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ARTHROGRAPHY OF THE KNEE IN THE DIAGNOSIS OF TORN SEMILUNAR CARTILAGE

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In 1948, *Lindblom* described an excellent technique of arthrography of the knee. Torn cartilage was correctly diagnosed in 95 per cent of his series, but he did not indicate the number of cases in which the diagnosis was verified by operation (3). Subsequently, several papers have been published concerning the value of arthrography in the diagnosis of meniscal injuries. In 1959, *Turner & Wurtz* stressed the usefulness of this method in the diagnosis of lesions of the medial meniscus, but stated that it was unreliable where the lateral meniscus was involved (9). Later authors have come to similar conclusions, and in 1965, *Sommer* as well as *Saugman-Jensen* stated that the diagnostic value of the arthrography of the knee is doubtful (4, 8). Furthermore, complications have occurred in connection with arthrography (*e.g.*, 6), and the method has therefore abandoned by some orthopaedic surgeons.

Nevertheless, a sound arthrographic technique in combination with judicious interpretation of the findings can be decisive in the diagnosis of a ruptured meniscus. The lack of agreement in the reports hitherto published may be partly attributable to differences in the methods employed, partly to varying experience in interpreting the arthrograms.

At the Orthopaedic Hospital of the Invalid Foundation arthrography of the knee joint has been used for some twenty years as a routine method in the diagnosis of meniscal injuries of the knee. The method of *Lindblom* (3) as modified by Edgren in 1957 is still used in this clinic.

The present contribution (*cf.* 2, 5, 7) is made in belief that our

results may throw further light on the value of arthrography in the diagnosis of torn semilunar cartilage. At the same time, *Lindblom's* modified method is presented.

MATERIAL

The results are based on analysis of 105 patients operated on for meniscal injuries or discoidal menisci in the Orthopaedic Hospital of the Invalid Foundation during the years 1957-1964. Prior to operation all patients were examined by arthrography. During the period in question more than 700 arthrograms were taken in order to diagnose injuries of the knee, but the material presented here consists solely of operated cases in which the condition of the semilunar cartilage was examined carefully at the operation. Of these patients, 59 were men and 106 were women. Seven patients were under 15 years of age at the time of operation.

OPERATIVE FINDINGS

According to the operative records 95 patients had torn medial semilunar cartilage. The lateral cartilage was ruptured in 39 cases, and both menisci were ruptured in 6 (Table 1). It is possible that the actual number of cases with rupture of both cartilages was larger, since it is difficult to examine the meniscus on the other side through an anterolateral or anteromedial incision. This applies in particular to the posterior horn of the meniscus. Arthrotomy was carried out by an anterolateral or anteromedial oblique incision, or in some cases by the typical incision of Payr. In 10 cases a discoidal semilunar cartilage was observed, and 4 of these were torn. In 15 cases both semilunar cartilages were normal, showing no signs of rupture (Table 1), but it should be pointed out that the operator may fail to observe a rupture (cf. *Watson-Jones*). It is particularly difficult to distinguish a rupture starting from the point of the meniscal wedge.

CLINICAL DIAGNOSIS

In the present series the clinical diagnosis was verified by the operative finding in 101 cases (61 per cent). In 64 cases the clinical diagnosis proved to be incorrect,

Table 1. Operative findings.

Meniscus	No. of cases
Lateral ruptured	39
Medial ruptured	95
Both ruptured	6
Discoidal	10
No rupture seen at operation	15
Total	165

Table 2.

Operative finding	No. of cases	Clinical diagnosis correct		Clinical diagnosis incorrect		Arthrography correct		Arthrography incorrect	
		No. of cases	%	No. of cases	%	No. of cases	%	No. of cases	%
Lateral meniscus ruptured	39	21	54	18	46	36	92	3	8
Medial meniscus ruptured	95	67	69	28	31	91	95	4	5
Both menisci ruptured	6	0	0	6*	100	6	100	0	0
Discoidal meniscus	10	3	30	7	70	10	100	0	0
No rupture seen at operation	15	10	67	5	33	11	73	4†	27
Total	165	101		64		154		11	

* Rupture of the meniscus was clinically diagnosed, but the fact that both menisci were ruptured was not recognized.

† At the operation no rupture of the menisci was observed in spite of clearly arthrographic finding (Figure 8).

or no diagnosis could be made on the basis of the history and the physical examination (Table 2). In 69 per cent of the cases the clinical diagnosis of torn medial semilunar cartilage proved to be correct, while in the cases showing rupture of the lateral cartilage the clinical diagnosis was correct in only 54 per cent of cases. A correct clinical diagnosis of discoidal meniscus was made in 3 cases out of 10 (Table 2). In 10 cases out of 15 the clinical diagnosis of a normal semilunar cartilage was correct. These 15 patients were operated on owing to severe symptoms of long standing.

TECHNIQUE OF ARTHROGRAPHY

A condition for achieving good arthrograms of the knee is that the central beam strikes tangentially on the part of the meniscus to be reproduced. In practice, this means that in each exposure the central beam must be parallel with part of the proximal plane of the tibia. The application of this rule requires acquaintance with the position of the proximal plane of the tibia and the factors influencing it.

In his pioneering monograph on arthrography of the knee using iodine salt aqueous solutions, *Lindblom* (1948) indicated certain standard projections to be used in stereo-arthrographies. In our opinion, based on experience gained at the Orthopaedic Hospital of the Invalid Foundation, these standard projections do not invariably yield the best possible results, because this method does not sufficiently reckon with variations in the position of the proximal plane of the tibia in relation to its longitudinal axis (see Figures 1 and 2), and on the motility of the knee joint, *e.g.* hyperextension or extension deficiency.

In order to obtain reliable information regarding the position of the proximal plane of the tibia in relation to the tabletop, each arthrography of the knee is

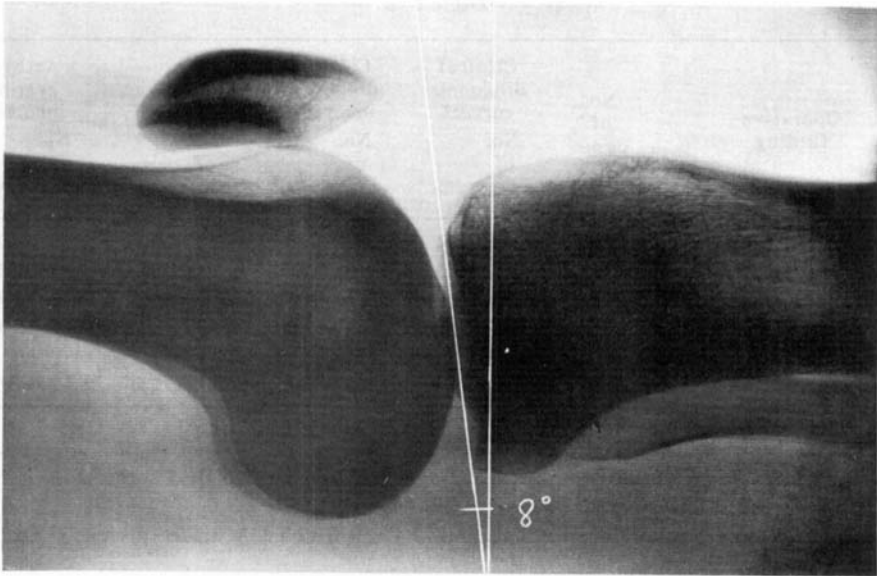


Figure 1. An example of a direction view. The proximal plane of the tibia is tilted 8 degrees.

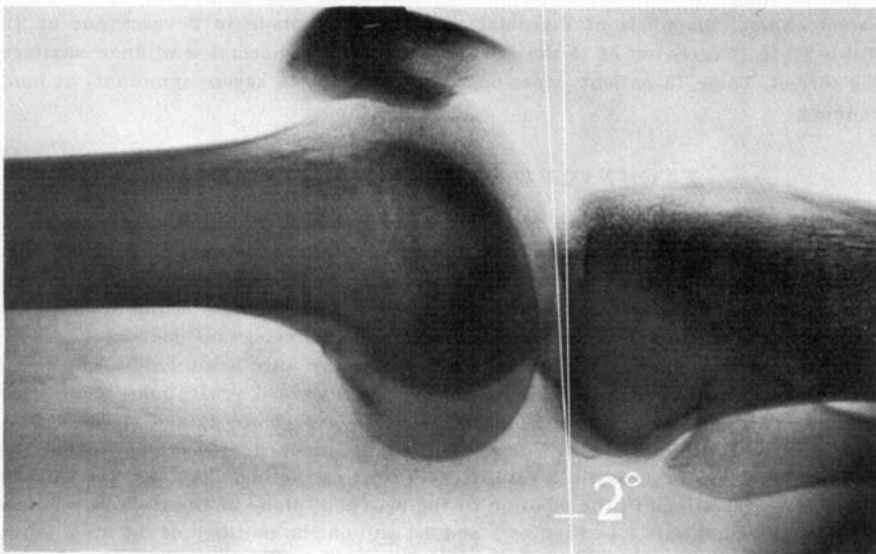


Figure 2. An example of a direction view. The proximal plane of the tibia is tilted only 2 degrees.

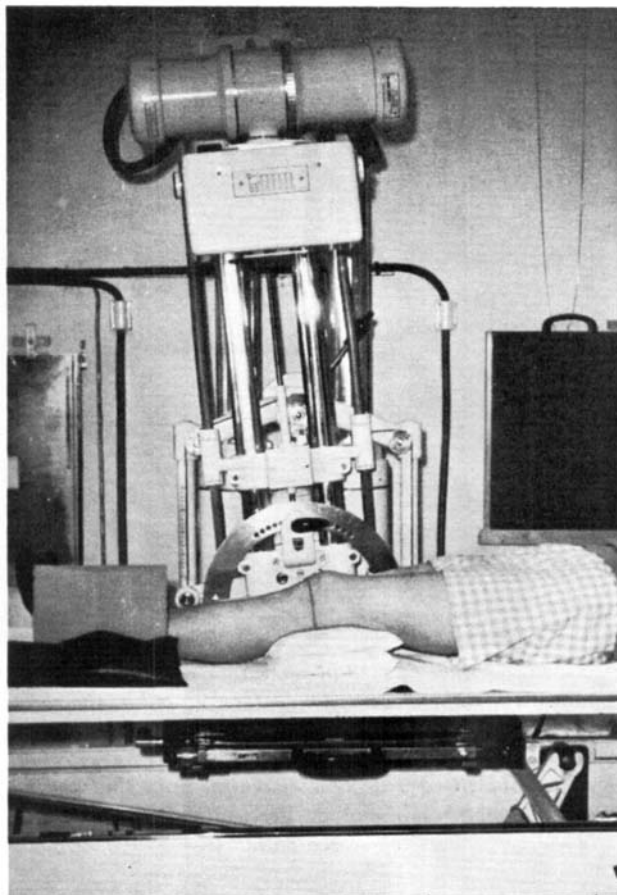


Figure 3. The patient in position for arthrographic examination. There was extension deficiency in the knee joint. The knee is supported with cushions. The joint space is drawn onto the skin according to the direction view, and the tube is tilted 5 degrees caudally so that the central ray parallels the proximal plane of the tibia.

preceded by the taking of a so-called "direction view" (Figures 1 and 2). This is taken with the aid of a movable bystand with horizontal beam direction. The patient is in the supine position with extended legs. The cassette (18×24 cm) is placed on edge against the medial surface of the knee, with one long side close to the tabletop. If an extension deficiency is present, the knee is supported by a cushion to eliminate unsharpness due to motion. On a lateral view thus obtained, the angle between the proximal plane of the tibia and the tabletop (= the long side of the film) can be measured directly (Figures 1 and 2). This angle determines the projections to be used in the arthrographies.

After local anaesthesia, hydropic joints are emptied and then the contrast medium (6-8 cc of 60 per cent Urografin) is injected.

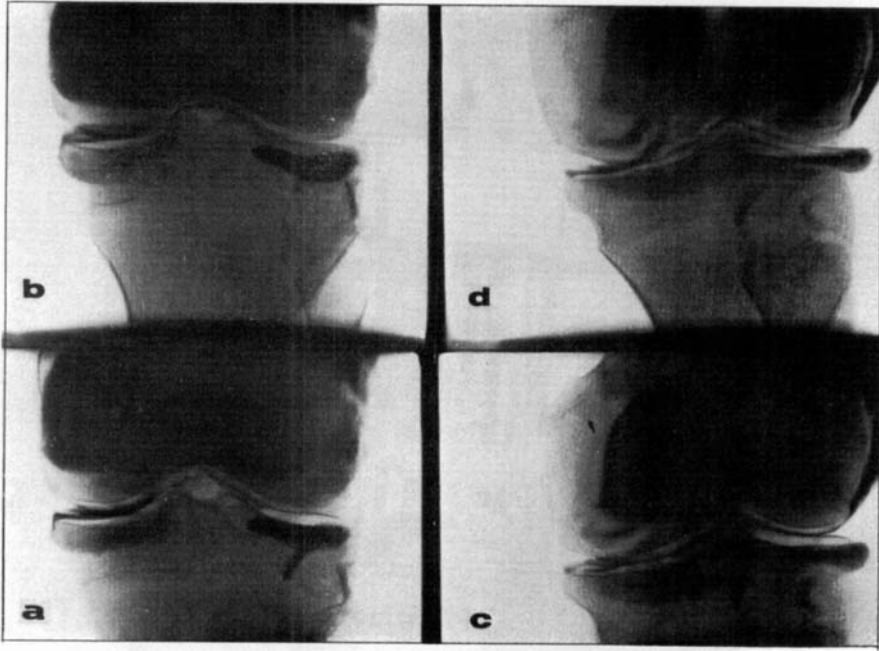


Figure 4. Boy aged 15. Rupture of medial semilunar cartilage. In the direction view the proximal plane of the tibia was tilted 2 degrees. a: and b: the right leg in neutral position = position I. c: and d: the leg was rotated 45 degrees outward = position II. a: X-ray tube in neutral position. b: tube tilted 5 degrees cranially. c: tube in neutral position. d: tube tilted 5 degrees caudally. Note that the rupture is more clearly visible in the pictures a and d. Vertically juxtaposed pictures forms a stereo-pair.

Exposures are taken in the three basic projections indicated by *Lindblom*: I = frontal, II = 45-degrees eversion, and III = 45-degree inversion. On the basis of the direction view the beam direction is determined by one of the following two methods. Either the tube is tilted so that the central ray parallels the proximal plane of the tibia. Exposures are taken in this position as well as with further tiltings of 5 degrees cranially and 5 degrees caudally (Figure 3). Or the knee is bent with the aid of cushions so that the proximal plane of the tibia becomes perpendicular to the tabletop, and exposures are then taken in neutral position as well as with tiltings of 5 degrees caudally and 5 degrees cranially. Our experience suggests that the latter alternative is to be preferred.

Film size 24×30 cm was used. The picture field was divided into four subfields with the aid of a semi-automatic seriograph so that the pictures on the short side of the film formed a stereo-pair (Figure 4). In examining children, a film of this size can be divided into six subfields. Projection IV, the "tunnel projection", has been taken as a ventrodorsal view with the patient still supine and with the knee in about 30-degree flexion over a cushion. The cassette, 13×18 cm, is placed cross-wise in the popliteal fossa. The tube is tilted in the caudal direction, and in this

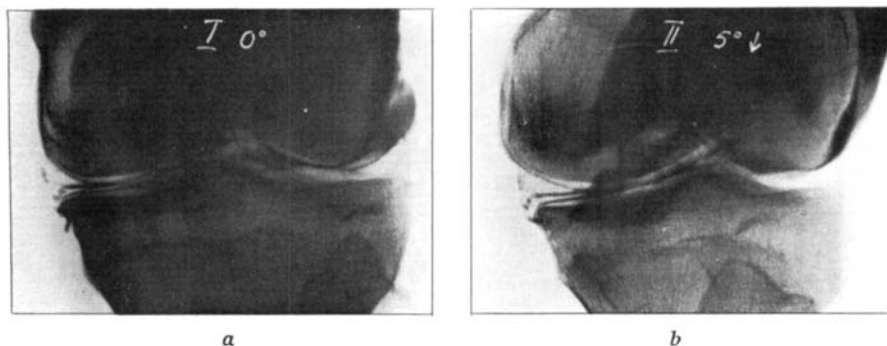


Figure 5. Man aged 24. The proximal plane of the tibia in the direction view was tilted 5 degrees and corrected to vertical with a cushion. In Figure 5 a, position I, tube neutral; in Figure 5 b, position II, tube tilted 5 degrees caudally. The medial horizontal rupture is clearly visible. The rupture was also diagnosed clinically. Verified by operation.

case, too, the degree of tilting must be determined by the direction of the proximal plane of the tibia. In the adjustment, the "decretion view" and a mark on the skin indicating as accurately as possible the joint space are very helpful. For projection V, the lateral projection, Lindblom's technique is used.

By variation of the degree of eversion and inversion, respectively, we have been able in some cases to visualize a rupture in the meniscus which had not been seen on the first examination. This applies to small ruptures of the horns of the semilunar cartilages.

RESULTS

By this modified technique of arthrography a correct diagnosis was made in 154 of the present 165 cases (93 per cent) (Figures 5a and b). In 64 cases in which the clinical diagnosis proved to be incorrect, a correct diagnosis was achieved on the basis of the arthrograms in 60 cases (94 per cent) (Figures 6a and b). On the other hand, in the group of 15 patients in which no rupture of the semilunar cartilage could be seen at operation, the arthrography showed a rupture in 4 cases (Table 2). In these cases the lateral meniscus was involved in three and the medial meniscus in one. In one of the former the meniscus was in part detached from the capsule, but in the meniscus itself no rupture was detected. As revealed by arthrography, there was in another of the lateral cases a horizontal rupture which started from the inner margin of the meniscus and was therefore difficult to detect (Figure 8). In the third case the rupture occurred in connection with removal of the meniscus. When an attempt was made to remodel the

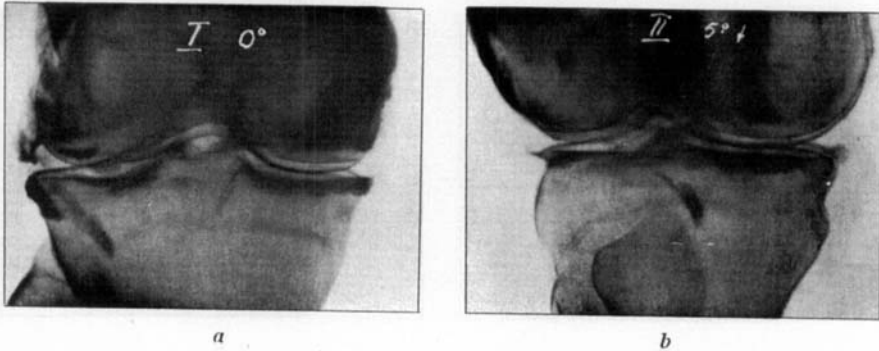


Figure 6. Woman aged 35. The proximal plane of the tibia in the direction view was tilted 5 degrees and was corrected to vertical, Figure 6 a, position I with the tube in neutral position. Figure 6 b, position II with the tube tilted 5 degrees caudally. Rupture of lateral semilunar cartilage is clearly seen in both figures. Rupture verified by operation, but not diagnosed clinically.

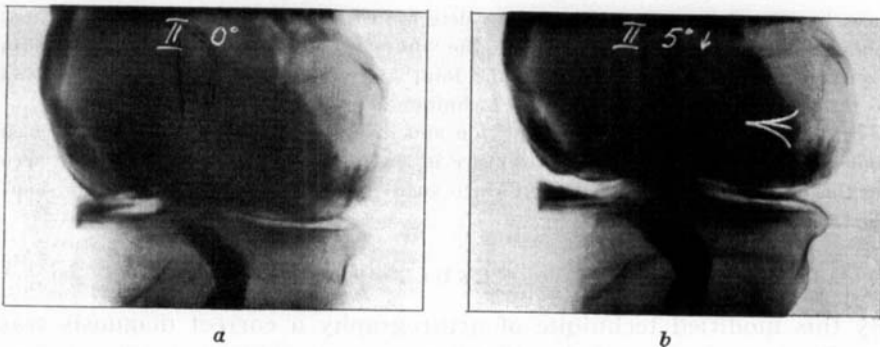


Figure 7. Woman aged 39. The proximal plane of the tibia was vertical in the direction view. Both figures from projection II. Figure 7 a: tube in neutral position; Figure 7 b: tube tilted 5 degrees caudally. The discoidal lateral semilunar cartilage is clearly seen in Figure 7 b, but not in Figure 7 a. Note also the horizontal rupture of the medial semilunar cartilage in Figure 7 b. The arthrographic findings was verified by operation. Clinical examination failed to reveal the discoidal meniscus and the rupture in the medial meniscus.

removed meniscus no rupture was observed, but it may have been overlooked. It should be borne in mind that ruptures sometimes escape discovery at operation (cf. Watson-Jones). All 10 cases of discoidal semilunar cartilage were correctly diagnosed by arthrography (Figures 7a and b), and the same holds good for the 6 patients showing rupture of both semilunar cartilages (Table 2).

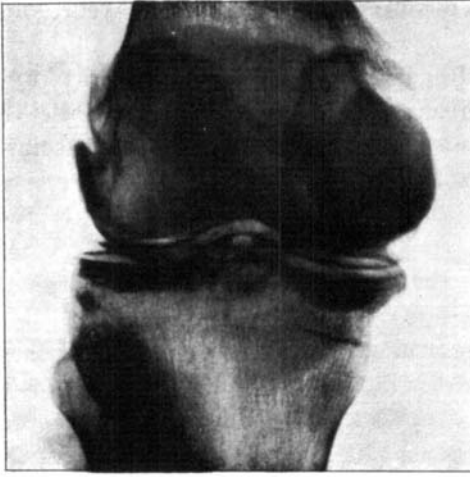


Figure 8. Man aged 39. A clear horizontal rupture is seen in the lateral meniscus, but the operator failed to find it. The arthrographic finding is so typical that it is obvious that the operator did not recognize the true condition of the semilunar cartilage.

DISCUSSION

Since arthrography performed by the technique described caused no complications in any of over 700 cases, the examination must be regarded as harmless. The complications reported in the literature are, perhaps, attributable to technical mistakes. On the basis of the present results arthrography seems to be indicated in all cases suspected of torn semilunar cartilage, even if the clinical diagnosis appears certain. Arthrography makes evaluation of the condition of both semilunar cartilages possible (cf. 1), including that which appears to be symptom-free. If a good arthrogram is available, it is possible to plan the operation adequately in cases showing rupture of both menisci. Furthermore, it should be borne in mind that it is difficult to diagnose a discoidal semilunar cartilage on the basis of the history and the physical examination. In such cases arthrography of the knee almost invariably yields a correct diagnosis. Finally, it should be emphasized that arthrography is a valuable aid in the diagnosis of injuries of the knee in cases in which the information obtained from the history and the physical examination is unsatisfactory.

SUMMARY

Arthrography of the knee was performed by a modification of Lindblom's technique in 165 cases in which the condition of the semilunar cartilages was subsequently verified by operation. Of the patients

59 were men and 106 were women. Seven patients were 15 years old or younger.

According to the operative findings, the medial meniscus was ruptured in 95 cases, the lateral meniscus in 39, and both in 6, while 10 patients had a discoidal semilunar cartilage. In 15 cases both semilunar cartilages seemed to be normal.

A correct clinical diagnosis was made in 101 cases (61 per cent) out of 165. In 64 cases the clinical diagnosis was incorrect.

A modification of Lindblom's arthrographic technique is described. No complications occurred in connection with arthrography.

By this modified method a correct diagnosis was made in 154 cases (93 per cent) out of 165. In 64 cases in which the clinical diagnosis proved to be incorrect, a correct diagnosis was made on the basis of the arthrograms in 60 (94 per cent). The arthrographic diagnosis was not verified at operation in 4 cases out of 15 in which the semilunar cartilages seemed to be normal at operation, but it should be borne in mind that the operator may fail to observe a rupture in the meniscus, particularly if a horizontal rupture is involved. This seems to apply to at least two of the four cases in question. The arthrographic diagnosis was correct in all 10 cases showing discoidal meniscus, and in all 6 cases in which both menisci were ruptured.

RESUME

L'arthrographie du genou a été pratiquée par une modification de la technique de Lindblom dans 165 cas chez lesquels l'état des cartilages semi-lunaires a été vérifié par l'opération. Sur ce nombre de malades, 59 étaient des hommes et 106 des femmes. Sept malades avaient 15 ans ou moins.

Selon les trouvailles opératoires, il y avait rupture du ménisque médian dans 95 cas, du ménisque latéral dans 39, des deux dans 6 cas, alors que chez 10 malades un cartilage semi-lunaire était discoidal. Dans 15 cas les deux cartilages semi-lunaires semblaient être normaux.

Un diagnostic correct a été posé dans 101 cas (61 pour cent) sur 165. Dans 64 cas, le diagnostic clinique était incorrect.

Une modification de la technique de Lindblom pour l'arthrographie est décrite. L'arthrographie n'a donné lieu à aucune complication.

Avec cette méthode modifiée, un diagnostic correct a été posé dans 154 cas (93 pour cent) sur 165. Dans 64 cas chez lesquels le diagnostic

clinique s'est montré incorrect, un diagnostic correct a été posé sur la base des arthrogrammes dans 60 cas (94 pour cent). Le diagnostic arthrographique ne s'est pas vérifié à l'opération dans 4 cas sur 15 chez lesquels les cartilages semi-lunaires semblaient être normaux, mais il faut se souvenir que le chirurgien peut n'avoir pas observé une rupture du ménisque, notamment s'il s'agit d'une rupture horizontale. Ceci semblait être le cas chez deux des quatre malades en question. Le diagnostic arthrographique était correct dans tous les 10 cas montrant un ménisque discoïdal et dans tous les 6 cas chez lesquels il y avait rupture deux ménisques.

ZUSAMMENFASSUNG

Bei 165 Fällen wurde eine Arthrografie mit einer modifizierten Methode der Lindblom-Technik durchgeführt, wobei nachher die Verhältnisse an den Menisken durch einen operativen Eingriff beurteilt werden konnten. Von den Patienten waren 59 Männer und 106 Frauen. 7 Patienten waren 15 Jahre alt oder jünger.

Die Operationsbefunde zeigten, dass in 95 Fällen der mediale Meniskus, in 39 Fällen der laterale Meniskus, in 6 Fällen beide Menisci rupturiert waren, während 10 Patienten einen discoïdalen Meniskus hatten. Bei 15 Fällen schienen beide Menisken normales Aussehen zu haben.

Eine richtige klinische Diagnose wurde in 101 Fällen von 165 (61 pro zent) gestellt. Bei 64 Fällen war die klinische Diagnose falsch.

Die Modifizierung der Arthrografietechnik von Lindblom wird beschrieben. Keine Komplikationen traten im Zusammenhang mit der Arthrografie auf.

Mit dieser modifizierten Methode wurde bei 154 Fällen von 165 (93 pro zent) eine richtige Diagnose gestellt. Von 64 Fällen mit einer unrichtigen klinischen Diagnose, konnte eine richtige Diagnose bei 60 Fällen (94 pro zent) auf Grund des Arthrogramms gestellt werden. Die arthrografische Diagnose wurde bei 4 von 15 Fällen nicht bestätigt; bei ihnen schienen die Menisken bei der Operation von normaler Beschaffenheit zu sein. Man sollte sich aber vor Augen halten, dass dem Operateur eine Ruptur des Meniskus entgehen kann, besonders wenn eine horizontelle Ruptur in Frage kommt. Dies scheint in mindestens zwei von den vier Fällen zugetroffen zu sein. Die arthrografische Diagnose war bei allen 10 Fällen mit einem diskoidalen Meniskus richtig, und bei allen sechs Fällen mit Rupturen in beiden Menisken.

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