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FRACTURE OF THE ASTRAGALUS

BY

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53 cases of fracture of the astragalus and its sequelae have been admitted in the past 12 years to the Orthopaedic Hospital, Aarhus. When doubtful cases and cases in which fracture of the astragalus was only a part—and not the more essential part—of a complicated injury were eliminated, 37 cases remained. Of these, 13 had fractures of the posterior process of the astragalus, while the remaining 24 had fractures of the astragalus proper.

First, a few remarks may be made about the former group —fracture of the posterior process—which is sharply distinct from the main group. This fracture is a small and apparently insignificant injury which may easily be overlooked on the radiographs, unless the examiner anticipates that it may be present. In our material, indeed, it had been missed several times at the first examination before the patient was referred to this clinic. It is, however, by no means an insignificant injury, as is evident from the fact that it had caused discomfort to 8 of the 13 patients for over half a year after the injury, before they were referred to this hospital, while in some of them other, and far more severe, injuries, had healed without sequelae.

So this is a fracture which should not be neglected. It occurs especially in distortion injuries—this was the etiology in 9 out of the 13 cases—sometimes on strong plantar flexion of the foot, not infrequently as a more or less essential com-

plication in fractures of the malleoli and calcaneus. Clinically, 2 symptoms suggest the diagnosis: local tenderness, and either reduced or painful plantarflexion of the foot. Both of these symptoms were recorded in 7 of the 13 patients. A third symptom—pain on flexion of the big toe, due to the course of the tendon of the flexor hallucis close to the posterior process—is more theoretical; it was not recorded in any of the cases.

On radiography, the diagnosis was obvious in some cases, and very doubtful in others, especially in those of long standing. In particular the occurence of os trigonum as a separate bone may make the diagnosis difficult,—though this is, perhaps, of minor practical importance, as an os trigonum exposed to a distortion injury may give the same indication for excision as fracture of the posterior process.

This radical treatment of the fracture—excision—was offered or advised in many of these cases, but it was performed only three times. The remaining cases were treated conservatively with plaster, novocaine injection or orthopaedic footwear. The cases have not been followed-up.

Before turning to the main group of the material, the 24 cases of fracture of the astragalus proper, I shall briefly mention the characteristic features of the astragalus that give the fractures of this bone their particular character:

1. The thick shape of the bone, its position between the other bones and its lack of muscle insertions explain the relative infrequency of its fracture. According to *Eiken* (1917), its incidence compared with that of fractures of the calcaneus is 1:10.

2. About three-fifths of its surface is covered with cartilage distributed on 7 articular surfaces, and a fracture line must nearly always involve one or more articular surfaces, so that even slight displacement will result in severe arthrotic changes.

3. The same feature makes the nutrition of the bone easily impaired, so that a fracture involves considerable risk of necrosis, especially of the body. Even though the numerous

ligamentous attachments are all accompanied by small vessels, by far the greatest blood supply is received through the neck of the astragalus—as can be seen in injection preparations. Therefore, any fracture through the neck involves considerable risk of necrosis of the body, and this necrosis is almost inevitable if, at the same time, the posterior ligamentous attachments are torn—as when there is fracture of the neck of the astragalus with backward displacement of the body. The frequency of necrosis in these two forms of injury is given by *Watson-Jones* to be 50 % and 100 %, respectively.

4. Finally, the central position of the bone, and its importance to the structure of the foot is a reason why deforming fractures may cause pronounced malpositions of the foot—more often a varus, but sometimes a valgus position.

It must be mentioned here that the present material consists almost exclusively of the sequelae of fractures which were treated primarily elsewhere. Only 3 cases were recent, 9 had occured up to 1 year, and 11 over 1 year before—with 13 years as maximum. This means that the material is selected, in that it consists of cases with sequelae who have applied to the clinic, but I think that the fact that we have received relatively many cases of this rare fracture signifies that it is a serious one.

I have tried to divide the 24 cases into several groups by comparing the data on the trauma with the type of fracture seen on the radiographs, and I think it is practicable to classify most of the fractures with a fair degree of certainty according to the way in which they occurred. But I must stress that the fractures are so various that any classification must in some degree be artificial. In 10 cases I found that the fracture occurred with traumatic dorsiflexion, in 5 cases with traumatic inversion and inflexion of the foot, in 4 cases with direct trauma—and finally there are 5 cases in which I was not able to determine the trauma.

I. Accordingly, in the first and largest group, comprising 10 cases, the trauma was either strongly dorsiflexing or acted on a dorsiflexed foot, and a fracture of the neck with or with-

out dislocation occurred. Of the 10 fractures 6 took place on a fall from a height, in which we have to assume that the foot hit the ground in dorsiflexion. According to *Böhler,* this is the ordinary mechanism of fractures of the astragalus, whereas fractures of the calcaneus are said to arise in falling

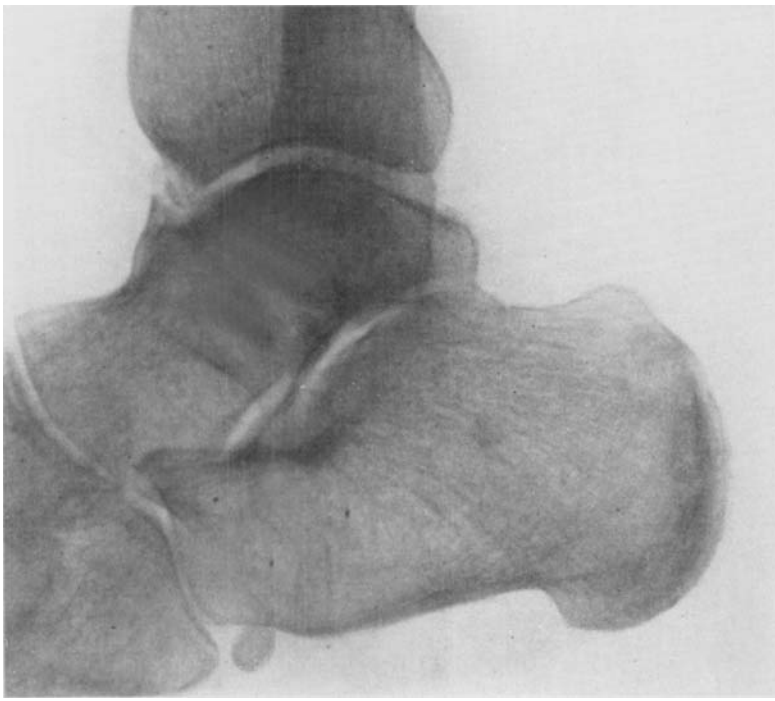

Fig. 1.
Simple fracture of the neck of the astragalus with the fracture angle open towards the dorsum. Sclerotic changes in the trochlea.

on the foot in neutral position. With the third possibility—traumatic injury to the foot in plantar flexion—the fracture is said to arise posteriorly in the astragalus by impact with the posterior margin of the tibia. Such a trauma is of rare occurrence, however, and therefore the corresponding fracture

is rare; our material, however, includes one typical case of this kind.

In the more common injury occurring in dorsiflexion, the anterior margin of the tibia is thought to be driven down like a wedge into the posterior part of the neck of the bone, sometimes into the anterior part of the trochlea, resulting in a transverse fracture, most often with an angle opening to the dorsum. However, according to the theory which was originally advanced by *Ombredanne* and was supported by *Eiken* and others, the fracture occurs normally as a simple flexion fracture, the body being fixed in the malleolar fork while the head is displaced dorsally, and the tibia plays no part in its production. But when—as seen in Fig. 1—the anterior margin of the tibia is also injured, the former origin seems more probable.

The patient was a woman who had fallen off a load of hay 4½ months before admission. There is a simple fracture of the neck of the astragalus with the angle open dorsally. In addition, sclerotic changes indicating nutritional disturbance can be seen in a small part of the trochlea.

This relatively simple fracture after dorsiflexing trauma was found in 8 of the 10 cases. Trauma acting further in this direction causes, in addition, forward dislocation of the distal fragment + the entire subtalar foot, including the calcaneus. Presumably such a dislocation had occurred in some of these 8 cases, but had been reduced immediately after the injury, so that it was not present on admission. It was mentioned in the history in 2 cases. One case, however, was hospitalized immediately after the injury, and it shows several interesting features:

The patient was a mason, 25 years old, who fell off a church tower. The radiograph is shown in Fig. 2: Fracture of the neck of the astragalus with about 2 cm. forward displacement of the distal fragment + the foot. The body is in the malleolar fork but appears to have rotated round a sagittal axis. Closed reduction was impossible, and at operation this was explained by the fact that both the peroneal tendons had been

dislocated forwards in front of the lateral malleolus. The reduction was easy after temporary division of these tendons, and a good position was obtained. He was working 1½ years after the accident, but since then he has had periodic discomfort, and now—10 years after the accident—he says that he is able to work only with difficulty. Thus the

Fig. 2.
Fracture of the neck of the astragalus with forward dislocation of the distal fragment and subtalar foot.

result is not satisfactory, presumably because of sclerosis of the body, which was visible 6 weeks after the injury and even more distinct 4½ years later (Fig. 3). There is now marked compression of the body. After 8 years the structure of the bone has become more normal, but the articular surfaces are irregular. This patient began weightbearing on the foot 12 weeks after the injury.

Finally, the most severe lesion in this group is a fracture of the neck complicated by backward dislocation of the body

fragment out of the malleolar fork. Such a dislocation depends on injury to the attachments of the posterior ligaments simultaneously with the fracture, and, presumably, on the fracture being posterior to the lig. interosseum, so that the corpus

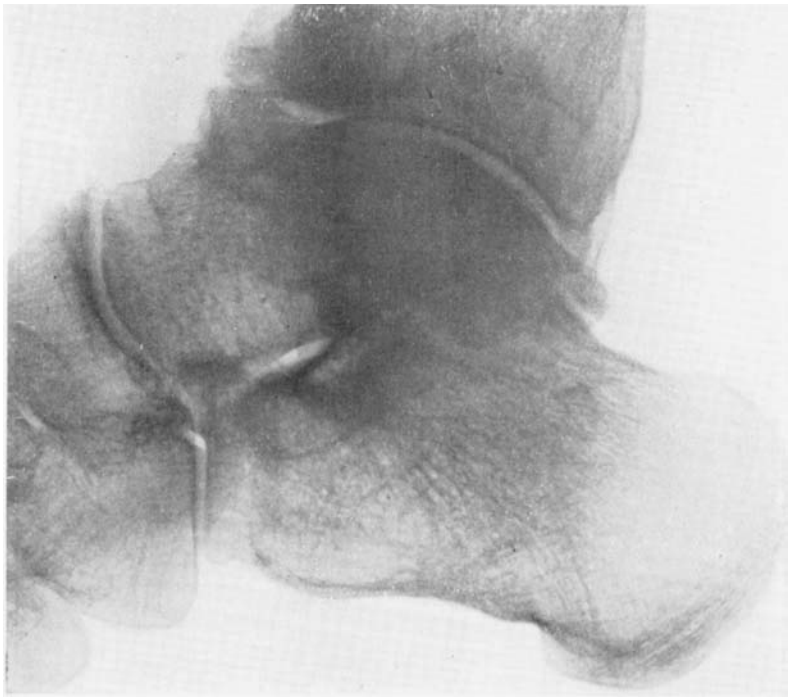

Fig. 3.
Same case as Fig. 2. Picture taken 4½ years after the reduction. Compression of the sclerotic body and arthrosis.

fragment can be dislocated almost freely. Our material also includes one case, which was treated immediately. The accident occurred in an uncommon but quite characteristic way:

The patient was a rescuer, 28 years old. While working with a crane car, the crane was overloaded and he tried to keep the front of the car down by bearing down on the fender. Then the wire of the crane broke suddenly and the front end of the car came down, with the fender strik-

ing his bent leg just above the knee on the femur, which did not break, but transmitted the impact to the foot, in dorsiflexion. This typical injury (Fig. 4) resulted: fracture of the neck of the astragalus with backward dislocation of the body, which is rotated 90 degrees round both a frontal and a sagittal axis. Operative reduction was easy after

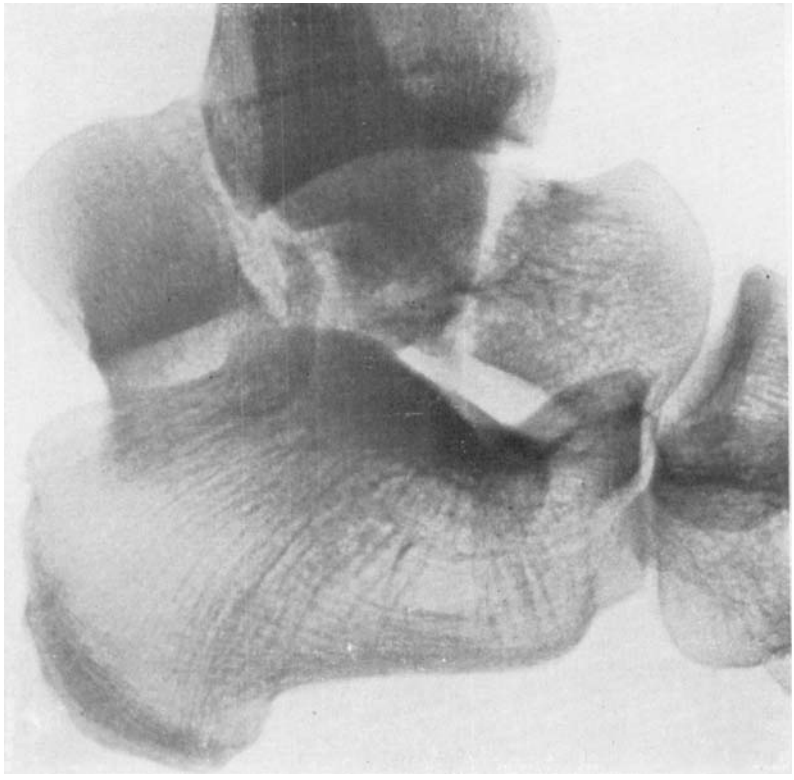

Fig. 4.
Fracture of the neck of the astragalus with backward dislocation of the body fragment.

temporary division of the Achilles tendon (Fig. 5) but — one might say, of course,—necrosis of the body with increasing density of the bone radiographically occurred. (Fig. 6.) After one year the sclerosis is decreasing. The joint space is narrowing towards the tibia, but there is no sign of arthrosis and no compression. This patient walked in a walking plaster for 20 weeks after the accident.

II. This group comprises 5 cases in which the fracture occurred with inversion and in flexion trauma. Usually this type of trauma causes distortion and dislocation, both subtalar and in Chopart's joint, but often the dislocation is accompanied by fracture of the astragalus, and I think that these

Fig. 5.
Same case as Fig. 4, immediately after operative reduction.

5 cases should be considered to have occurred in this way, though usually the dislocations were not seen here in the hospital. The traumas were of various kinds: falling from a height, motor accident, falling off a bike, stumbling while playing, faulty jumping; in several cases the fracture caused compression of both the head of the astragalus and the os naviculare.

Fig. 7 gives an example of this injury: the patient was run over by a wagon 9 months before admission; there is marked compression of the head of the astragalus and medial dislocation of the navicular bone.

III. In the four cases in this group there was a history of direct trauma. In 3 of the cases a heavy object fell down on

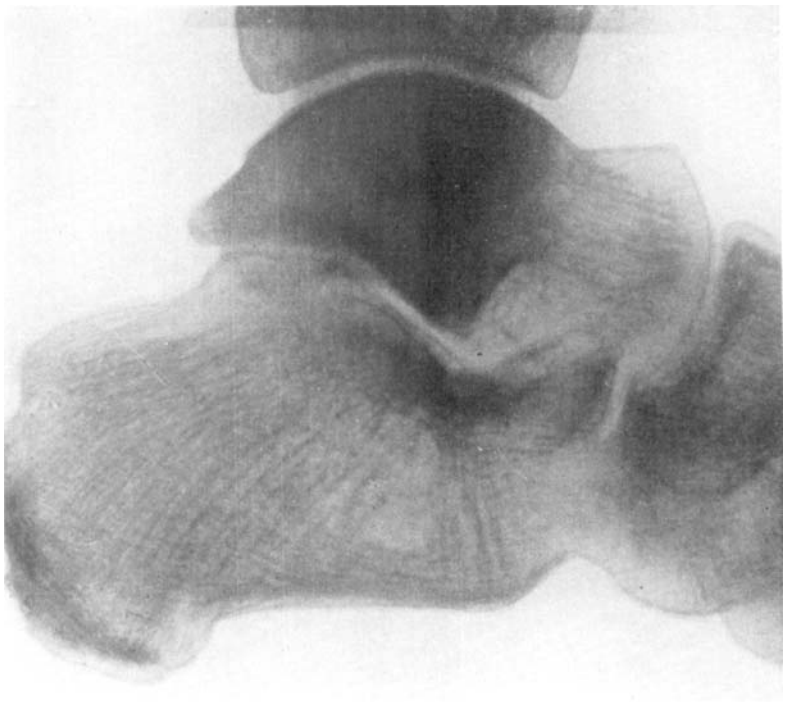

Fig. 6.
Same case as Fig. 4. Photo taken 4 months after the reduction. Pronounced sclerosis of the body, but no compression. Normal joint surface.

the foot, producing an open fracture in 2; the fourth case was due to a gun-shot injury. In all, the fracture was untypical, involving chiefly the body.

IV. Finally, there are 5 cases which I have not been able to place in any definite group from the available data.

It will be seen that this etiological classification corresponds roughly and with several exceptions to an anatomical

grouping, the dorsiflexion traumas involving especially the neck, inversion traumas the head, and direct traumas the body.

It is the protracted sequelae of fractures of the astragalus which brings the patients to seek orthopaedic treatment. There are three main sequelae: necrosis of the body with compression, arthrosis, and deformity of the foot. The reasons

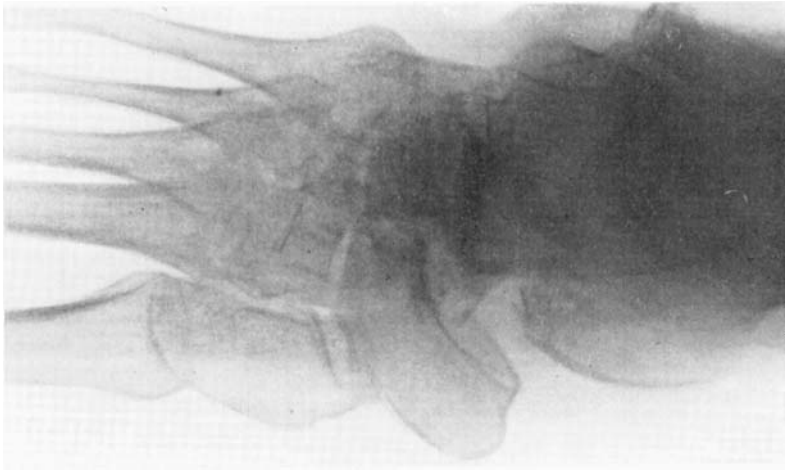

Fig. 7.
Inversion fracture. Compression of the head of the astragalus and medial dislocation of the navicular bone.

why these three sequelae are frequent in fracture of the astragalus have already been discussed.

Necrosis: 5 cases presented radiographic signs of necrosis of the body, and in 2 necrosis was the direct cause of compression of the body. Further, this compression may be the cause of arthrosis as well as of deformity. It should be the aim of the treatment to prevent it by means of prolonged protection from weight bearing. We have seen one case with compression after 12 weeks protection from weight-bearing, and another case without compression after 20 weeks protection, which indicates perhaps how long it should be continued.

Arthrosis: Of the 24 cases 11 showed radiographic and

clinical signs of arthrosis on admission. In 6 the arthrosis was most marked in the talonavicular joint; in 5 in the talocalcanear joint, and in one of these it was also marked in the talocrural joint. Arthrosis has appeared as early as 2 months after the accident. In 6 cases it was found on admission of the patient within one year after the accident; and the longest time for its appearance was 4½ years. In some cases, rather slight displacement of the joint surfaces has caused severe arthrosis, while, conversely, severe injuries may give lesser sequelae, especially if they cause spontaneous ankylosis. Arthrodesis has been considered for all these 11 cases of arthrosis; it was performed on 7 patients—6 times as a subtalar arthrodesis, once as a panarticular arthrodesis.

Deformity: The deformity after poor union of a fracture of the astragalus is generally said to be a pes equino-varus, a traumatic club-foot. However, valgus deformities are also seen in some cases. Marked deformity was found in 13 of our patients: varus in 9, valgus in 4. Valgus deformity was found after fracture of the neck with dorsal opening of the angle. With this deformity, on the whole, the astragalus has a similar form as in pes plano-valgus with a very wide inclination angle, so that the valgus deformity is easily explained. (cf. Fig. 1.) This was the pathogenesis in 3 of the 4 cases, while the fourth patient had no deformity of the astragalus, but in addition to the fracture he had had a subtalar dislocation, which probably caused insufficiency of the foot.

Of the nine patients with varus deformity 5 had compression of the body, either as a direct result of the fracture of the body, or secondary to its necrosis. If the patient is first examined only long after the accident it may be impossible to decide which is the case. When the injury to the body leads to a varus deformity it is probably due to the fact that somehow the compression has mainly occurred in the medial part of the corpus. In 2 other cases the varus deformity appeared after an inversion trauma. In 2 cases the reason for the varus deformity was somewhat obscure.

The present material gives no occasion to discuss the treat-

ment of the fresh fracture. In the treatment of its sequelae, arthrodesis holds a prominent position. As already mentioned, this material is made up chiefly of severe consequences of the fracture, and there was no indication for an arthrodesis in only 7 out of the 24 cases. In 8 cases, arthrodesis has not yet been performed for various reasons; it has been done in 9,—as subtalar arthrodesis in 8 and panarticular in one. The indications have been arthrosis or faulty position or, most often, both. Varus deformity has been a contributory indication in 6 cases, valgus in 3, and arthrosis in 7.

We have obtained information on the results of the operation, either at out-patient examinations or from written questionnaries answered by the patients from 3 to 8 years after the operation. On the basis of these data I have estimated the results as being good or fair in 5 cases and unsatisfactory in 4. All the patients, however, are able to carry on their previous occupations, but those who are termed unsatisfactory have reduced working capacity and have to wear hand-made footwear. Reexamination showed that in 3 a considerable degree of varus deformity was the cause of the permanent disability. So, I think that this material justifies the conclusion that arthrodesis is indicated in severe sequelae of fracture of the astragalus, and that it may be expected to have a good result, provided that a possible varus deformity is fully corrected by the operation. The good prognosis associated with the arthrodesis should lead to the following principle: Excision of the astragalus, which used to be recommended in all severe fractures of this bone, should be avoided as far as possible.

SUMMARY

A series of cases of fractures of the astragalus—from the Orthopaedic Hospital in Aarhus—is presented; it consists chiefly of cases with severe sequelae to the fracture, and includes only 3 recent cases.

There are altogether 37 cases; the posterior process of the

astragalus was fractured in 13, and the astragalus proper in 24.

The fractures are classified according to their origin, and examples of the various forms are given.

Mention is made of the late sequelae: necrosis of the head, arthrosis, and deformity.

The writer emphasises both the importance of prolonged protection from weight-bearing on the fresh fracture in cases with necrotic changes in the body in order to avoid compression, and the value of arthrodesis in the treatment of sequelae.

RESUME

Une série de cas de fractures de l'astragale — de l'Hôpital Orthopédique d'Aarhus (Danemark) — sont rapportés; il s'agit principalement de séquelles de fractures, 3 cas seulement étant récents.

Les observations portent sur 37 cas au total; fracture de l'apophyse de l'astragale 13 cas et de l'astragale proprement dite 24 cas.

Les fractures ont été classées d'après leur origine et il est donné des exemples de leurs formes variées.

Il est fait mention des séquelles tardives: nécrose de la tête de l'astragale, arthrose et déformité.

L'auteur souligne à la fois l'importance qu'il y a à protéger de tout poids pendant très longtemps la fracture fraîche quand il y a des modifications nécrotiques du corps de l'astragale, afin d'éviter toute compression, et la valeur de l'arthrodèse dans le traitement des séquelles.

ZUSAMMENFASSUNG

Eine Reihe von Fällen von Talusfrakturen — aus dem Orthopädischen Krankenhaus in Aarhus — werden mitgeteilt; das Material besteht hauptsächlich aus Fällen mit Sequelae der Fraktur und enthält nur 3 frische Fälle.

Es umfasst insgesamt 37 Fälle; der Processus posterior

tali war in 13 Fällen gebrochen und der Talus selbst in 24 Fällen.

Die Frakturen werden nach ihrer Ursache eingeteilt, und für die verschiedenen Formen werden Beispiele gegeben.

Die Spätfolgen werden erwähnt: Caputnekrose, Arthrose und Deformität.

Verfasser betont die Bedeutung einer prolongierten Immobilisierung und Entlastung der frischen Fraktur in Fällen mit nekrotischen Veränderungen des Corpus zur Vermeidung einer Kompression sowie den Wert einer Arthrodese bei der Behandlung der Sequelae.