up in 1990. The length of follow-up was 2.5–5 years. In 21 patients the operation was regarded as unsuccessful: reoperation and cleansing proved necessary. In the remaining patients, the operation was followed by very marked alleviation (26) or complete elimination of the symptoms (13). Macroscopical, histological and biochemical examination could be performed in 21 patients in whom reoperation was necessary because of failure of the transplant. At follow-up arthroscopy 1–1.5 years after the transplantation, biopsies could be obtained of five successful transplants.

The biopsy samples of the successful transplants showed a picture of hyaline cartilage, although the cartilaginous structure was not always completely normal (collagen II 90%). A loose body consisting of a connective tissue nucleus with calcifications and surrounded by fibrous cartilage was found in 11 patients. The cartilaginous portion of these loose bodies consisted of 28–40% of collagen II corresponding to fibrous

cartilage. In seven patients, a local hypertrophy was observed macroscopically. Histologically this involved fibrous cartilage with scattered hyaline features. Collagen typing revealed proportions of collagen II of 56-87%. The histological and biochemical features fit those of 'repair' cartilage as also observed after cleansing with reaming of the subchondral bone layer. No remnants of the perichondrium were found.

It is concluded that the fixation of the perichondrium to the subchondral bone layer had led to the failure of the operation in 18 patients.

The value of MRI for the diagnosis of intra-articular lesions of the knee

J. G. Konings, C. J. P. Thijn and E. L. Mooyaart

Departments of Orthopedics and Radiology, State University, Groningen, the Netherlands

In this prospective study 50 patients with knee symptoms and suspicion of meniscal pathology were examined by means of MRI. The objectives of the study were 1) determination of the sensitivity, specificity and reliability of MRI as compared with arthrographic and arthroscopic findings in the diagnosis of meniscal lesions, cruciate ligament ruptures and chondropathy and 2) to gain an impression of the additional information to be provided by MRI regarding the internal aspects of these structures. The MRI examination was carried out on the day before or on the day of arthroscopy. The MRI scans were examined by two radiologists not in possession of the clinical and arthroscopic information. A high signal area in the MRI scan was observed in 69 of the 100 medial and lateral menisci, 31 of them with a grade 3 abnormality (= 'rupture').

At arthroscopy/arthrography 36 meniscal injuries were established. Compared with this the MRI assessment of a meniscal rupture was false positive twice and false negative seven times.

The diagnostic reliability of MRI for the demonstration of a meniscal rupture was 88%. With MRI, seven of the 11 cruciate ligament lesions were diagnosed correctly and there were seven false-positive results. Retropatellar chondropathy was diagnosed with MRI in six of the 13 cases. Degenerative lesions in the meniscus and abnormalities situated subchondrally can be demonstrated adequately with MRI. Development of a rupture in a meniscus is also reasonably well demonstrable with MRI. However, MRI as yet provides no good information about the shape and size, and accordingly the surgical relevance, of the avulsed part of the meniscus.

Double contrast computed tomography (CT) arthrography and arthroscopy of the shoulder—a prospective comparative study

M. J. P. F. Ritt, R. L. te Slaa, L. H. L. Winter, B. R. H. Jansen and C. P. Vroeghe

Departments of Orthopedics, Traumatology and Radiology, Reinier de Graaf Gasthuis, Delft, the Netherlands

There are few studies documenting the usefulness of CT double contrast arthrography compared with arthroscopy in shoulder pathology.

A prospective study was made of 35 consecutive patients subjected to double contrast CT arthrography prior to shoulder arthroscopy: 23 males and 12 females with a mean age of 36 (17-58) years. The mean duration of symptoms was 3 years (1 week-12 years). The preoperative diagnosis was instability in 26 patients (recurrent glenohumeral dislocation 11, recurrent glenohumeral subluxation 7, acute anterior glenohumeral dislocation 1 and multidirectional instability 7). Two patients had pain of unknown origin, three had pain caused by impingement and four had a frozen shoulder.

The results were recorded by a radiologist not informed of the arthroscopic findings when making the final CT reading.

The sensitivity, specificity and accuracy of CT arthrography findings compared with arthroscopy were 66%, 100%, 96% for rotator cuff lesions; 100%, 100%, 100% for loose bodies, 85%, 79%, 81% for Hill-Sachs lesions; 94%, 88%, 88% for anterior labrum defects and 100%, 100%, 100% for posterior labrum defects.

These findings correlate well with the mean accuracy of double contrast CT scans reported in the literature, which is 93% for rotator cuff lesions, 87% for Hill-Sachs lesions and 80% for anterior labrum defects.

We conclude that the double-contrast CT scan has a high accuracy (81-100%) for the specific shoulder lesions mentioned above, and that it is a reliable diagnostic method in shoulder pathology. Double contrast CT scanning is the method of first choice for the analysis of shoulder instability.

Inter-observer variation in arthroscopic examination of the knee joint

H. W. J. Koot, A. van Kampen and M. C. de Waal Malefijt

Department of Orthopedics, University Hospital, Nijmegen, the Netherlands

A videotape, recording the whole or a part of the arthroscopic examinations of the knee joints of eight different patients was submitted, together with a preprinted questionnaire to 84 orthopedic surgeons in the Netherlands. Anonymous answers were requested and received from 52 colleagues (response rate 62%). The observers' mean age was 43 (33-62) years, with a mean experience as orthopedic surgeon of 8 (0-26) years. On average they performed 174 (0-475) knee arthroscopies annually.

There was a distinct uniformity in the assessment of the condition of the cruciate ligaments and in noticing an injured meniscus. There were striking differences in the assessment of the quality of the cartilage. There were also major differences in the determination whether or not plicae were present. The different types of meniscal ruptures were not diagnosed uniformly. With five arthroscopic images the diagnosis and treatment were requested. In case of a fresh total ligamentous anterior cruciate ligament lesion, one-half decided on conservative treatment, one-third considered reconstruction in the future and one-fifth performed immediate reconstruction. One-half of the group failed to recognize a pigmented villonodular synovitis or confused it with an aspecific synovitis or rheumatic lesion. In an avulsion fracture of the eminencia with anterior cruciate ligament, three-quarters decided on immediate fixation and one-quarter remained conservative.

Results of arthroscopic meniscopexy

J. H. Barentsz, H. Penterman, T. E. Lim and W. J. Willems

Department of Orthopedics, Medical Center, Alkmaar, the Netherlands

The objective of this study was to determine the short-term results of the meniscopexy and the difference, if any, in the results of a meniscopexy in a knee with or without anterior cruciate ligament instability.

Method: An arthroscopic meniscopexy was carried out in 67 patients. The interval between the injury and the operation on average was 7 months. In 29 patients the operation was performed within one month. The medial meniscus was ruptured in 48 and the lateral meniscus in 19 cases. The ruptures involved a posterior horn in 16 cases, a posterior/medial horn in 43 and a posterior/anterior horn in eight cases. According to the classification of Arnoczky (1984), the rupture was in the area 'red/red' in 38 cases, in 'red/white' in 21 cases and in 'white/white' in eight cases. Two methods of meniscopexy were performed, inside-out (Henning) 61 times and outside-in (Morgan) 6 times.

The average follow-up period amounted to 17 (12–48) months.

For the classification of the results the patients were subdivided into three groups.

- A. 22 patients: exclusively a meniscal rupture;
- B. 18 patients: meniscal rupture with moderate to severe anterolateral instability, in whom for various reasons correction of the instability was refrained from;
- C. 27 patients: meniscal rupture with moderate to severe anterolateral instability in whom, in addition to a meniscopexy, an arthroscopic anterior cruciate ligament reconstruction was carried out with the aid of a patellar tendon or semitendinosus or gracilis tendons.

Results: Group A: good clinical results in 18/22 patients, rerupture occurred in 4 cases;

Group B: good clinical results in 10/18 patients, rerupture occurred in 8 cases;

Group C: good clinical results in 26/27 patients, rerupture occurred in 1 case.

Rearthroscopy was carried out 25 times: 13 times for treatment of a rerupture with a meniscectomy while in the 12 other knees excellent healing of the rupture was observed.

Conclusion: In our opinion, meniscopexy is a useful and justified procedure, provided it is performed in a stable knee or in a knee to be stabilized at the same time.

Arthroscopic treatment of the meniscal cyst

H. Lacroix and M. P. Heijboer

Department of Orthopedics, University Hospital, Rotterdam, the Netherlands

Until recently the treatment of the meniscal cyst originating predominantly in the lateral meniscus consisted in exploration of the cyst and partial or complete meniscectomy of the injured/degenerated meniscus, usually via an arthrotomy.

Since 1987 we have treated the meniscal cyst arthroscopically. Since then, 20 patients have been treated; in all of them the cyst was in the lateral meniscus. A rupture of the lateral meniscus was present in 18 patients. In case of a rupture partial lateral meniscectomy was carried out followed by internal decompression of the cyst. This was achieved by cutting the capsule with scissors via the rupture following which the contents of the cyst flow into the joint and cause brown discoloration of the articular fluid. In the absence of a meniscal lesion, internal decompression is performed via multiple needle punctures.

Postoperative treatment was as after an arthroscopy. To the patient, this mode of treatment means minimal intervention with preservation of part of the meniscus so that rapid resumption of activities of everyday life is possible.

The hypermobile meniscus

M. P. Heijboer and W. Kooops

Department of Orthopedics and Radiology, University Hospital, Rotterdam, the Netherlands

The problem of the hypermobile meniscus is discussed with reference to three patients. With the lower legs in endorotation and the knee in maximal flexion these patients could provoke locking symptoms, which they could undo by extending the knee. The latter was accompanied by a loud and characteristic crack. Two patients were able to keep their knee in the locked position while MRI examination of the joint in question was carried out.

It was found that the posterior horn of the lateral meniscus was displaced forward and was wedged between the femoral condyle and the tibial plateau. This caused outward bulging of the central portion and a vertical position of the anterior horn.

In one patient, a policy of wait and see was adopted, in another arthroscopic meniscopey was performed successfully and in the third, after two so-called diagnostic arthroscopies, a partial meniscectomy and an unsuccessful meniscopey, a subtotal resection of the posterior horn of the lateral meniscus was carried out.

Open versus arthroscopic reconstruction of the anterior cruciate ligament using the central portion of the patellar tendon

J. L. Schoen, T. van Loon, R. K. Marti

Department of Orthopedics, Carolus Hospital,
's-Hertogenbosch, the Netherlands

This prospective study was designed to evaluate the advantages, if any, of arthroscopic reconstruction of the anterior cruciate ligament over reconstruction by arthrotomy.

In 1987 and 1988, 50 patients were subjected to reconstruction of the anterior cruciate ligament by means of a bone-tendon-bone autograft consisting of the central 40-50% of the patellar tendon.

In 22 patients, the reconstruction was performed either via a small medial arthrotomy, or through the defect in the patellar tendon and an arthrotomy through the body of Hoffa, because arthroscopy afforded an insufficient view of the intercondylar space.

In 28 patients, the intervention was carried out arthroscopically.

The two groups were comparable as to age, sex, additional lesions, additional interventions and interval between injury and operation.

All patients were given the same functional treatment after the operation and were reexamined after 6 weeks, 3 months, 5 months, 8 months, and 1 year. Subsequent follow-up examinations were performed once a year, those after 2 and after 3 years being performed by someone else than the surgeon.

Results: The maximal quadriceps atrophy as revealed by the thigh circumference averaged 3.4 cm in the arthrotomy group as against 2.1 cm in the group treated arthroscopically.

Knee function was recovered significantly more quickly in the arthroscopy group. Six patients required a noninvasive mobilization after 3 months because of insufficient normalization of flexion: four times after open reconstruction (three acute reconstructions) and twice after arthroscopic acute reconstruction.

One year postoperatively none of the patients had a loss of extension of more than 5° or a loss of flexion of more than 20°. Four patients had a flexion loss of 10°-20°, all after open reconstruction.

KT-1000 measurements 6 weeks postoperatively in all patients revealed less AP translation with more stiffness than contralaterally. One year postoperatively the arthrotomy group showed a mean increase compared with contralaterally by 0.6 mm, with >2 mm in four knees.

In the arthroscopy group, the mean increase was 0.3 mm, with >2 mm in three knees.

One year postoperatively, only nine of the 22 knees in the arthrotomy group were completely free of pain, as against 20 of the 28 in the arthroscopy group.

Two and three years postoperatively the advantages of the arthroscopic reconstruction were still obvious, with a mean Lysholm score of 90.3 in the arthroscopy group, as compared to 82.6 in the arthrotomy group, the difference being largely attributable to pain.

Reconstruction of the anterior cruciate ligament of the knee under arthroscopic control

T. E. Lim, J. H. Barentsz, H. Penterman, J. L. Schoen
and W. J. Willems

Department of Orthopedics, St Joseph Hospital, Veldhoven,
the Netherlands

In 153 patients with chronic instability of the knee the authors performed a reconstruction of the anterior cruciate ligament under arthroscopic control. A patellar tendon transplant was used for the reconstruction in 111 patients (group 1) and a semitendinosus/gracilis transplant in 42 patients (group 2). Prior to operation all patients had a Lachman test >2+ and a pivot shift >1+. Follow-up was at least 1 year. Group 1 included 67 males and 44 females with a mean age of 27 (16-46) years. Group 2 consisted of 23 males and 19 females with a mean age of 31 (21-50) years. Extraarticular plastic reconstructions were performed in 48 patients (41 in group 1 and 7 in group 2). Meniscopey was carried out in 21 patients of group 1 and in 10 patients of group 2. The follow-up was 1.5 (1-3.5) years. The mean HSS knee score was 46 before operation and 90 at follow-up. The KT-1000 measurement at follow-up was 0-3 mm in 75 patients, 3-5 mm in 21 patients and >5 mm in five patients in group 1. Classification in group 2 was: 0-3 mm in 34 patients, 3-5 mm in five patients and >5 mm in two patients.

Complications: Complications were seen seven times in group 1: once a pulmonary embolism, once infection at the tractopexy site, in three cases a cicatricial node had to be removed intra-articularly, and twice an open adhesiolysis was carried out because of intraarticular adhesions. In group 2, two cases of synovitis developed because of which the intra-articular sutures had to be removed.

Radiological examination of arthroscopic repair of Bankart lesions

A. M. J. Burgers and P. M. Rozing

Department of Orthopedics, University Hospital, Leiden, the Netherlands

Arthroscopic repair of Bankart lesions was started in 1988. Because of the high proportion of recurrences reported in the literature a prospective study was carried out in which 20 patients underwent CT arthrography pre- and postoperatively.

The clinical results were assessed according to the Rowe system in 15 patients with a follow-up of more than one year. Radiological follow-up was possible in 16 patients.

Clinical results: One patient had recurrent subluxations after the operation. Of the remaining 14 patients 13 were excellent and one good. The restriction of exorotation at the last follow-up averaged 5°.

Radiological results: The preoperative CT-arthrographic abnormalities were confirmed in all 20 patients. Of the 16 patients of whom both a pre- and a postoperative scan were present, 15 had a Bankart lesion. Postoperatively, this lesions was repaired in six patients. In one patient stripping of the capsule healed, and in another only the labrum healed. Seven patients showed no improvement postoperatively. One of these seven patients had a recurrence. A striking finding was the relationship between restriction of exorotation 6 months postoperatively and a good radiological result.

Conclusion: Although the results in our patients were good at clinical follow-up, the radiological results were highly disappointing. In 47% of our patients, we saw no postoperative improvement at all and it is likely that this group is at risk for recurrent dislocations.

Arthroscopic treatment of anterior traumatic (sub)luxation of the shoulder

W. J. Willems, H. Penterman, J. L. Schoen, T. E. Lim and C. N. van Dijk

Department of Orthopedics, Medical Center, Alkmaar, the Netherlands

During the period 1989–1990, the authors performed an arthroscopic reconstruction in 70 patients with recurrent anterior traumatic (sub)luxation of the shoulder. Each author developed a personal technique and used it consistently. The questions to be answered by this retrospective multicenter study were:

1. does the considerably less traumatic arthroscopic technique yield results comparable with those of the traditional open techniques?
2. are there demonstrable differences between the various arthroscopic techniques?

The series consisted of 43 males and 27 females. The mean age at the time of operation was 29 (18–56) years. The mean duration of the symptoms was 2.7 (0.5–1) years. In 43 cases, a

distinct traumatic dislocation was involved, while the other 27 were cases of traumatic subluxation. In 42 patients, the (sub)luxation had occurred during athletic activities. The dominant side was involved in 51 patients. In 36 cases, the arthroscopic transglenoid suturing technique according to Rose was applied; in 28 cases the labrum was refixed using a resorbable staple (Suretac); in six cases a suturing technique with use of small anchors countersunk in the glenoid (Mitek) was performed.

The follow-up time was 15 (6–25) months. Four redislocations occurred: one in the group treated by the Rose technique (3%), two in the Suretac group (7%) and one in the Mitek group (17%).

In one patient of the Rose technique group a subluxation occurred.

Mean restriction of exorotation at 0° abduction was 5° (0°–40°); mean restriction of exorotation at 90° abduction was also 5° (0°–40°).

At the last postoperative follow-up none of the patients had pain of any importance. The Rowe score could be calculated in 65 patients: excellent 55, good 4, poor 3, bad 3.

Conclusion. In this combined series the results as regards re(sub)luxations (7%) and function are acceptable compared with open techniques. No significant differences between the various techniques can be demonstrated.

Although improvement is still necessary, particularly of fixation techniques, the arthroscopic treatment of traumatic (sub)luxation of the shoulder appears to constitute a good alternative to the open techniques.

Arthroscopic subacromial decompression

H. Penterman, C. N. van Dijk, T. E. Lim, J. L. Schoen and W. J. Willems

Department of Orthopedics, Waterland Hospital, Purmerend, the Netherlands

The authors operated 90 patients arthroscopically because of a subacromial compression syndrome. The overall results according to the UCLA score were: excellent and good 71%, poor 21% and bad 8%. An intact rotator cuff was present in 49 cases, 27 patients had a partial rupture of the cuff and 14 a complete rupture. Mean age was 48 (21–83) years. Thirteen times an additional pathology was treated: five times freshening of an SLAP lesion, twice a biceps resection, five times partial labrum resection and once, removal of a loose body.

Conclusion: Arthroscopic subacromial decompression yields results comparable with those of an open procedure. Glenohumeral pathology can be assessed and treated better. The patient can begin exercising immediately. The procedure is well tolerated and may, if necessary, be performed in day treatment.

Arthroscopic Mumford operation in arthrosis of the acromioclavicular joint

W. H. M. Castro, J. Jerosch, J. Rondhuis and P. Wuisman

Department of Orthopedics, University Clinics Münster and Düsseldorf, FRG

In an anatomical study, 111 acromioclavicular joints (57 cadavers) were examined. The intraarticular degenerative lesions were assessed. A significant number of degenerative lesions (cartilaginous ulcers, disk pathology, osteophyte development) in the anteroinferior quadrant of the joint were encountered. On the basis of these findings an arthroscopic technique was developed for removal of the degenerative articular disk and the arthrotic portions of the AC joint without influencing the stability of the joint. Using this technique, 15 patients with arthrosis of the AC joint were operated on. Intra- or postoperative complications were occasionally observed.

Clinical relevance: The early experiences are encouraging, the surgical technique has been standardized and is reproducible and the short-term results are not worse than with the conventional open technique. However, the 2- and 4-year results will have to show whether the arthroscopic technique can replace the conventional operation and whether the preservation of joint-stabilizing structures in the long run has a positive influence on the results.

Arthroscopy of the ankle

C. N. van Dijk, A. W. F. M. Fiévez, M. P. Heijboer, W. J. Willems, T. E. Lim, R. A. A. Bots, H. Penterman, J. G. Konings and A. van Kampen

Department of Orthopedics, University Hospital, Amsterdam, the Netherlands

During 1986–1991 the authors performed ankle arthroscopy in 259 patients. The series includes 161 males and 98 females. The mean age at the time of operation was 26 (16–73) years. The indications were: diagnostic 106, osteochondral defect 42, impingement syndrome 42, loose body 31, and arthrodesis 8.

In the diagnostic group the arthroscopy was performed because of chronic pain: unknown cause 61, problems after ankle ligament reconstruction 9, arthrosis 18, and chronic synovitis 18.

In 30 patients a diagnostic arthroscopy was carried out after an acute supination injury. The technique varied. Most authors routinely used the anterolateral + anteromedial approach. Follow-up time was 1.9 (0.5–5) years.

In 10 patients a total of 11 complications occurred: 7x hypesthesia over the dorsum of the foot in the area of the superficial peroneal nerve, 1x neuroma of the sural nerve, 1x Sudeck's dystrophy, 1x haematoma from the greater saphenous vein and 1x a ring sequester of the tibia. Complications had no adverse influence on the final result (5x good, 5x excellent). In the osteochondral defects arthroscopic surgical treat-

ment was performed in 32 patients, viz. débridement and reaming of the defect 25 times, loose body resection 4 times, osteophyte resection 3 times, soft tissue resection 7 times and adhesiolysis once. Good to very good results were accomplished in 29 of the patients.

Treatment of the anterior impingement syndrome was by arthroscopy in 38 patients, viz. osteophyte resection of the distal tibia and/or the neck of the talus 16 times and soft tissue resection 22 times. Good to very good results were obtained in 36 patients.

In the diagnostic group with chronic synovitis a biopsy was performed in six patients. In four of the others an arthrosis was found, for which cleansing was carried out with a good result in two cases, while in eight patients only a synovitis was encountered, for which synovectomy was performed in one case. In seven of these eight patients the results were good. The diagnostic arthroscopies in status after ankle ligament reconstruction revealed synovitis in five patients all of whom underwent arthroscopic cleansing with good to very good results in all five. In four patients, arthrosis was found, for which arthroscopic cleansing was carried out with bad to poor results in all cases. In three patients, no abnormalities were found; in all three the results were poor. In the diagnostic arthroscopy group in arthrosis the arthrosis was confirmed in all 18 cases.

Cleansing was carried out in 10 patients. Good to very good results were obtained in only 3 patients in this group.

In the group diagnostic ankle arthroscopy in ankle symptoms of unknown origin an osteochondral defect was observed twice, an osteophyte three times, synovitis 12 times, arthrosis 33 times and no abnormalities 11 times. Arthroscopic surgical treatment consisted of cleansing/resection in 29 patients. In this group of 61 patients 43 were poor to fair at follow-up.

Regarding the preoperative diagnostics in the diagnostic arthroscopy group, in 44%, apart from the survey radiographs, no other form of preoperative diagnostic examination was carried out at all! In only 24% of the patients did the accessory examination include a combination of technetium scanning and planigraphy or CT scan. A diagnostic infiltration was done in only six patients.

Arthroscopic surgery of the ankle offers excellent possibilities to treat lesions such as osteochondral defects of the talus, loose bodies, impingement syndromes and synovitis with only little morbidity.

The principal cause of the 70% bad to poor results in the diagnostic arthroscopy group was undoubtedly inadequate preoperative diagnostics, viz. no technetium scanning, planigraphy/CT scanning and/or diagnostic infiltration. If the accessory examination reveals no abnormalities and at physical diagnostic examination there is no synovitis, diagnostic ankle arthroscopy will provide no further information and consequently is not indicated.

Arthroscopic arthrodesis of the ankle—a new technique

R. M. Hartel, C. N. van Dijk, A. van Kampen and M. de Waal Malefijt

Departments of Orthopedics, University Hospitals, Amsterdam and Nijmegen, the Netherlands

An arthroscopic arthrodesis of the ankle was performed in eight patients. Mean age: 50 (32–66) years. Indications: septic arthritis 2, posttraumatic arthrosis 1, clubfoot 2, and hemophilia 3. Fixation: internal screw fixation 5 and external fixation 3. Evaluation period: 0.5–1.5 years.

In five patients the difficult arthroscopic technique was simplified. Via a small anterolateral incision the talofibular ligament is severed. Approach via the anteromedial portal and lateral mini-arthrotomy. Osteophytes of talus, anterior tibial edge and anterior capsule are shaved off. Via the arthrotomy, adequate space can be created with the single-pronged hook on the talus, or with an AO bone spreader. During the shaving of all compartments, the debris flows out via the arthrotomy. Posture corrections of less than 10° are possible. Only minimal shortening results. Fixation with percutaneous internal screw fixation or external fixation. The position is plantigrade with some dorsalization of the foot, to be corrected under visual control via the mini-arthrotomy. First day postoperatively, mobilization without weight bearing, with two crutches.

Results: Clinical consolidation after 6 weeks, radiographic consolidation after 8–10 weeks. No infections, abnormal positions or neuromas.

Discussion: The results are comparable to those in the recent literature on the arthroscopic technique with use of external distraction. Consolidation may be more rapid than with the open technique owing to minimal devascularization.

Conclusion: This simplified arthroscopic technique constitutes a good alternative, especially in cases at risk for impaired wound healing and in case of need of early mobilization.

Study of the cause of pain on the medial side of the ankle joint after supination injury

C. N. van Dijk

Department of Orthopedics, University Hospital, Amsterdam, the Netherlands

Residual symptoms after a supination injury occur frequently, irrespective of the nature of the primary treatment. They mostly consist of pain, swelling and functional impairment during activity; localized to the medial side of the ankle. In a personal prospective study of 400 patients with an arthroscopically demonstrated rupture of one or more lateral ankle ligaments, there was initially pain on palpation over the medial aspect of the ankle in 65%. At the 6-month follow-up, 28% of the patients reported residual symptoms localized on the medial side of the ankle. In an attempt to identify the cause of this medial pain, 30 successive patients from the above-mentioned

series of 400 had arthroscopy of the ankle joint performed about one week after the injury at the same session as suturing of the lateral capsular ligamentous apparatus. The findings were: macroscopical injury to cartilage 19x, synovitis or fibrous cords 4x and rupture of the deltoid ligament 1x.

The cartilaginous injury was localized usually at the tip of the medial malleolus (13x) and the opposing medial surface of the talus (8x). In five patients the cartilaginous injury was localized in the distal anteromedial portion of the tibia, while injury to the medial talus was seen only once. In the last-mentioned patients, an osteochondral defect was involved, in five cases also a loose body.

It was only in six of the 30 patients that no medial intra-articular lesion was encountered. In a supination injury with rupture of the lateral capsular ligamentous apparatus, impingement between the medial malleolus and the medial surface of the talus occurs. In 19 of the 30 patients, this resulted in macroscopical cartilaginous injury.

The clinical relevance of synovial biopsy at arthroscopy

T. V. S. Klos, M. E. I. Schipper, J. W. van der Eijken and B. E. E. M. J. Veraart

Department of Orthopedics, Onze Lieve Vrouwe Gasthuis, Amsterdam, the Netherlands

During the period 1987–1991, 102 synovial biopsies were performed during arthroscopy. The group consisted of patients with lesions of 91 knees, seven ankles, two hips, one shoulder and one elbow. The arthroscopies were performed in 41 females and 61 males. In 50 patients, the indication for histological examination was determined prior to operation. In 52 patients the biopsy was decided upon peroperatively.

The findings at arthroscopy are subdivided into four groups:

1. mild synovitis secondary to other lesions in the knee (meniscopathy, chondropathy), 53;
2. slight synovitis without distinct other abnormalities, 31;
3. evident synovitis without distinct other abnormalities, 14;
4. other evident intra-articular lesions (e.g. synovial tumor), 4.

In group 1, the histological diagnosis was reactive synovitis. In group 2, hardly any diagnoses were made. In group 3 the diagnosis could be made on the basis of histological examination in two cases. In group 4 the evident intra-articular lesion was confirmed by histology.

The protocol includes bacteriology, histological examination and immunofluorescence; total costs may be as high as Dfl. 700.-

Conclusion: If at arthroscopy only slight hydrops and synovial irritation are observed, synovial biopsy appears to be an expensive diagnostic examination which rarely provides useful information.

Equally, in disorders where the diagnosis becomes clear in other ways, synovial biopsy in our clinic rarely leads to the definite diagnosis.

Arthroscopy of the hip

H. Penterman, M. Ipreburg, J. L. Schoen
and W. J. Willems

Department of Orthopedics, Waterland Hospital, Purmerend,
the Netherlands

The authors have operated 26 patients; 19 of them have a follow-up of over one year. The indications for arthroscopy of the hip included: unexplained hip pain 10x, chondral defect 3x, loose body 2x and osteochondral defect after injury 1x. In unexplained hip pain the arthroscopy was performed purely for diagnostic purposes; in the other cases the primary intention was therapeutic.

Results: Twelve of the 19 patients felt better after one year than prior to the operation; in particular, patients with chondral lesions and loose bodies (5x) after operation had completely restored mobility and experienced no restrictions. In seven patients, there was no clear improvement after the operation.

Complications: In one case, transient paresthesiae of the foot occurred. Although the indications for arthroscopy of the hip are not definitely established, the technique appears to have its uses. Removal of loose bodies—normally not possible without major interventions—is one of the possibilities. Also, unexplained pain can be assessed without major morbidity. In 7 out of 10 patients with unexplained pain, a cause was found. With further improvement of the instrumentarium the surgical possibilities will increase. The technique can be applied in day care.

Arthroscopy of the hip

F. K. Kurek and C. N. van Dijk

Department of Orthopedics, University Hospital, Amsterdam,
the Netherlands

Indications: If in unexplained hip symptoms the traditional diagnostic methods are insufficiently informative, arthroscopy may be considered.

Technique: Use of an extension table is necessary. No such table was used for the first two arthroscopies, resulting in poor imaging. The approach is via at least two portals, so that instrumentation is possible.

Patients: In nine patients an arthroscopy was performed because of unexplained hip symptoms. In three cases, a synovitis was involved. In one patient there was a cyst in the roof of the acetabulum. In the other patients, accessory examinations before the arthroscopy revealed no abnormalities.

Results: In two cases, imaging was insufficient because of technical problems (without use of the extension table) so that no diagnosis could be made.

In one case, a coxarthrosis was diagnosed, in one an acetabular cyst which was reamed, once a chondromatosis, once rheumatoid arthritis, once villonodular synovitis, once non-specific synovitis and in one patient no intraarticular abnormalities were found.

In the last-mentioned patient a malignancy of the ilium was demonstrated a few months later.

Conclusion: In unexplained hip symptoms arthroscopy as the final diagnostic examination may make an important contribution. In six of the nine patients a diagnosis could be established and treatment instituted.

Arthroscopy of the MTP-I joint

C. N. van Dijk

Department of Orthopedics, University Hospital, Amsterdam,
the Netherlands

We present 13 consecutive patients in whom an arthroscopic surgical intervention of the hallux (MTP-I joint) was carried out. The follow-up examinations in this prospective study were performed 4 months and 1 year postoperatively.

After development of the technique (4 portals) arthroscopy was resorted to for the following indications: dorsal impingement syndrome (relative hallux rigidus) 5x, nonunion sesamoid bone 4x, hallux rigidus/arthritis 2x, loose body 1x, and bacterial arthritis 1x.

Before operation, all patients had pain and functional impairment of the hallux. Five of the six patients with a dorsal impingement syndrome or loose body were incapable of sports or occupational activities, with pain during dorsal flexion and a painful osteophytic rim dorsally. Extirpation of a sesamoid bone was resorted to if pain persisted in spite of conservative treatment for at least one year, with radiological nonunion and a positive technetium scan. No complications occurred. The results in the dorsal impingement group and the patient in whom the loose body was removed were always good to very good, with complete resumption of sports/occupation in all six patients. In the hallux rigidus group, results were only moderate, with alleviation of pain. In the nonunion/sesamoid bone group, the results varied. In this group, none of the patients became free of symptoms.

Arthroscopy of the MTP-I joint appears to have its place in the diagnostic and therapeutic arsenal of the arthroscopic surgeon.