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INTRA-ARTICULAR FRACTURES OF THE DISTAL TIBIA

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In a study of 23 intra-articular fractures of the distal tibia of which 18 were re-examined after an average follow-up period of 5.4 years, two major fracture patterns were identified: type A, a rotational pattern, caused by low energy trauma and type B, a compressive fracture pattern caused by high energy trauma. Type B fractures could be divided into three subgroups: 1) An isolated fracture of the anterior or posterior margin of the distal tibia, 2) an extra-articular comminuted fracture with extension into the ankle joint and 3) a comminuted intra-articular fracture.

When the initial displacement and comminution were severe or the reduction was not complete, the final results of the comminuted intra-articular fractures were not acceptable. The incidence of osteoarthritis was highest in the group of comminuted intra-articular fractures. The extra-articular comminuted fractures seemed to have a better prognosis as indicated by the final clinical results, including the occurrence of osteoarthritis.

It is clear from this study that comminuted intra-articular fractures should not be treated by primary operation. All fractures treated non-operatively had acceptable final clinical results.

Key words: ankle fractures; ankle joint; articular; explosion fractures; fractures; fractures of the distal tibia; intra-articular fractures

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In the treatment of fractures of the distal part of the tibia, there is a certain small group of fractures which causes difficulty in management and classification. They are often referred to in the literature as "explosion fractures of the distal tibia", "comminuted intra-articular fractures of the distal tibia" or simply as "severe ankle fractures". There is still some controversy concerning the classification and treatment of this type of fracture.

Several authors use the classification of malleolar fractures suggested by Lauge Hansen (1948), but often it is not possible to fit a small percentage of the fractures of the distal end of the tibia into this system. Vasli (1957) reported that 1.6 per cent and Klossner (1962) that 3 per cent of the malleolar fractures in their series could not be classified according to Lauge Hansen's genetic classification. These fractures were mostly comminuted intra-articular fractures of the distal tibia caused by a fall from a great height. Rüedi & Allgöwer (1969) noted that 5 per cent of all fractures of the lower leg were intra-articular fractures of the distal tibia.

The purpose of this paper is to present a follow-up study of those intra-articular fractures of the distal tibia which cannot be fitted into Lauge Hansen's classification and also to evaluate possible fracture patterns and factors that might influence the prognosis.

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PATIENTS AND METHODS

The records of all patients with tibial and ankle fractures admitted to the Department of Orthopaedic Surgery, Municipal Hospital of Aarhus, from January 1st 1970 to December 31st 1980 were reviewed. Fractures involving the distal 6 cm of the tibia with intra-articular involvement were selected. None of the fractures could be fitted into Lauge Hansen's classification of malleolar fractures. Using these criteria 23 intra-articular fractures in 23 patients were found. These comprised 2.6 per cent of the tibial fractures (884 fractures) and 3.5 per cent of the ankle fractures (658 fractures) treated during this period. Patients under 18 years of age were excluded.

Data were obtained from case records and radiographs taken initially and during treatment. At follow-up all patients were reviewed personally by the authors and clinically examined for deformity, function and subjective symptoms. Radiographic examination was performed to evaluate any dislocation, angulation or osteoarthritis.

Two patients had died, and three could not be contacted at the time of the follow-up. Thus is was possible to re-examine 18 of the patients (12 men and 6 women) with an average follow-up of 5.4 years (range 1.7–10 years). The average age was 46 years (range 19–67 years).

The average length of hospital stay was 35 days (range 11–73 days), and the average period of absence from work was 7.6 months. Two patients received insurance compensation and two were pensioners at the time of the injury.

The following data were recorded from the X-rays and the clinical re-examination.

The initial displacement of the fractures was graded *mild* if displacement was less than 1 cm or *severe* if displacement was at least 1 cm.

The comminution of the fractures was graded *mild* if there were one to four fragments or *severe* if there were five or more fragments. In the present study the two groups could be combined as follows: *Mild* – one to four fragments with displacement of less than 1 cm; *severe* – five or more fragments with displacement of at least 1 cm.

The accuracy of reduction was evaluated by X-ray and graded acceptable or not acceptable according to the criteria: *Acceptable* – displacement of the talus less than 5 mm, no angulation, and no displacement of a major intra-articular fragment amounting to more than 5 mm. *Not acceptable* – any talar displacement, any angulation, or dislocation of a major intra-articular fragment of more than 5 mm.

The final radiographic results were assessed with regard to the presence or absence of osteoarthritis, defined as a narrowing of the joint space.

The final clinical results were graded acceptable or not acceptable according to the following criteria: *Acceptable* – ankle and foot motion at least 50 per cent normal, no swelling or only mild swelling, normal gait, no pain or only occasional pain during sports or other demanding activities. *Not acceptable* – ankle and foot motion less than 50 per cent normal, swelling, any visible deformity or limp and constant pain. The appearance of osteoarthritis did not influence the classification of the final clinical results.

Figure 1. Intra-articular fracture of the distal tibia. Rotational fracture pattern – Type A.

The initial radiographs were reviewed to determine any particular fracture pattern that could be associated with the mechanism of the injury. Two distinct fracture patterns were observed:

Type A. A rotational fracture (Figure 1) consisting of an intra-articular spiral fracture in the lower end of the tibia, in one case associated with a transverse fracture in the fibula just proximal to the joint surface. There were three fractures in this category.

Type B. A compression fracture with some degree of comminution of the joint. This type of fracture was found in 15 patients. These fractures were often associated with a fracture of the fibula at the same level as the fracture of the tibia. All type B fractures were caused by high energy trauma.

The type B fractures could be divided into four subgroups. *B1:* An isolated fracture of the posterior margin. *B2:* An isolated fracture of the anterior part of the distal tibia (Figure 2). *B3:* An extra-articular comminuted fracture of the lower part of the tibia with fracture lines extending into the ankle joint (Figure 3). *B4:* A comminuted intra-articular fracture of the distal tibia (Figure 4).

At the follow-up all fracture types except type B1

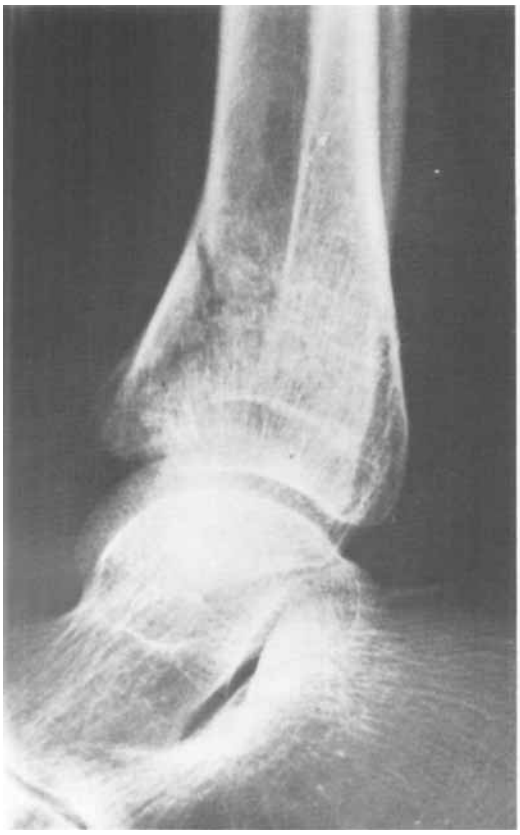

Figure 2. Intra-articular fracture of the distal tibia. Compressive fracture pattern – Type B. Isolated fracture of the anterior margin of the distal tibia – Type B2.

Figure 3. Intra-articular fracture of the distal tibia. Compressive fracture pattern – Type B. Extra-articular comminuted fracture of the distal tibia – Type B3.

were represented. The distribution of the 18 fractures was as follows: Type A, three cases; type B2, three cases; type B3, five cases; and type B4, seven cases.

The treatment of the 18 fractures was operative in 13 cases and conservative in 5. The non-operatively treated fractures were one B2, three B3 and one B4 type fracture. Three type B3 and three type B4 fractures were open and treated by operation except in one case (B4). Because of bone loss three type B3 and five type B4 fractures needed bone grafting. All fractures were immobilized in plaster for 3 months. The average period without weight-bearing was 4.5 months (range 25 days to 10 months).

Complications occurred in seven patients. All had been treated by operation. Two patients had superficial wound infections, which healed after conservative therapy. Two patients developed infected non-unions.

Figure 4. Intra-articular fracture of the distal tibia. Compressive fracture pattern – Type B. Intra-articular comminuted fracture of the distal tibia – Type B4.

Arthrodesis was performed in both cases, but one of the patients had to undergo a below-knee amputation because of painful non-union in the ankle arthrodesis. Two patients developed delayed union; one of them was treated by arthrodesis and the other healed after 10 months in plaster. One patient with osteomyelitis healed after conservative therapy. All complications were associated with comminuted fractures type B3 (two cases) and B4 (five cases).

RESULTS

At the follow-up all patients with type A fractures had clinically acceptable results (Table 1). All were able to pursue the same occupation as before their accident. The objective findings were normal and no osteoarthritis was observed in this group.

The results in B2 fractures were similar to those in type A fractures. In one case the fracture had been severely displaced at the moment of injury (Table 1), but there were no signs of osteoarthritis and the only complaint was transient pain, especially during bad weather. One patient had 10 per cent diminished dorsiflexion but no subjective symptoms. Osteoarthritis could not be demonstrated.

Four of the B3 fractures were initially severely displaced and comminuted (Table 1) and three of these were poorly reduced (Table 2), but none of the final clinical results were classified as not acceptable. Osteoarthritis was only observed in one case. The commonest complaints were pain after demanding activity and during bad weather, and in one, occasional mild swelling.

Table 1. Final clinical results in relation to the degree of initial displacement and comminution of intra-articular fractures of the distal tibia

Initial displacement and comminution	Final clinical results (n = 18) Acceptable A	B2	B3	B4	Not acceptable A	B2	B3	B4
Mild to moderate	3	2	1	–	–	–	–	–
Severe	–	1	4	1	–	–	–	6

A = intra-articular spiral fracture of the distal tibia
B2 = intra-articular fracture of the anterior margin of the distal tibia
B3 = extra-articular comminuted fracture of the distal tibia with intra-articular involvement
B4 = intra-articular comminuted fracture of the distal tibia

Table 2. Final clinical results of intra-articular fractures of the distal tibia compared with the accuracy of reduction

Accuracy of reduction	Final clinical results (n = 18) Acceptable A	B2	B3	B4	Not acceptable A	B2	B3	B4
Acceptable	3	3	2	1	–	–	–	2
Not acceptable	–	–	3	–	–	–	–	4

A = intra-articular spiral fracture of the distal tibia
B2 = intra-articular fracture of the anterior margin of the distal tibia
B3 = extra-articular comminuted fracture of the distal tibia with intra-articular involvement
B4 = intra-articular comminuted fracture of the distal tibia

The poorest results were seen in the B4 fractures. This group consisted of two patients with arthrodesis, one amputee and three patients with chronic swelling, pain and less than 50 per cent normal ankle motion. Two of the patients used a foot brace constantly. The last patient in the group that had been treated non-operatively was the only one classified as having acceptable results. He had occasional pain, but X-ray did not show osteoarthritis.

Osteoarthritis was found in four patients. Three had had B4 fractures and one a B3 fracture. In all four fractures, the initial displacement and comminution had been severe and the accuracy of reduction poor. Osteoarthritis was only observed in fractures that had been treated by operation.

The fractures of the fibula that had been stabilized with a rod healed with varus deformity. In the remaining patients in the non-operated group (five cases) only one valgus deformity occurred. All the B4 fractures healed with anterior angulation varying from 5° to 25°, regardless of treatment.

We found that the operated cases were comparable with the non-operated cases for fracture types A, B2 and B3 as regards initial displacement and accuracy of reduction and the results in

all these fractures were classified as clinically acceptable. On the other hand, all B4 fractures treated by operation (six cases) were clinically not acceptable. Of the total of 13 fractures treated by operation, seven (54 per cent) were clinically acceptable, but when the B4 fractures were excluded the group operated on showed acceptable results in 100 per cent of cases.

DISCUSSION

Weber (1966) accounted for explosion fractures of the lower end of tibia as being caused by impaction of the talus into the distal tibia by an axial compression force. Lauge Hansen (1948) showed that there are probably two mechanisms that can cause this fracture, a rotational pronation dorsiflexion force and an axial compression force with the foot either in dorsiflexion or in the neutral position at the moment of impact.

Like Lauge Hansen we found two major fracture patterns, one rotational and one compressive, but they resulted in intra-articular fracture of types different from those described by Lauge Hansen. In our study the former was due to low energy trauma and the results were in general acceptable, whereas those fractures caused by high energy trauma (unfortunately the more common fracture pattern) had a different and more serious prognosis. Thus it seems, as has also been noted by Kellam & Waddell (1980), that the two fracture patterns mentioned above can produce other variants of intra-articular fracture besides those found by Lauge Hansen.

A great variety of treatment of intra-articular fractures of the distal tibia is recommended. Jergesen (1969) claimed that the explosion fracture of the lower end of tibia was "not amenable to internal fixation". Cox & Laxon (1952) and Scheck (1965) recommended traction and possibly limited open reduction. Burwell & Charnley (1965), Rüedi & Allgöwer (1969) and Lippay (1978) considered that early fixation, early motion and delayed weight-bearing were the best treatment.

The results of surgical treatment in this study were rather discouraging for B4 fractures; 86 per cent (6 cases) were classified as having clinically not acceptable results. There were no talar fractures in the series, but in all the B4 fractures treated operatively damage to the articular surfaces of the talus, often combined with defects in the subchondral bone, were noted. This may have contributed to the poor results observed in this group.

The severity of injury, estimated from the degree of initial displacement and comminution, corresponded well with the final clinical results of the B4 fractures (Table 1). This may be used as a prognostic factor. On the other hand, the results in all B3 fractures were acceptable, in spite of severe displacement and comminution.

The accuracy of reduction did not seem to influence the final clinical results in the same manner; the results in the comminuted intra-articular fractures tended to be not acceptable, regardless of the accuracy of reduction (Table 2). In contrast, the results in the extra-articular fractures were clinically acceptable.

The incidence of osteoarthritis depends on the accuracy of reduction (Burwell & Charnley 1965). This was confirmed in the present study for B4 fractures. The B4 fractures developed osteoarthritis, whereas the B3 fractures seemed to develop osteoarthritis less frequently, in spite of severe initial displacement and comminution. As has also been stated by Burwell & Charnley (1965) and Rüedi & Allgöwer (1969), the final clinical results correlate well with the incidence of osteoarthritis, but in the present study this only applied to B4 fractures. An obvious reason for the development of osteoarthritis is the unknown amount of articular damage at the time of injury. Osteoarthritis occurred only after fractures caused by high energy.

Rüedi & Allgöwer (1969), Lippay (1978) and Kellam & Waddell (1980) stressed the importance of restoring the fractured fibula to its normal length. We found that restoration of the length by means by a rod but without accompanying support of the medial tibia resulted in varus deformity. We found it remarkable that all of the intra-articular comminuted fractures resulted in various degrees of anterior angulation. One reason might have been extensive damage to the joint surface resulting in forward dislocation and healing having taken place in this position.

Skin damage and secondary infection caused by high energy trauma are important factors involved in the poor results of tibial shaft fractures (Edwards 1965). High energy trauma was an important causative factor in the poor results observed in the comminuted intra-articular fractures of the distal tibia, but with this type of fracture the reason seemed to be articular damage rather than skin damage.

The conclusion drawn from this study was that the results of the majority of the comminuted intra-articular fractures were clinically not acceptable when initial displacement and comminution were severe and the accuracy of reduction was poor. The incidence of osteoarthritis was high in this group. The extra-articular comminuted fractures, on the other hand, seemed to have a different and better prognosis as determined by the final clinical results, including the occurrence of osteoarthritis.

The initial X-ray could not be used to predict the final result except for the intra-articular comminuted fractures. These fractures should, according to the present observations, obviously not be treated by primary operation. We cannot answer the question of whether comminuted intra-articular fractures should be treated by non-operative methods or by primary arthrodesis, but we feel that arthrodesis should be used only as a salvage procedure.

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