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FRACTURES OF THE TIBIAL CONDYLES

BY

KAUKO A. SOLONEN

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FRACTURES OF THE TIBIAL CONDYLES

Fractures of the tibial condyles which damage the largest human joint are of great importance and their treatment is difficult. The principal aim of the treatment should be perfect function of the knee joint, i.e. the knee should become stable without valgus or varus deformity, extension should be complete and flexion as free as possible. According to various clinicians, this goal is best achieved either by 1) conservative procedures alone, 2) chiefly operative procedures, or 3) conservative or operative methods as indicated in the individual cases.

The following investigation is based on a follow-up examination of fractures of the condyles treated in our clinic during the period 1951 to 1960. My aim has been personally to evaluate the end-results of the treatment of this important group of injuries and the arguments for and against the different procedures used.

M a t e r i a l

A total of 77 patients with fractures were treated. Two patients died during hospitalization, both of pulmonary embolism. 53 patients (70 per cent) reported for follow-up examination and were all examined personally by me. Of the patients, 26 were men and 27 women.

The follow-up period ranged from 11 to 2 years. Of the patients followed up, 34 had fracture of the lateral condyle (age 16 to 78

years), 9 of the medial condyle (age 27 to 69 years) and 10 bicondylar fracture (age 37 to 62 years). At the time of the accident the age distribution of these patients was: 26 patients 16 to 50 years, 27 patients 51 to 78 years, the average age at the time of the accident being 50 years.

Aetiology and mechanism of trauma

There is no reason to call these fractures bumper fractures since, in the majority of cases, the mechanism does not involve the impact of a bumper. The commonest, it is true, is a direct mechanism of origin, i.e. the medial or lateral side of the extended or slightly flexed knee is struck with sudden force. The fracture may also be the indirect result of stumbling or falling from a height, the fracturing force being directed vertically from the femoral condyle towards the tibial plateau. Injuries to the lateral tibial condyle are commoner, since one leg protects the other from trauma exerted from the medial side, the protecting leg thus receiving the valgus-producing injury which damages the lateral condyle.

There are two divergent opinions as to the mechanism of monocondylar fracture. WATSON-JONES (1955) and SMILLIE (1962) are among those who believe that lesion of the collateral ligament on the other side is necessary before the condyle can fracture as a result of direct mechanism. Injury to the tibial collateral ligament is commoner. This is because of the direction of violence and because the whole ligament is taut when the knee is extended and one part of it remains taut in all flexion positions of the knee (BRANTIGAN & VOSHELL, 1941—1943, DePALMA 1954). The anterior cruciate ligament is likewise readily injured, since its function is very similar to that of the medial collateral ligament and this ligament, too, is taut in extension and flexion except at the very beginning of flexion (FICAT 1962). The mechanism of the trauma is such that the lateral collateral ligament is less often damaged than the two former. MARTIN's experimental investi-

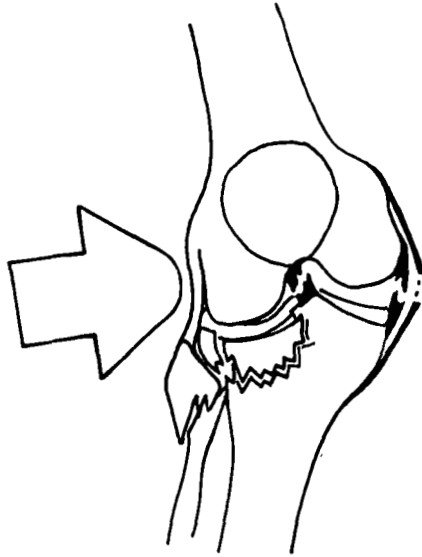


Fig. 1. Simultaneous injury of the ligament and fracture of the condyle.

gations (1960) argue in favour of simultaneous injury to the collateral ligament and fracture of the condyle (fig. 1). This is also my opinion.

There are also those who believe that fracture of the opposite condyle only occurs when the collateral ligament escapes injury (BANCROFT & MURRAY 1945, among others), i.e. there will be either rupture of the collateral ligament or fracture of the opposite condyle.

Lesion of a ligament seems seldom to be diagnosed in connexion with fracture of a condyle.

From the point of view of aetiology the present material can be grouped as follows:

TABLE 1. *Aetiology*

Fracture	1 Run over by vehicle	2 Fell from motor- cycle or bicycle	3 Tripped when walking	4 Fell or jumped from great height	5 Direct trauma to the side of the knee*	Total
Fracture of the lateral condyle	17	3	7	4	3	34
Fracture of the medial condyle	1	3	4	—	1	9
Bicondylar fracture	2	3	1	3	1	10
Total	20	9	12	7	5	53

*) The great majority of fractures of column 1 are known to have occurred in this way.

P a t h o - a n a t o m y

Monocondylar fracture occurred in 87 per cent and bicondylar in 13 per cent of the cases of the present series.

Of the monocondylar fractures, 55 (82 per cent) were fractures of the lateral condyle and 12 (18 per cent) of the medial condyle. A survey of the literature shows that in ENDER's (1955) series of monocondylar fractures the lateral condyle was involved in 89.75 per cent and the medial condyle in 10.24 per cent. bicondylar fracture being present in 16.72 per cent of cases. HOLLE & HART's (1958) corresponding figures were: of the monocondylar fractures 77.7 per cent were fractures of the lateral condyle and 22.2 per cent of the medial condyle; the bicondylar fractures constituted 38 per cent of the entire series. CORNELL & HARDY (1929) reported the following percentages: fractures of the lateral condyle 76 per cent and of the medial condyle 24 per cent of monocondylar

fractures, the bicondylar fractures constituting 9 per cent (intercondylar 5 per cent).

There are many suggestions for a more detailed grouping of fractures according to their type (HULTÉN 1929, MIKKELSEN 1933, BADGLEY & O'CONNOR 1952, DEPALMA 1954, ENDER 1955, SLEE 1955, FICAT 1962, WELLER & KÖHNLEIN 1962, and others). In clinical work a simple division into three or four type groups would seem adequate, although it is obvious that few fractures strictly conform to one type and that mixed types are the commonest. The better a fracture can be visualized, the less typical it usually proves, and the harder to classify.

The cases of the present series can be classified as follows:

1. 15 split fractures, comprising 6 fractures of the lateral and 9 of the medial condyle (Fig. 2 A.).
2. 20 compression fractures, all of the lateral condyle, with compression sometimes of the anterior, sometimes of the posterior and sometimes of the central portion (Fig. 2 B.).
3. 10 bicondylar fractures (Y-, V-, T-fractures), all of them more or less comminuted (Fig. 2. C.).
4. 8 marginal fractures, all of the lateral condyle. Most authors pay no attention to these fractures. Yet they are of great importance and of particular diagnostic significance. Some of them seem to have occurred by avulsion, or are split or compression fractures (Fig. 2 D.).

A c c e s s o r y i n j u r i e s

In connexion with fracture of the condyles there are often other simultaneous injuries besides the ligamentous injuries already mentioned, i.e. rupture of the patellar ligament, often rupture of a meniscus, fracture of the head of the fibula sometimes accompanied by injury to the peroneal nerve, injury to the large vessels and sometimes, as a result of violent trauma, other fractures.

In the present series there was rupture of the medial collateral ligament in 4 cases but only in one case had the rupture been



Fig. 2. The main types of fracture of the condyle. A. Split fracture B. Compression fracture C. Bicondylar fracture D. Marginal fracture.

repaired at the time of the primary treatment. CAVE (1948) is against primary repair of the ligament in cases of fracture of a condyle, while most other authors maintain silence on this point.

Lesions of the cruciate ligament had not been primarily recorded.

Rupture of a meniscus was mentioned and there was also mention of the removal of the meniscus on the side of the fractured condyle in 6 of the 12 operated knees. Although many authors (DEPALMA, CHARNLEY 1961, LEADBETTER & HAND 1940, BANCROFT & MURRAY, BÜRKLE DE LA CAMP, and others) recommend removal of the meniscus as part of the operative treatment and in order to improve the view, some even advocate it as a routine measure, I wholeheartedly agree with PALMER (1951), ENDER (1955) and BÖHLER (1957) that the meniscus should be removed only when it is irreparably injured. After it has been partly freed, it should be replaced and sutured to aid retention of the fragments and to protect the joint surface of the femur from the roughness of the opposing surface.

In the present series there was fracture of the fibula head in 6 cases, in 2 cases in conjunction with fracture of the lateral condyle, in 2 of bicondylar compression fracture and in 2 split fractures of the medial condyle. In the latter cases the fracture of the fibula head is actually an avulsion injury of the collateral ligament.

Injuries to the peroneal nerve were not observed.

Rupture of the tibiofibular joint may also occur; no such ruptures were noted in the present series.

There were no ruptures of the patellar ligament among the present cases.

D i a g n o s i s

In the era of modern radiology diagnosis is not difficult. To determine the degree of severity of the fracture may prove difficult, however. Tomography is sometimes necessary, to demonstrate a depressed fragment, for instance, and the projection is



Fig. 3. The significance of projection in radiography. In the radiograms on the left a dislocation requiring reposition is not demonstrated while such a dislocation is evident in the pictures on the right.

often of conclusive importance (fig. 3) although I have not seen mention of this in the literature.

Treatment

Although there are divergent opinions as to whether conservative or operative treatment of these fractures is superior, the

importance of early mobilization is universally acknowledged (HALDEMAN 1938, CAVE 1948, MAISEL & CORNELL 1948, CORNELL & HARDY 1950, PALMER 1951, LINDHOLM 1954, APLEY 1956, HOHL & LUCK 1956, HOLLE & HART 1958, DUPARC & FICAT 1960, ROMBOLD 1960, CHARNLEY 1961, REIBEL & al. 1962). By 'early', however, these authors mean sometimes weeks, sometimes days.

TABLE 2. *Primary treatment*

Fracture	Treatment		Total
	Conservative	Operative	
Split fractures	11	4	15
Compression fractures	14	6	20
Bicondylar fractures	7	3	10
Marginal fractures	7	1	8
Total	39	14	53

In more than half the cases referred to the group of conservatively treated fractures, the treatment consisted of immobilization in a plaster bandage after reduction or attempts at reduction, while in a few cases the patient was merely confined to bed. In less than half the cases the conservative treatment consisted of mobilization (KALLIO 1960) after or without correction of the position of the fragments (fig. 4). The average duration of immobilization in plaster cast or mobilization in suspension was 8 weeks and the patient was then allowed to be up without weight-bearing for an average of 4 weeks, after which weight-bearing was as a rule begun.

Operative treatment was resorted to in some instable cases and in cases in which it was believed that better results would be obtained by surgical intervention than by the conservative treatment first employed. In most cases operative reduction was followed by plaster immobilization, but in a few cases active mobilization was begun immediately. In the last few years this mobilization method has been used with advantage in numerous cases (Fig. 5 and 6).

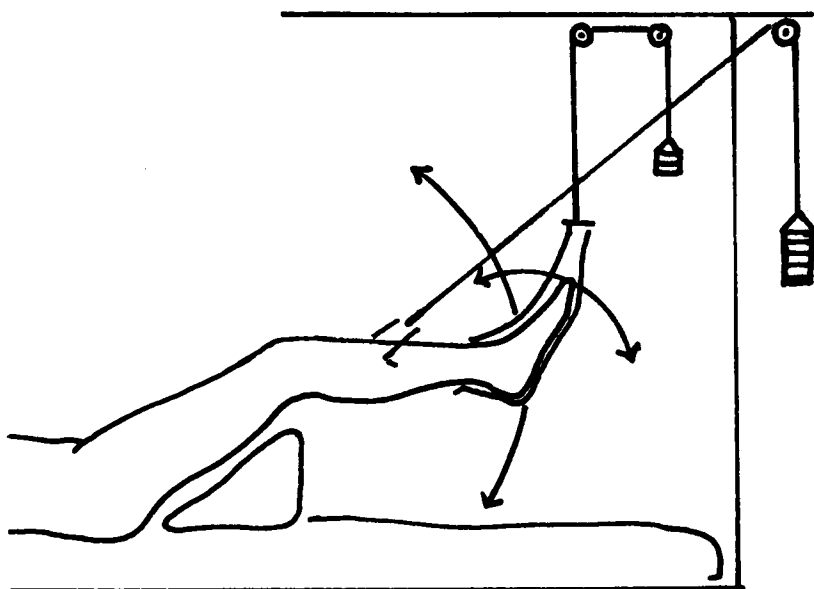


Fig. 4. Mobilization traction. In no case was there any significant detrimental effect of the traction nails.



Fig. 5. Open reduction was carried out on this fracture (A) and, since it was comminuted, stable fixation was not possible. The fragments were fitted together with chromic catgut sutures. Active mobilization as illustrated in fig. 6, was commenced on the first postoperative day. The second picture (B) shows the result after two years.

Results of treatment

When the results are evaluated it should be observed that the treatment was given by many surgeons with varying experience. A less experienced surgeon on duty often had to carry out the important primary treatment. There had also been great variations in the details of the treatment.

Using HOHL and LUCK's (1956) criteria of grading*), the final results were as follows:

*) CRITERIA OF GRADING USED IN THE FOLLOW-UP STUDY OF
227 TIBIAL CONDYLAR FRACTURES

Anatomic Grade	
<i>Excellent</i> (All of the following) 1. Normal valgus within 5 degrees 2. Restoration of displacement within 3 millimeters 3. No degenerative joint changes	<i>Good</i> (Not more than one of the following) 1. Valgus of more than 5 degrees 2. Minimal degenerative joint changes
<i>Fair</i> (Not more than two of the following) 1. Valgus deformity of more than 10 degrees 2. Moderate degenerative joint changes 3. Lack of fracture reduction	<i>Poor</i> (All of the following) 1. Moderate or severe degenerative joint changes 2. Lack of fracture reduction 3. Valgus deformity of more than 10 degrees
Functional Grade	
<i>Excellent</i> (All of the following) 1. Full extension of the knee 2. 120 degrees range of motion or more 3. No abnormal abduction rocking 4. Normal strength and endurance 5. Occasional ache permissible	<i>Good</i> (Not more than one of the following) 1. Lack of knee extension beyond 170 degrees 2. Excessive lateral mobility 3. Mild aching each day 4. 90 degrees total range of motion 5. Weakness or easy fatigue
<i>Fair</i> (Not more than two of the following) 1. Lack of knee extension more than 170 degrees 2. 75 degrees range of motion 3. Discomfort for ordinary activity 4. Excessive lateral mobility	<i>Poor</i> (Three or more of the following) 1. Lack of useful motion (less than 75 degrees) 2. Unable to work 3. Pain in all activity 4. Excessive lateral mobility

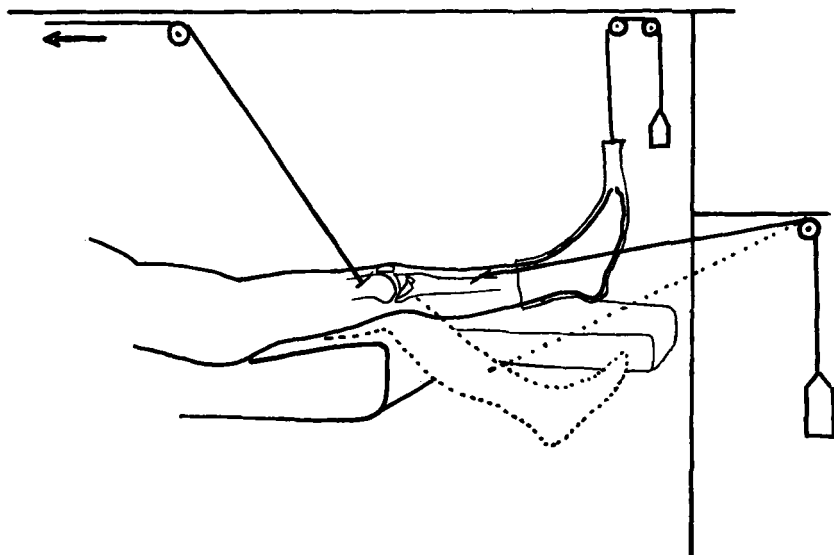


Fig. 6. The method of postoperative mobilization in a specially constructed bed. The femoral counter-fracture was thought important to help the patient to maintain the thigh in the same position the whole time in the beginning.

A. Results in the different types of fracture

In split fractures both anatomically and functionally excellent or good results were obtained in 10 out of 15 cases (67 per cent).

In compression fractures an anatomically good result was obtained in 5 cases only (25 per cent) but functionally the result was excellent or good in 12 cases (60 per cent).

In marginal fractures the anatomical result was always at least 'good', but the functional result was excellent or good in 6 out of 8 cases only (75 per cent). The cause was ligamentous insufficiency.

B. Results of different methods of treatment

When the results obtained with different methods of treatment are compared we find that immobilization gave an excellent or

good result anatomically in 68 per cent of cases but functionally in only 52 per cent of cases. Mobilization gave an excellent or good result anatomically in 60 per cent and functionally in 73 per cent of cases. After operative treatment an excellent or good result was obtained anatomically in 15 per cent and functionally in 85 per cent of cases.

It is readily understandable that in these intra-articular fractures immobilization gave a higher proportion of poor results. It was surprising, however, to find that the results of operative treatment tended to be anatomically unsatisfactory although functionally good (fig. 7). The unsatisfactory anatomical results of operation confirm the opinion that these fractures require technically exacting operations. The best results were achieved in the cases treated with early active mobilization after operative reduction.

The above figures do not give any information as to which method is the best. The indications for the different methods are different but no doubt another choice could have been made in many cases.

C. Comparison of the results of fractures of the medial and lateral condyles

When the end-results of treatment of similar fractures of the medial and lateral condyles (i.e. split fractures) are compared, we find that in fractures of the medial condyle, which, from the point of view of weight-bearing, are more important, better results were obtained. The result was excellent or good in eight out of nine cases, as compared with a good result in three out of six cases of fracture of the lateral condyle.

D. Results in various age groups

The functional results were best in the youngest and the oldest patients; the result was excellent or good in 63 per cent of the age group 16 to 30 years, in 53 per cent in the age group 31 to 50 years and in 74 per cent in the age group 51 to 78 years.



Fig. 7. Radiologically poor result of operative treatment (B). The last picture taken four years later, of the now functionally excellent knee (C) (female 28 years).

Discussion of end-results

It will be observed that a good anatomical result, demonstrable radiographically, is an almost certain guarantee of a good functional result provided that the aftertreatment is correct. However, a functionally good result was also obtained in many cases with an anatomically unsatisfactory result (fig. 8). Prolonged immobili-

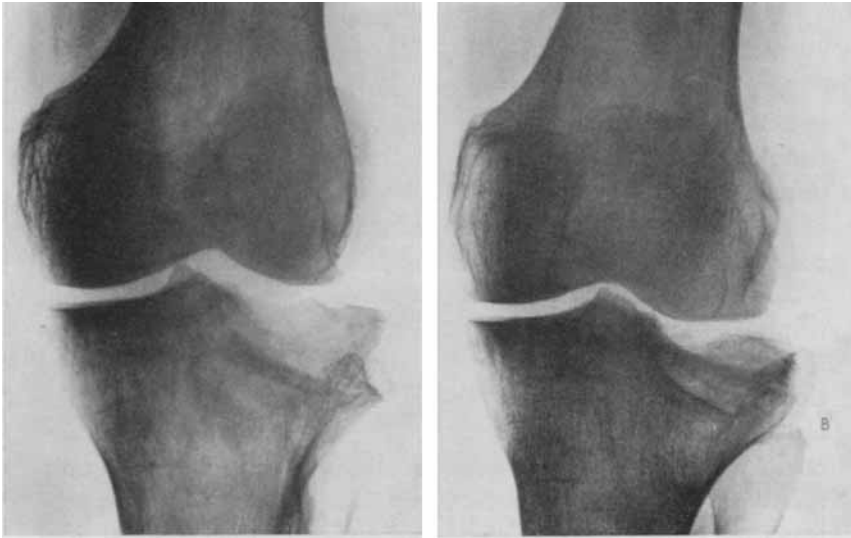


Fig. 8. Unreduced fracture, since the patient refused operation. Functionally the result was good 3 1/2 years later (B) (male 57 years).

zation is clearly a factor that greatly impairs the functional result. As would be expected, one reason for poor end-results is unsatisfactory correction of the position of the fragments, for instance in cases in which a depressed central fragment has remained unreduced. Reduction is sometimes rendered impossible by severe wound complications or by a critical general condition of long duration. An unrepaired ligamentous lesion is sometimes the cause of a poor result, as is also secondary arthrosis, although the latter is actually part of the poor result. To what extent the degree of severity of the arthrosis depends on the method of treatment could not be concluded from the present series. The achievement of good function despite a poor anatomical result is puzzling, but this phenomenon is well known in cases of arthrosis deformans, for instance, in which the subjective symptoms are not directly correlated with the degree of deformity.

Ligament injuries

At follow-up examination insufficiency of 4 lateral and 8 medial ligaments was observed (23 per cent of the cases). One case of rupture of the medial collateral ligament primarily diagnosed but untreated was symptom-free at follow-up. There was insufficiency of the lateral collateral ligament in 3 cases of fracture of the lateral condyle and 1 of the medial condyle. At follow-up the medial collateral ligament was lax in 7 cases of fracture of the lateral condyle and in 1 bicondylar fracture. Whether in these cases there is always an unhealed ligamentous rupture dating from the time of the fracture or whether sometimes a stretching of the ligament has been caused by a change in the bony joint structure, could not be concluded. Yet the condyle was depressed in only a few of these cases. The fact that a depressed condyle is probably the cause of subsequent insufficiency of the collateral ligament should argue in favour of careful reduction.

At follow-up, clear insufficiency of the anterior cruciate ligament was observed in 5 cases and of the posterior cruciate ligament in 1 case, all in extremities with powerful muscles.

Besides these clear cases of damaged ligaments, instability of the knee was the most serious complaint of many patients, although clinically there was nothing to indicate lesion of a ligament.

In the insignificant marginal fractures, insufficiency of the collateral ligament cannot depend on deformity of the bone. However, in 2 out of 8 (25 per cent) such fractures there was indisputable insufficiency of the medial collateral ligament and in one of them, in addition, laxity of the anterior cruciate ligament (fig. 9 and 10). Thus the diagnostic value of these »insignificant fractures», as indicators of ligamentous lesions is obviously considerable.

There were probably primarily a greater number of ruptures of collateral ligaments than were found at follow-up. This is indicated by the fact that a ligamentous rupture had healed without any special treatment and that these ligaments are known sometimes to heal after immobilization alone.

In many knees in which follow-up showed that the condyle



Fig. 9. The fracture is insignificant but there was simultaneous tearing of the medial collateral ligament and the anterior cruciate ligament.



Fig. 10. In this knee, besides fracture of the lateral condyle, there was complete rupture of the medial collateral ligament.



Fig. 11. Bicondylar fracture (A) primarily treated with mobilization suspension and the anatomically and functionally good end-result four years later (B). Cf. picture of the sound knee (C) (male 60 years).

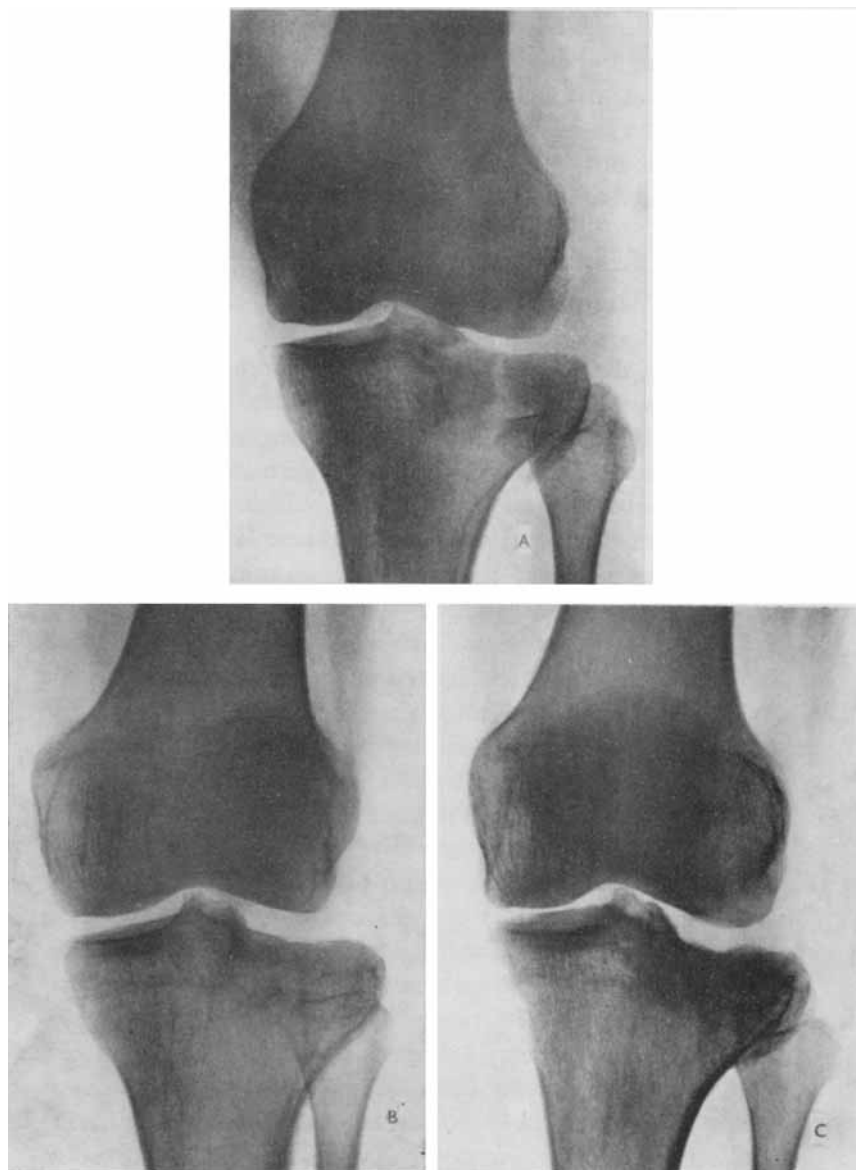


Fig. 12. A fair primary result (A) after immobilization but 2 1/2 years later (B) the knee was poor as a result of aseptic necrosis (female 39 years).

had remained depressed, no pathological mobility could be detected. This might be explained by the presence of fibrous or fibrocartilaginous tissue filling the depression (HOHL & LUCK, DUPARC & FICAT) and possibly by a sufficient support to the femur provided not only by the tissues mentioned but also by the non-depressed area of the joint surface.

M e n i s c u s l e s i o n s

At follow-up, there was reason to suspect rupture of a meniscus in split fractures of one medial and one lateral condyle treated conservatively in which the end-result with regard to the fracture was excellent but in which locking of the joint indicated a sequel of injury to the meniscus. In no case in which the partly freed meniscus was replaced and sutured were there late complications arising from the lesion of the meniscus.

DISCUSSION AND CONCLUSIONS

Examination of this series and the experience gained in the present-day treatment of similar fractures have confirmed the opinion that to achieve perfect function of a fractured knee joint, the anatomy of the joint should be restored as carefully as possible. When a radiogram is interpreted it should be remembered that the joint cartilage, menisci, ligaments and joint capsule are also essential parts of the joint. Reduction of the fragments is important and mostly possible. Retention, however, may cause difficulties. There are those who advocate stable fixation of fragments. Often this cannot be perfectly achieved but that should not prevent otherwise indicated operative reduction, since absence of stable fixation can, as a rule, be compensated by suitable after-treatment allowing controlled collapse of the fragments only to the extent that this can occur without relaxation (fig. 5 and 6). Even a bicondylar fracture can be mobilized from the beginning and yet preserve the favourable position achieved at reduction, and good consolidation may be obtained despite the fact that this procedure is in pointed contrast to the traditional principles of fracture surgery (Fig. 11). There was not one case of non-union in cases thus treated. Conservative treatment, and in particular mobilization treatment, is indicated when reduction is unnecessary, i.e. when the total depression of the condyle is only a few millimetres, or when the depression or elevation of separate fragments is insignificant, or when the fracture is so complicated or so fragmented that operative reduction is hopeless or prevented and

in old persons even on slighter indications. The value of operation without opening of the joint, a procedure which has sometimes been advocated, is debatable. The intra-articular damage is always larger than is radiographically evidenced. — Operative repair of the fracture, i.e. surgery of the joint, like surgery of the hand, must be atraumatic. Otherwise neither rapid postoperative mobilization nor a successful end-result can be expected. The reduced fragments can be fixed in many different ways: with wires, sutures, bolts or screws. It is often necessary to support the depressed fragment with osseous transplants, either autogenous or of conserved bone. It is important to make sure by means of radiograms taken during the operation that the depressed condyle has been sufficiently elevated. Otherwise it may happen that although the joint surface is perfect the condyle remains depressed. There is reason to remove small loose fragments which are doomed to necrosis, for the space they occupy will be filled with fibrous tissue or fibrocartilage and even with hyaline cartilage (HALDEMAN 1938, HOHL & LUCK). Menisci should be removed only if they are damaged. There is reason to repair ligament ruptures in these cases as well as in the case of simple ligament lesion. The following treatment must be adapted accordingly. Intensive active motion is always called for either from the very beginning or later, depending on the method of treatment and the kind of accessory lesions. To prescribe absolute rules for treatment is not possible. In each individual case many more factors than the type and condition of the local fracture must be considered. The final aim — good function — presupposes restoration of the shape of the joint, in suitable cases atraumatic repair of damaged parts of the joint and always early active mobilization.

SUMMARY

A follow-up examination was made of 53 patients 2 to 11 years after fracture of the tibial condyle.

The majority of the fractures were sustained in traffic accidents.

Among the patients the two sexes were more or less equally represented.

Ages ranged from 16 to 78 years, the average age being 50 years.

The methods of treatment were (reduction +) immobilization, (reduction +) mobilization, or operative treatment (+ immobilization) + mobilization.

The best results were obtained in the group of split fractures. The results in compression and bicondylar fractures were equally good. Small marginal fractures are diagnostically important, since they often indicate ligamentous rupture.

Operative and mobilization treatment were the methods that produced the best functional results.

An anatomically good primary result is usually followed by a functionally good end-result. Consolidation always takes place.

Operation is difficult and requires considerable experience and an atraumatic technique.

The method of treatment must be chosen to suit each individual case. In some instances conservative and in others operative treatment is called for. Active mobilization is always indicated either as the principal method of treatment or as the earliest possible continuation of some other method.

In the author's opinion the most important observation in the present investigation was that ligamentous damage or secondary laxity of ligaments as a result of a persisting osseous deformity are often the cause of an unsatisfactory late result. In suitable cases lesions of the ligament then require to be repaired and the other treatment must be adapted accordingly.

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