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Double Contrast Arthrography of the Knee

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Arthrography is a safe and relatively simple diagnostic procedure which provides an accurate and graphic preoperative means of defining pathology of the knee. In those cases where the expeditious evaluation and diagnosis of knee injury are of prime importance, ie, the athlete and industrial compensation case, arthrography provides a significant contribution. The clinical pathological features, salient anatomy and technic of study of internal derangements of the knee are discussed. Selected double contrast arthrograms illustrate normal and abnormal findings. Arthrotomies were performed in 20 of the 32 patients in this study with a positive arthrogram-arthrotomy correlation of 85%.

The technique of arthrography of the knee was first described by Werndorff and Robinson[1] in 1904 and later modified by Bircher's Double Contrast technic.[2] Arthrography has episodically assumed a position of importance in the armamentarium of both the roentgenologist and orthopedic surgeon. Lindblom,[3] in 1948, clearly demonstrated the diagnostic value of arthrography in the diagnosis of meniscal lesions. More recently, arthrography has regained popularity because of better visualization, increased accuracy, and the use of less irritating contrast media. The modern day athlete and industrial compensation patient individually represent substantial financial investments and, in these patients, arthrography is a reliable adjunct to the diagnosis of knee injuries.

Clinical Pathological Features

The largest double-hinged joint in the body,[4] the knee is vulnerable to both direct and indirect, angular and torsional stresses. A three-dimensional view of the articular surface of the tibia (Fig 1) illustrates the important anatomy of the knee. The two strong collateral ligaments prevent displacement and lateral angulation of the knee. The cruciate ligaments, anterior and posterior, respectively, prevent forward and backward displacement of the tibia. The medial and lateral menisci lie between the femoral and tibial condyles which compensate for the incongruity of their surfaces and maintain tension on the cruciate ligaments. The medial meniscus is stationary with joint movement,[5] its posterior portion is broad, and its basic configuration is oval or comma-shaped.[6] Inferiorly, it is attached to the tibia by the coronary ligament and the remainder of its base is firmly fused with the inner aspect of the medial collateral ligament. Injury of the medial meniscus occurs five to fifteen times as frequently as injury of the lateral meniscus and usually results from a sudden internal rotation of the femur upon the fixed tibia when the knee is abducted and flexed.[4] The lat-

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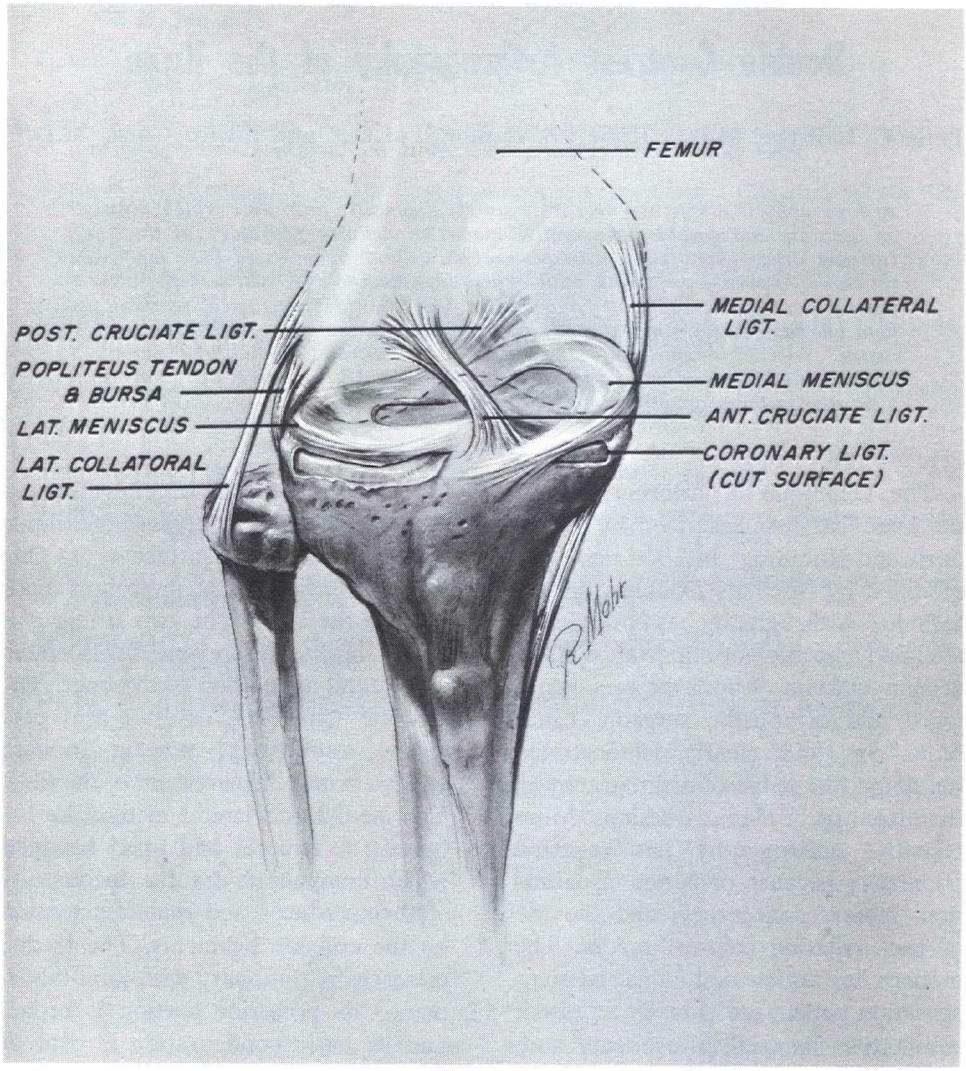

Figure 1

Three dimensional view of the articular surface of the tibia as viewed from above and anteriorly.

eral meniscus moves with joint motion. It has a partial, loose, peripheral attachment to the joint capsule, is thicker than the medial meniscus, and is semicircular or "C" shaped.[5-7] The lateral meniscus is injured by forceful external rotation of the femur upon the tibia when the knee is adducted and flexed.[4] Meniscal injuries may occur in association with tibial plateau fractures, with exercise such as "duck waddling", and by clipping injuries in football.

Treatment of laceration of either meniscus is total excision unless there

is only a peripheral detachment which has the potential of healing spontaneously.

Method and Materials

Thirty-two arthograms were performed on 32 patients, 15 to 67 years of age, with clinically-suspected internal derangements of the knee. Arthrotomies were not performed in 12 patients. Of these, seven had negative arthrograms and five had findings of or were suggestive of meniscal lesion. These cases are not included in the statistics or discussion because no conclusions can be made without arthrotomy. In the other 20 patients, there was a positive arthrogram-arthrotomy correlation of 85%. The arthrographic diagnosis of laceration of the medial meniscus was made in 16 patients and 15 lesions of the medial meniscus were identified at arthrotomy. Three lacerations of the lateral meniscus were recognized roentgenographically and six were identified at the time of surgery. Laceration of the medial collateral ligament, diagnosed in one patient, was substantiated at surgery. Popliteal cysts were diagnosed in three patients (one of which was evident clinically) but none were explored surgically. Postmenisectomy arthrograms in two patients revealed regeneration or retained cartilage. Both were surgically documented.

The technique of arthrography of the knee we use is a modification of the techniques of Heisser et al[8] and Olson.[9] From routine AP, lateral, and oblique roentgenograms of the affected knee, we attempt to delineate the specific nature of the internal derangement. Old fractures or avulsed fragments of bone in the area of the cruciate or collateral ligaments suggest specific sites of possible meniscal injury. Usually the roentgenograms are normal.

With the knee in the supine anteroposterior position, preliminary films are made with the x-ray tube angled five degrees caudally, five degrees cephalad, and occasionally at zero degrees to determine the best projection for demonstration of the joint space. In most examinations the optimal view is obtained with five degrees caudal angulation because of the caudal slope of the tibial plateau when the knee is in the extended position.

An 18-gauge needle is introduced into the intra-articular space by a lateral approach, following which the joint is aspirated and filled with 10 cc of Renografin-60 and 20-25 cc of room air. The knee is then passively flexed and extended for a period of one minute to distribute the contrast material and air throughout the joint space. Exposures are obtained as rapidly as possible. Multiple projections must be obtained since only that portion of the meniscus which is tangential to the rays can be evaluated. A delay of greater than 20 minutes can result in a suboptimal study because of dilution and absorption of contrast material. With the patient supine, the leg is positioned and immobilized by the radiologist. The basic film format is 1) Anteroposterior view, 2) four films in internal rotation at 20-degree increments, 3) four films in external rotation at 15-20 degree increments, 4) a 90-degree lateral, and 5) posteroanterior view using a 10-degree cephalad angulation. After injection the entire procedure can be completed in two to four minutes. If there is a questionable finding, the

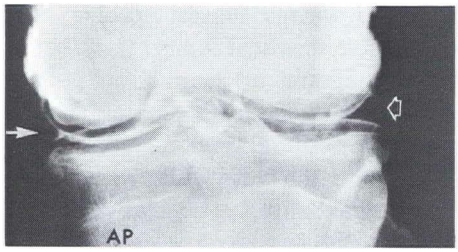

Figure 2

Anteroposterior radiography, after injection of contrast material and air, demonstrating the midportions of the medial (solid arrow) and lateral (open arrow) menisci.

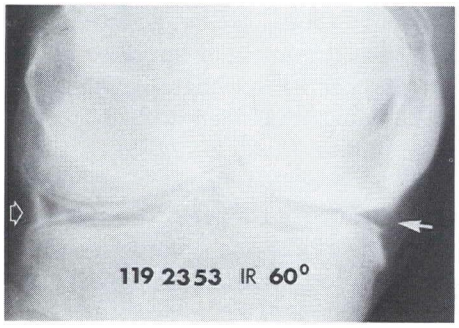

Figure 3

Radiograph in internal rotation demonstrating the triangular wedge of the anterior horn of the medial meniscus (solid arrow) and the posterior horn of the lateral meniscus (open arrow).

Figure 4

Radiograph in external rotation showing the posterior horn of the medial meniscus (solid arrow) and the anterior horn of the lateral meniscus (open arrow).

films may be repeated—remembering, however, that the contrast material is totally absorbed within one hour. The air may remain in the knee for 36 hours.[10]

In the normal arthrogram the menisci appear as sharply delineated wedges whose inner margins are coated with contrast material and surrounded by air. In the anteroposterior view the mid-portion of each meniscus is visualized (Fig 2). With internal rotation of the knee, the anterior horn of the medial meniscus and the posterior horn of the lateral meniscus are seen (Fig 3). The anterior horn of the lateral meniscus and posterior horn of the medial meniscus are demonstrated on external rotation (Fig 4). Normally there are three small contrast filled synovial recesses located at the anterior inferior margin, at the superior outer margin of the medial portion of the medial meniscus, and at the anterior inferior margin of the lateral meniscus[3] (Fig 5). The posterior portion of the lateral meniscus is crossed by the popliteus tendon and bursa. The latter communicates with the joint space and fills with air and contrast material which may obscure the posterior horn of the lateral meniscus (Fig 6). On a well-penetrated lateral view the cruciate ligaments appear as radiolucent crossing bands extending to their respective attachments[7] (Fig 7). The suprapatellar bursa is always visualized while the semimembranosus-gastrocnemius bursa is visualized in approximately 20% of cases.[3,9,11] Enlargement of this posterior bursa is a popliteal or Baker's cyst, and, when present in an adult, is indicative of joint effusion secondary to trauma and/or inflammation[6,12,13] (Fig 8). Childress has indicated that the oc-

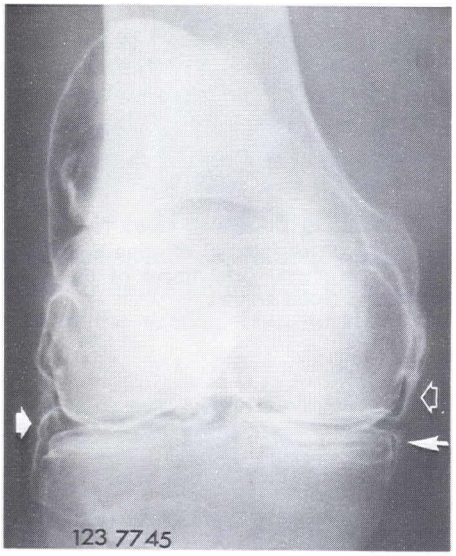

Figure 5

Anteroposterior radiograph demonstrating the three synovial recesses outlined with contrast material: recess of the superior outer portion of the medial meniscus (open arrow); recess of the anterior inferior margin of the medial meniscus (solid thin arrow); and the recess of the anterior inferior margin of the lateral meniscus (solid broad arrow).

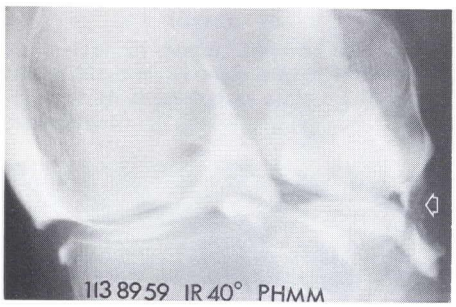

Figure 6

The popliteus tendon appears as a radiolucent band (open arrow) with contrast at its medial edge within the popliteus bursa. Both the tendon and bursa cross the posterior horn of the lateral meniscus.

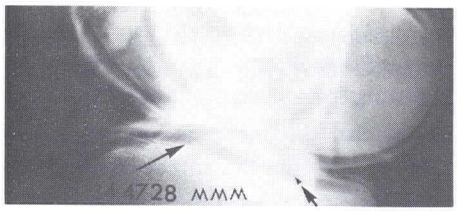

Figure 7

The cruciate ligaments, anterior (solid arrow) and posterior (dotted arrow), appear as radiolucent crossing bands extending to their respective attachments.

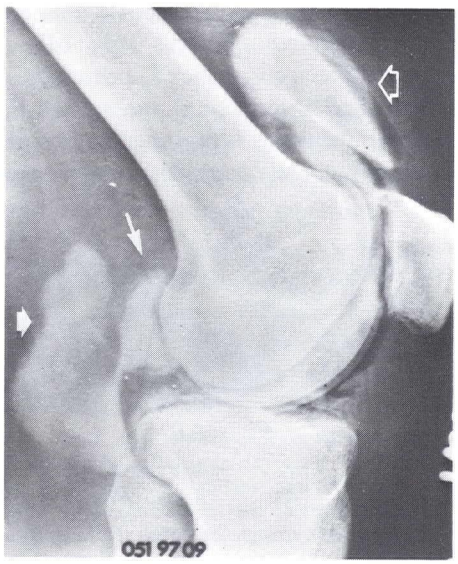

Figure 8

Lateral radiograph demonstrating the bursae of the knee: suprapatellar bursa (open arrow); posterior capsule (thin solid arrow); and the semimembranosus-gastrocnemius bursa (solid broad arrow).

currence of an unrecognized laceration of the posterior horn of the medial meniscus can be associated with popliteal cysts.[14]

In the abnormal arthrogram, a deformity in the contour of the meniscus or abnormal collection of contrast material within the meniscal wedge is indicative of cartilage laceration. Tears may be classified as: 1) complete, 2) in-

complete (Fig 9), 3) vertical (Fig 10), 4) transverse (Fig 10), 5) peripheral detachment (Fig 11) and 6) mixed types (Fig 12). Rupture of the medial collateral ligament is manifested by contrast within the soft tissues paralleling the course of the ligament[9,10] (Fig 13). In patients who have had menisectomies the remaining meniscus can be evaluated without alteration in routine. A blunt wedge in the site of a previous menisectomy is evidence of a retained or regenerated meniscus (Fig 14). A discoid meniscus, which is primarily an atavistic developmental anomaly of the lateral meniscus,[4] presents as an abnormally wide wedge without an apex,

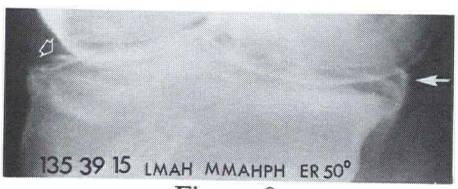

Figure 9

Radiograph in external rotation demonstrating: A complete vertical laceration of the posterior horn of the medial meniscus (solid arrow); and a complete transverse laceration of the anterior horn of the lateral meniscus (open arrow).

Figure 10

Radiograph in external rotation showing an incomplete laceration of the posterior horn of the medial meniscus (solid arrow).

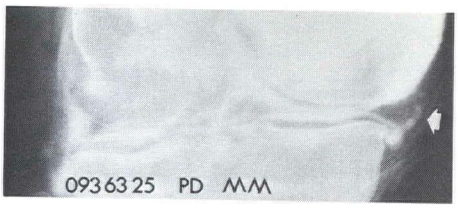

Figure 11

Radiograph in internal rotation demonstrating a peripheral detachment of the medial meniscus (solid arrow).

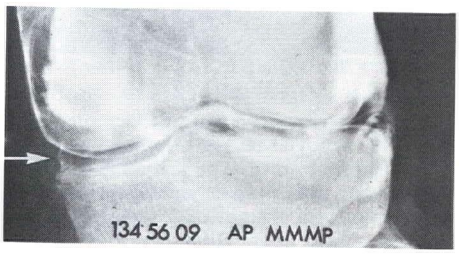

Figure 12

Anteroposterior radiograph demonstrating a mixed type of meniscal laceration comprised of vertical and horizontal components (solid arrow).

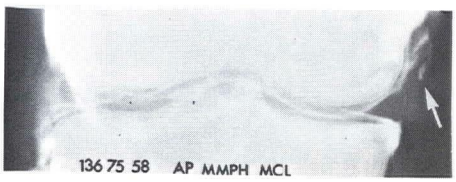

Figure 13

Anteroposterior radiograph demonstrating a laceration of the medial collateral ligament with contrast material in the soft tissues paralleling the course of the ligament (solid arrow).

extending toward the center of the joint (Fig 15).

In this series of 32 cases no contrast allergies, air embolus, joint sepsis, or complete extra-articular injection were encountered. Three cases of air embolus have been reported in the literature,[15,16] each of which occurred because adequate precautions were not taken to insure an intra-articular position of the needle. Transitory eosinophilia has also been reported.[17] Few cases of joint sepsis have been reported.[3,11] Myositis ossificans has occurred following the intra-articular use of lipiodol.

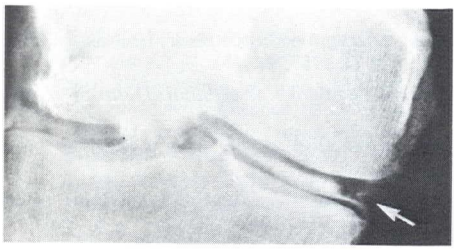

Figure 14

Radiograph in moderate external rotation showing the blunt wedge of a regenerated medial meniscus (solid arrow).

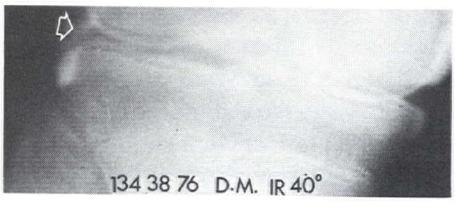

Figure 15

Radiograph in internal rotation demonstrating an abnormally wide wedge, without an apex, which characterizes a discoid meniscus (open arrow).

Summary

Arthrography of the knee was performed in 32 patients in 85% of whom the condition of the menisci were verified by arthrotomy. Ninety-four percent of medial meniscal lesions were diagnosed and documented. Eighty-three percent of lateral meniscal lesions were in the posterior horn, but only 50% were documented at the time of surgery. Arthrography is a safe, accurate, and relatively simple diagnostic procedure which provides an accurate and graphic peroperative means of defining pathology of the knee. In those patients in whom the expeditious evaluation and diagnosis of knee injury are of prime importance, that is, the athlete and industrial compensation patient, arthrography provides a significant contribution by reinforcing the clinical impression. A negative arthrogram does reinforce the negative or doubtful clinical opinion. When utilizing this technique (vertical beam), evaluation of a lesion in the posterior horn of the lateral meniscus is less dependable.

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