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OPERATIVE TREATMENT OF TORN LIGAMENTS IN INJURIES OF THE KNEE JOINT

By

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The stability of the knee joint is a complicated function in which, besides bony and cartilaginous structures, soft tissues take part, *i.e.* a number of muscles and their tendons and several ligaments, the most important of which are the cruciate and collateral ligaments, and the joint capsule. The main function of the cruciate ligament is perhaps to act as a guide-rope for movements, not as a checkstrap (*Helfet* 1963).

When a ruptured ligament is treated conservatively there is no guarantee of reliable reduction and fixation of the ligamentous ends. When methods of conservative and operative treatment have been experimentally compared, it has appeared that healing is quicker and better when apposition and fixation of the ligamentous ends have been carried out operatively (*Clayton & Weir* 1959).

In our hospital, acute total ligamentous injuries have in recent years as a rule been repaired surgically. The results of treatment will be presented in the following.

MATERIAL

During the period 1958–1965, 128 total ruptures of the cruciate or collateral ligament were treated operatively; 90 (71 per ceent) were followed up for 1 to 8 years aftr the trauma. Of these cases, 71 were recent and 19 old, meaning cases operated on within three weeks or later. The followed patients had had a total of 156 ruptures. The various combinations are shown in Table 1.

Together with ligamentous tears there were fractures of the tibial or femoral condyles in 13 cases. Injuries of the meniscus occurred in 47 patients. In connection with tearing of the lateral collateral ligament the fibular nerve was totally ruptured in two cases. In connection with other ligamentous injuries there was total avulsion of the patellar ligament in 4 cases.

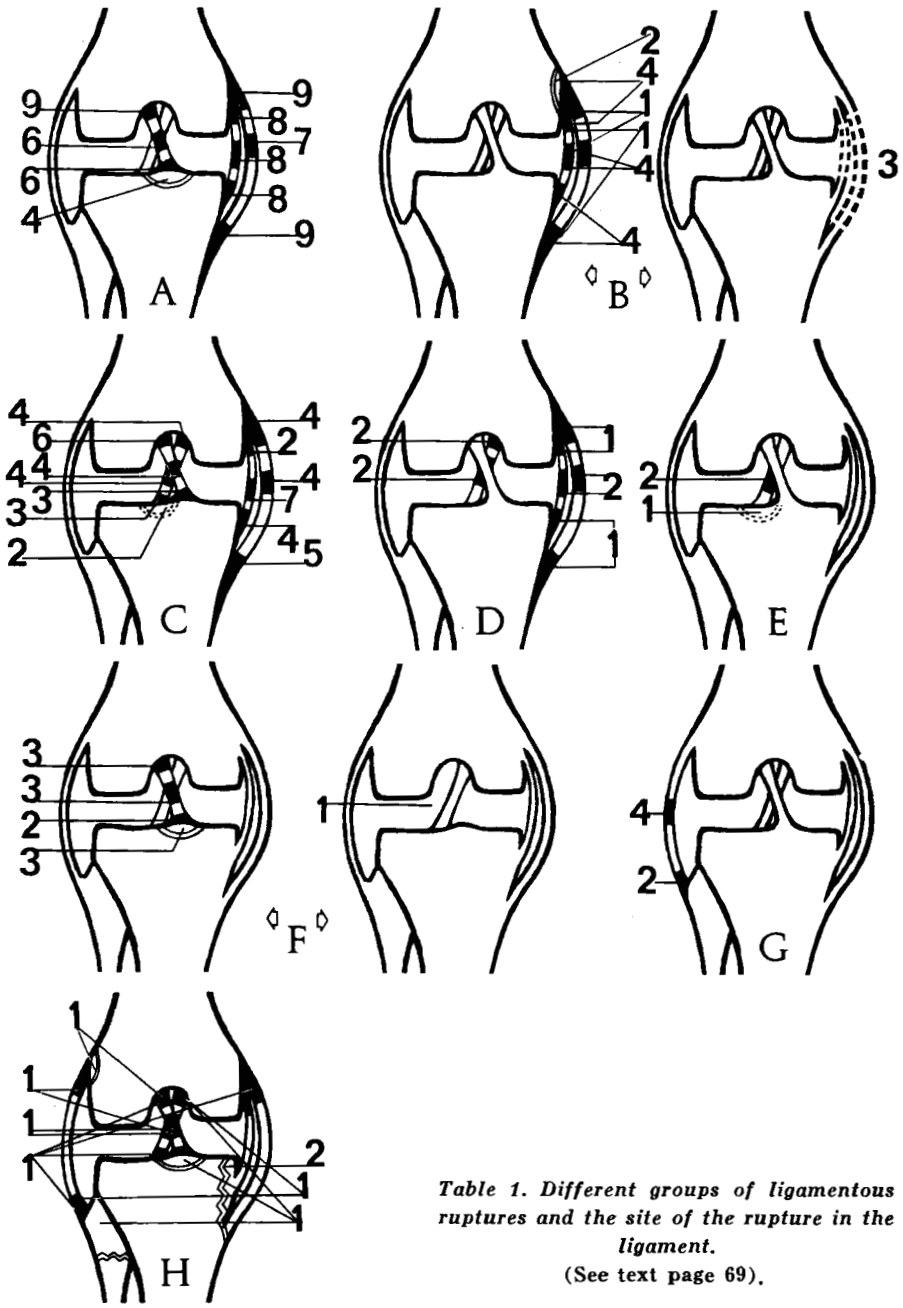

Table 1. Different groups of ligamentous ruptures and the site of the rupture in the ligament.

(See text page 69).

The following types of traumata were represented: 38 traffic accidents, 24 falls, 22 injuries in athletics, 4 direct blows, and 2 open lacerations.

Of the patients 65 were males and 25 females. 13 of the patients were under 20 years old, 39 were 21 to 40, 33 were 41 to 60 and 5 over 60. In all patients over 60 the main indication for operative treatment was an intra-articular fracture.

DIAGNOSIS

Diagnosis was based on clinical examination, largely according to *de Palma* (1954), and on plain radiograms. Particular attention was paid to abnormal movement as a result of torn ligaments of the knee joint. Examination as soon after the trauma as possible was considered to be ideal. The diagnosis was often confirmed under anaesthesia immediately before the operation. Arthrography or roentgenographic examination under stress were not employed.

OPERATION

Operation was carried out on the day of the trauma in 19 cases, on the first or second posttraumatic day in 34 cases and within 3 to 11 days in 18 cases. 19 old injuries were operated on 3 weeks to 3 years after the trauma (after more than 4 months in 14 out of 19 cases). Operation was carried out under general anaesthesia and the limb was exsanguinated, provided that no contraindications existed. Ligamentous ruptures were, as a rule, sutured with chromic catgut. Insertion ruptures and avulsion fractures were fixed with sutures or screws to their freshened sites (Figure 1). In 4 recent cases the ruptured anterior cruciate ligament was reinforced by a distally based fascial graft to act as its core, the remnants of the ligament being handled as atraumatically as possible. One recent rupture of the medial collateral and anterior cruciate ligaments was repaired by *Hey Groves'* (1917, 1920) method.

For the repair of old tears the following methods, among others, were employed: for the repair of the anterior cruciate ligament Hey Groves' method and modifications thereof (*Bosworth* 1936, *O'Donoghue* 1963), reinsertion of avulsion fracture,

Table 1.

A. Medial collateral and anterior cruciate ligament	25	cases
B. Medial collateral ligament	19	„
(The site of the rupture could not be determined with certainty in 3 old cases)		
C. Medial collateral and anterior and posterior cruciate ligament	13	„
D. Medial collateral and posterior cruciate ligament	4	„
E. Posterior cruciate ligament	3	„
F. Anterior cruciate ligament	12	„
(In one old case the ligament was entirely absent)		
G. Lateral collateral ligament	6	„
H. Other (combinations)	8	„
Total	90	cases

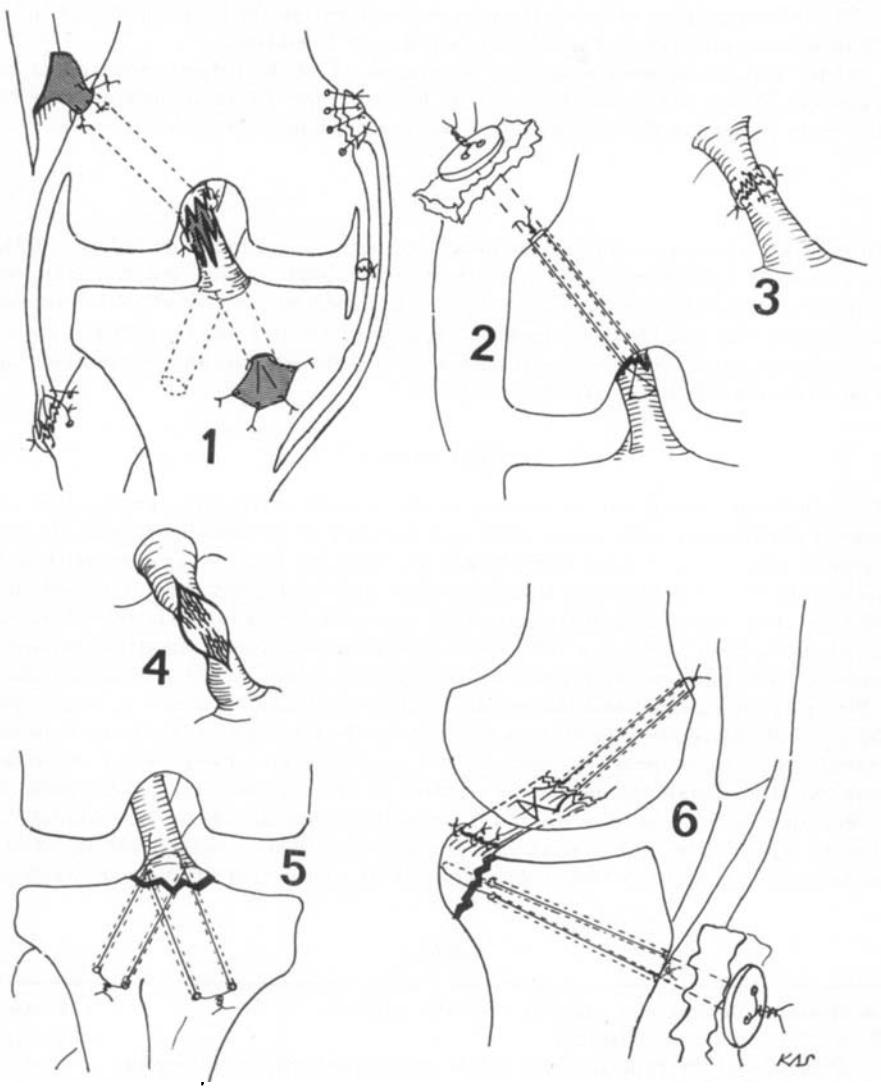

Figure 1. Different types of diagnosed ruptures and the methods used for primary repair.—The torn ligament has already been strenghthened at the primary operation by a graft, the ligamentous tissue nevertheless being preserved as undamaged as possible (1). The most important factors are the correct position and direction of the ligament, but not the intraosseous course of the graft or the thread (1, 2, 5). The cruciate ligament was sometimes repaired with thin transligamental sutures but more often with transosseous sutures, which could be left or removed (2, 3, 5, 6). A stretched cruciate ligament was torn, often totally though subsynovially (4).

for the repair of the medial collateral ligament *Hey Groves'*, *McMurray-Helfet's* (1963), *Mauck's* (1936) and the reversed Mauck method, for the repair of the lateral collateral ligament *Edward's* (1921) method and transplantation of the insertion according to Mauck.

Postoperatively, the limb was immobilized in slight flexion in a plaster cast usually for 6 to 8 weeks. Exercise of the quadriceps muscle was, if possible, begun on the first postoperative day, walking with crutches 1 to 2 weeks after the operation, and weight-bearing after 3 to 6 weeks. Fractures that had occurred simultaneously with ligamentous injuries often influenced the postoperative treatment in particular.

RESULTS

When evaluating the end results at follow-up, we aimed at appraising the result of treatment of the whole knee injury. In cases of fracture, separate mention will be made of the result of treatment of the ligament involved. For the classification of results, we have defined excellent, good, fair or poor results as follows:

Excellent. Full mobility and stability, no pain during activity, only slight muscular atrophy of the thigh.

Table 2. Results of treatment of recent ligamentous injuries which were not accompanied by fracture of condyles.

Ligamentous injury	Total	Excellent	Good	Fair	Poor
Medial collateral and anterior cruciate	21	5	7	7	2
Medial collateral	10	4	2	4	–
Medial collateral and anterior and posterior cruciate	10	3	3	2	2
Medial collateral and posterior cruciate	4	1	–	–	3
Posterior cruciate	3	–	1	–	2
Anterior cruciate	3	2	–	–	1
Lateral collateral	2	–	–	1	1
Other	5	1	1	2	1
Total	58	16	14	16	12
Per cent	100	28	24	28	20

Good. Full extension, range of flexion at least 110 degrees or not more than 20 degrees less than in the other limb, no pain during activity, not more than 2 cm difference in the circumference of the

thighs, subjectively stable, and objectively slight insufficiency of one ligament only.

Fair. Insufficiency of extension not exceeding 10 degrees, flexion to at least a right angle, pain at sport or other such exertion, subjectively stable, but slight objective instability of 1 to 2 ligaments was accepted.

Poor. Poorer than the above.

Table 3. Results of treatment of old ligamentous injuries.

Ligamentous injury	Total	Excellent	Good	Fair	Poor
Medial collateral and anterior cruciate	3	1	–	1	1
Medial collateral	3	1	1	1	–
Anterior cruciate	9	1	3	3	2
Lateral collateral	2	–	–	1	1
Other	2	–	1	–	1
Total	19	3	5	6	5
Per cent	100	16	26	32	26

The results of treatment of recent and old ligamentous injuries are given in Tables 2 and 3. When these results are compared, we find that there were relatively more excellent results and fewer poor results among the recent injuries than among the old injuries, while the number of good and fair results was largely the same. When recent mono- and multiligamentous injuries are compared, we find excellent to good results in 50 per cent of the cases of monoligamentous and in 52 per cent of multiligamentous injuries. Multiligamentous injuries are often accompanied by other injuries (fractures, ruptured menisci).

In multiligamentous injuries no specification of the ligaments has been made. It seems, however, that in repair of a detached ligamentous insertion a better result was obtained because the procedure was technically easier and continuity of the ligament was preserved. At all events in avulsion fracture of the insertion, a good result was obtained in all but one case. There were 8 cases of avulsion fracture of the distal insertion of the anterior cruciate ligament and 3 of the posterior cruciate ligament, 2 cases of fracture of the proximal and 2 of the distal insertion of the medial collateral ligament and 1 of avulsion fracture of the distal insertion of the lateral collateral ligament.

There was a relatively greater number of multiligamentous injuries

in patients over 50, who constituted one-fifth of the series, than in young patients. We concluded that it was the severity of the injury, not the patient's age, which had influenced the end result.

When studying the time of operation and the end results we found that a good or excellent result was obtained in 40 per cent of cases operated upon on the the day of the injury, in 65 per cent of cases operated upon on the first or second posttraumatic day, and in 55 per cent of cases operated upon on the third to eleventh posttraumatic day.

Table 4. Involvement of meniscus in ligamentous injury.

Ligamentous injury	Number of cases			
	Involvement of medial meniscus	Involvement of lateral meniscus	Involvement of both menisci	Total
Medial collateral and anterior cruciate	13	1	2	16
Medial collateral	2	2	–	4
Medial collateral and anterior and posterior cruciate	4	4	2	10
Medial collateral and posterior cruciate	2	–	1	3
Anterior cruciate	3	1	1	5
Lateral collateral	1	3	–	4
Other	3	2	–	5
Total	28	13	6	47

There were 53 injuries of the meniscus, both menisci being injured in 6 cases (Table 4). In connection with old ligamentous injuries there was tearing of 6 medial and 2 lateral menisci. Injury to the meniscus was commonest in the group of rupture of the medial collateral, anterior cruciate and posterior cruciate ligaments (10/13). In two of these cases both menisci were ruptured. Only those injuries of the meniscus which required surgical repair were taken into account under this heading. In 34 cases the meniscus had to be removed. In 17 cases the meniscus, detached to a varying degree, was sutured to its site. In 2 cases a small pedunculated tag of the meniscus was excised. In no case in which a partly detached meniscus was sutured to its site, did this meniscus subsequently cause any distress. The results of treatment of

knee injuries with involvement of the meniscus were no worse than when the meniscus was intact.

The results of treatment of ligamentous injuries associated with fracture of the condyle are seen in Table 5. These cases do not include avulsion fractures of the insertions, or extra-articular fractures of the same limb. Besides the fracture mentioned in the table, there was sometimes fracture of the tibial spine or of the neck of the fibula, or insertion fracture of the patellar ligament, fracture of the patella, etc. The total result is aggravated by the deformity or reduced mobility caused by the fracture. In 3 cases the ligamentous result alone was excellent, and in the remaining cases less than excellent.

Table 5. Results of treatment of ligamentous injuries associated with fracture of condyles.

Ligamentous injury	Fractured condyle	Total	Excellent	Good	Fair	Poor
Medial collateral and anterior cruciate	Medial tibial	1	–	–	–	1
Medial collateral	Lateral tibial	6	–	3	2	1
Medial collateral and anterior and posterior cruciate	Medial tibial	1	–	1	–	–
	Lateral femoral	2	–	–	2	–
Lateral collateral	Both tibial	2	–	2	–	–
Anterior and posterior cruciate	Lateral tibial and femoral	1	–	–	–	1
Total		13	–	6	4	3

In 22 cases out of the 86 in which rotation of the knee joint could be measured with the joint flexed at 90 degrees, this movement had changed after operation. Where there was instability of the medial collateral ligament, in some cases with instability of the anterior cruciate ligament as well, the range of rotation in the knee joint had increased in 14 cases. When the medial collateral ligament was taut, the range of rotation was reduced in 8 cases.

Muscular atrophy of the thigh was measurable in half the cases. It was even subjectively demonstrable many years after successful treatment with good end results, also in young and active persons. Disturbed sensibility of the skin after operative damage to the saphenous nerve

or its infrapatellar branch was observed in one-third of the patients, and gave rise to inconvenience many years after the operation.

Causes of Poor Results

1. Faulty diagnostics. In at least 6 cases some ligamentous injury had escaped diagnosis.

2. Faulty treatment. 5 cases were found in which the injury had been considered to be mere straining of the anterior cruciate ligament, which was consequently left unrepaired. It should be mentioned that in 4 cases the synovial membrane of the allegedly strained anterior cruciate ligament was opened and the ligament found to be completely torn, whereupon it was successfully repaired. In 4 cases a diagnosed injury of the posterior cruciate ligament was left unrepaired, and in all of them the result was poor. In 9 cases persistent ligamentous insufficiency was observed as a result of unsuccessful surgery.

3. Faulty postoperative treatment. There was markedly reduced mobility of the knee joint in 4 cases, the reason in at least 3 cases being the patient's inactivity.

4. 2 cases of wound infection. One of these cases was a multiligamentous injury in which infection led to marked reduction of the mobility in the knee joint. The second case was one of old ligamentous injury which had been operated on for the same reason four times at some other hospital.

DISCUSSION

On the basis of the present study we could establish that an excellent or good result was obtained by operative treatment in 52 per cent of cases of recent injuries of ligaments and in 42 per cent of cases of old injuries of ligaments. In ligamentous injuries accompanying fracture of a condyle, the result of treatment was impaired by deformity or reduced mobility as a result of the fracture. The extent of the surgically treated injuries is illustrated, among other things, by the fact that 50/90 injuries were multiligamentous and that in more than half the cases the meniscus was involved as well.

The principal causes of poor results were faulty diagnosis and treatment. A contributory factor was that treatment was undertaken by numerous surgeons of varying experience. The patient's cooperation in the postoperative treatment also proved to be of importance.

To improve the diagnostics a thorough knowledge of the anatomy

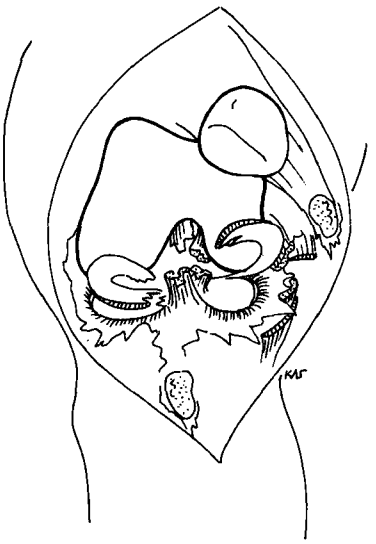

Figure 2. Schematic drawing of the injuries to two dislocated knees. In both cases the result of treatment was excellent.

and function of the knee joint is essential, although opinions still vary greatly with regard to fundamental questions (*Palmer* 1938, 1958, *Brantigan & Voshell* 1941, 1943, 1946, *Abbot, Saunders, Bost & Anderson* 1944, *O'Donoghue* 1950–1963, *DePalma* 1954, *Chapchal* 1954, *Kaplan* 1957, 1962, *Smillie* 1962, *Ficat* 1962, *Helfet* 1963, *Hallén & Lindahl* 1965, 1966). It is important that all components of the injury should be diagnosed preoperatively and not later than at operation. A clinical examination performed as early as possible after the accident is the easiest and most reliable method. For confirmation of the diagnosis various radiological methods have been suggested, such as roentgenographic examination under stress and arthrography, but these also involve certain risks.

In the recent literature, operative treatment of total ligamentous injuries of the knee has been increasingly advocated (*Palmer, O'Donoghue, DePalma, d'Aubigne & Ramadier & Fayt* 1957, *Starr* 1962, *Ficat, Smillie, Helfet, Matzen* 1963). *Jonasch* (1964), among others, recommends principally conservative treatment. *Lange* (1957) considers surgical intervention indicated if conservative treatment does not lead to a good result. Operative treatment is also indicated in the presence of associated injuries, *e.g.* of a meniscus, which can then be adequately

repaired. Moreover, the satisfactory results obtained in many extensive injuries, such as the two cases of dislocation of the knee (Figure 2), speak in favour of operative treatment. It is evident that in such cases the very fact that the injury is extensive contributes not only to a correct diagnosis, but also to adequate repair of the injury.

An analysis of the poor results shows that all totally ruptured igaments should be repaired. When, for various reasons, a ruptured ligament was left unrepaired, the end result was poor except in cases of undislocated avulsion of ligamentous insertions. The importance of the posterior cruciate ligament was underestimated. In 4 cases, rupture of this ligament had been left unrepaired, and in each case the result was poor. There was a spontaneous "drawer sign" backwards, and one of these patients himself suggested a brace. To what extent injuries to other posterior supporting elements were of significance in these cases cannot be judged from the operative reports. It may perhaps be assumed that the synchronism and interaction of ligaments and muscles are disturbed, if some part is not functioning. It seems not unlikely that the absence of one important element would provoke disturbance of the others. The fact that patients who had initially been treated conservatively, subsequently sought treatment also speaks in favour of operative treatment in the acute stage.

Operation carried out on the day of the accident is an emergency procedure. On the subsequent days the conditions are more favourable. The results indicate that emergency operations are not as a rule unavoidable, but that operation should preferably be carried out during the next few days—after careful examination and under adequate operative conditions.

Although, in the present series, the results of operative treatment as a whole are by no means satisfactory, disappointing results are often due to factors which, with better understanding of the case and with greater operative skill, might be eliminated.

The results in a few cases indicate that a badly torn ligament should be supported by a graft right from the beginning. It would also seem that the remnants of the ligament should be damaged as little as possible so that their neurovascular elements can be preserved in the reconstructed ligament, which without such elements may develop into a kind of "neuropathic" articular element. The reconstructed or repaired ligament, however, does not need to be quite as good as a normal one if its is the only stabilizer damaged and if the muscles controlling the knee are uninjured.

Primary repair of ligaments gives better results than reconstruction. Probably, it does not matter how or from what tendinous or fascial tissue the distally based graft is taken, since its circulation and innervation must necessarily be severed. In reconstruction, the future aim should perhaps be to replace the ligament by a new ligament or tendon comprising neurovascular elements.

SUMMARY

The results of operative treatment of ruptures of the collateral and cruciate ligaments of the knee are discussed on the basis of a follow-up of 90 patients 1 to 8 years after the trauma. Of these, 71 were recent and 19 old ligamentous injuries. In 50/90 cases the injury was multiligamentous. Besides the ligamentous injury, there was fracture of a condyle in 13 cases and lesion of the meniscus in 47 cases.

Excellent to good results were obtained in 52 per cent of the cases in recent injuries and in 42 per cent in old injuries. The unsatisfactory results were due to factors which might be reduced by improved diagnostics, treatment and after-treatment. Operative treatment need not be carried out as an emergency procedure but should preferably be performed within the first few days after the injury, after careful examination and under adequate operative conditions.

The continuity and strength of torn ligaments should be safeguarded by using grafts, when necessary, even at the primary stage. Evidently all torn ligaments should be repaired.

RESUME

Les résultats du traitement opératoire des ruptures des ligaments latéraux et croisés de l'articulation du genou sont discutés sur la base du réexamen de 90 malades entre une et huit années après le trauma. Dans 71 cas, il s'agissait de lésions ligamenteuses récentes, dans 19 cas de ésions anciennes. Dans 50 des 90 cas la lésion était multiligamenteuse. A côte de la lésion ligamenteuse, il y avait fracture de condyle dans 13 cas et lésion du ménisque dans 47 cas.

Dans 52 pour cent des cas de lésions récentes et dans 42 pour cent des lésions anciennes, des résultats excellents ou bone ont été obtenus. Les résultats peu satisfaisants étaient dus à des facteurs qui peuvent être en partie éliminées par une amélioration du diagnostic, du traitement et du traitement complémentaire. Il n'est pas nécessaire de pratiquer d'urgence l'intervention chirurgicale, mais il vaut mieux la

pratiquer dans les premiers jour qui suivent la lésion, après un minutieux examen et dans de bonnes conditions opératoires. La continuité et la force des ligaments déchirés doivent être assurés par l'utilisation de greffes lorsque cela est nécessaire même dans le stade primaire. Il est évident que tous les ligaments déchirés doivent être réparés.

ZUSAMMENFASSUNG

Die Resultate operativer. Behandlung von Seiten- und Kreuzbandschäden des Kniegelenkes werden durch eine Nachuntersuchung von 90 Patienten, 1–8 Jahre nach der Verletzung, besprochen. Unter diesen waren 71 neue und 19 ältere Bandschäden. In 50 Fällen waren die Schäden multiligamentär. In 13 Fällen fand sich nebenbei ein Kondylenbruch und in 47 Fällen eine Meniscusverletzung.

Bei 52 Prozent der Fälle von Neubeschädigten und bei 42 Prozent von Altbeschädigten waren die Resultate ausgezeichnet oder gut. Die unbefriedigenden Resultate waren von Faktoren abhängig, die durch bessere Diagnose und bessere Behandlung hätten vermieden werden können. Operative Behandlung braucht nicht als Notfallsverfahren eingesetzt, soll aber am liebsten während der ersten Tagen nach dem Unfall gemacht werden, nach sorgfältiger Untersuchung und unter guten operativen Bedingungen. Die Kontinuität und Stärke des abgerissenen Ligamentes soll – wenn nötig schon primär – durch Transplantation sichergestellt werden. Alle mit Sicherheit abgerissenen Bänder sollen repariert werden.

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