

FRACTURES OF THE TARSAL BONES.¹

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THE importance of the early diagnosis and the institution of the proper treatment of fractures of the tarsal bones is well recognized at the present time. Prior to the routine use of X-ray pictures by progressive surgeons, injuries of these bones were thought to be comparatively rare, and many of the cases were treated as severe sprains, etc. In 1894, Gaupp (*Beiträge zur klinische Chirurgie*, Vol. xi) was able to collect sixty cases of fractures of the astragalus. In looking over the literature of the subject, the writer was surprised to find few cases relatively of fractures of the other tarsal bones reported.

It is only within recent years that we have begun to diagnose fractures of the astragalus and calcaneus, and I shall attempt to show by the report of some cases the necessity of making such a diagnosis as early as possible. '

Injuries of the other tarsal bones are so rare that I shall confine this paper to the consideration of fractures of the astragalus and os calcis.

Surgical Anatomy.—The principal points of interest in the surgical anatomy of these two bones are that the astragalus, through its articulation with the tibia and fibula, bears the entire weight of the body, with the aid of its fellow of the other side. This portion (trochlea) corresponds to the body of the bone, and in falls upon the feet one can see how it is caught between the os calcis lying beneath it and the malleoli, and thus crushed. The neck of the astragalus joins the body with the head (the latter articulating with the scaphoid), as can be seen in an X-ray of a normal foot (Fig. 1). This

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narrow neck of the astragalus is the most fragile part of the bone, and hence the most frequently broken.

The os calcis placed beneath the astragalus assists it in supporting the weight of the body, and like it is subjected to a crushing force in falls from a height.

In addition, it has attached to its tuberosity the powerful tendo-Achillis, which plays a great rôle in producing fractures of this bone. The astragalus and calcaneus are firmly bound to the tibia and fibula, to the other tarsal bones, and to each other by powerful ligaments, so that at times a force may tear such a connecting band of fibres, or cause these structures to tear away a portion of the bone itself.

Mechanism.—Fractures of the astragalus and calcaneus may be produced in one of six different ways, given in their order of frequency:

1. Compression fractures. These form the larger number of the cases. They occur, as is shown in Cases I, II, and III, reported below, by the patient falling from a height and striking upon the ground, so that the sole of the foot receives the major part of the weight of the body. The latter is transmitted to the astragalus and os calcis, which are wedged in between the bones of the leg and the surface struck, and are crushed or compressed, so that they must break. Such compression fractures are frequently associated with fractures of the malleoli, or with a dislocation of the astragalus. The plane of fracture varies. It may be horizontal, vertical, or oblique. There may be simply a division of the bones into two large fragments, or they may be so splintered as to be scarcely recognizable.

2. Fractures of the neck of the astragalus following sudden dorsal flexion of the foot. In this variety the line of fracture is in the frontal plane, the anterior edge of the tibia impinging upon the neck, and thus cutting its way through. Such fractures are frequently associated with a fracture of the inner malleolus.

3. Fractures of both astragalus and calcaneus following forced supination or pronation of the foot. These are in all

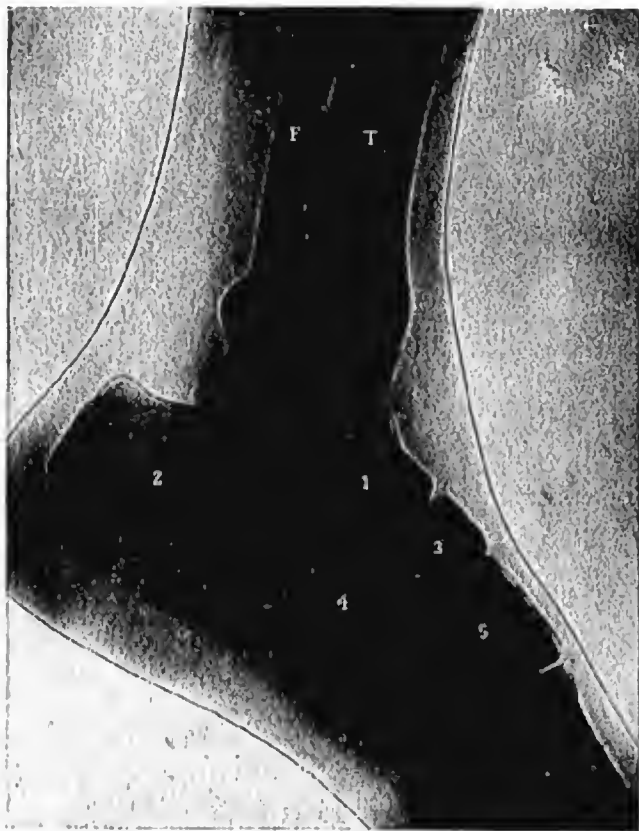


FIG. 1.—X-ray of normal foot. F, Fibula. T, Tibia. 1, Astragalus. 2, Os Calcis. 3, Scaphoid. 4, Cuboid. 5, Cuneiform.

probability due to the fact that the interosseous ligaments have in many instances greater resisting power than the bones, and probably pull the bones apart, a variety of tearing fracture so well illustrated in the next method.

4. Fractures of the os calcis which result from forcible action of the muscles of the calf. In this variety the os calcis, as in Cases IV and V, is most frequently fixed, and the sudden contraction of the powerful gastrocnemius and solcus muscles really pulls the tendo-Achillis from its attachment to the tuberosity of the os calcis, or carries a portion of the latter with it (Fig. 5).

5. Crushing fractures. In this variety the other tarsal bones are also involved. It follows such accidents as being run over, etc.

6. Gunshot fractures. All of these, with the exception of the last two, may be simple fractures, with or without noticeable displacement of fragments.

In many cases there is no important injury of the soft parts, the latter being usually found more or less contused. In other cases the fragments may penetrate the skin, or may so press upon the skin as to cause secondary necrosis, the prevention of which is of the utmost importance.

Diagnosis.—For the sake of brevity, I shall mention the symptoms and diagnosis together, as follows:

1. Marked swelling of the ankle-joint. This is present in both tarsal fractures and in sprains of the ankle, but is more marked in the former.

2. Obliteration of the normal depressions below and behind the malleoli. This is also more marked in fractures of the astragalus and os calcis (Fig. 2).

3. Crepitus and abnormal mobility. These can rarely be elicited, and but little reliance placed on them.

4. Dislocation of fragments. Such a detached portion may at times be felt beneath the malleoli, or, as in Cases IV and V, just above the tuberosity of the os calcis (Fig. 5). If felt and recognized to be a part of one of the tarsal bones, this sign is of the greatest value.

5. Lowering of the malleoli through diminution in thickness of the astragalus or os calcis. This is very seldom sufficiently marked to be of value, on account of the swelling.

6. Shortening of the foot when found is of great value.

7. Abnormal positions of the foot, such as pes valgus or pes varus, if fixed, are also of confirmatory value.

8. X-ray examination. This has been adopted as the most accurate means of diagnosis. In every case one should, however, compare the picture of the injured foot with an X-ray of the normal one.

9. History of injury is of great value, as it so frequently follows falls from a height.

To sum up, the following are of the greatest value in making a diagnosis of fractures of the tarsal bones, viz., palpation of a fragment, pes valgus or varus traumaticus, the X-ray examination, and the history of the case.

Treatment.—1. *In Simple Fractures without Displacement.* In these the foot should be immobilized at right angles, best of all in a removable cast, well padded around the ankle and heel. Massage should be begun on the third or fourth day, in order to reduce the peri- and intra-articular effusion, and prevent atrophy of the leg muscles. The cast should be worn for eight weeks, and at the end of this time the patient gradually permitted to put his weight on the foot. Convalescence may be delayed, as in many cases of simple sprain, by the presence of a flat foot (pes valgus traumaticus) following the injury. The pain and discomfort caused by this condition can be quickly relieved by a suitable steel insole.

2. *In Simple Fractures with Displacement.* If there is the least danger of secondary necrosis of the skin through a fragment impinging on it, it is best to convert the fracture into a compound one, taking extraordinary pains to secure aseptic surroundings, etc. If the fragment lies laterally, it can be easily removed. If it lies behind the ankle and is complicated by detachment of the tendo-Achillis, the latter should be sutured, as in Case IV, to the body of the os calcis. If either the astragalus or os calcis are so badly splintered as to render



FIG. 2.—Outlines of normal ankle and of ankle after fracture of the tarsal bones. Note how depressions are marked in normal (right) ankle and are obliterated in pathological (left) ankle.

their retention impossible, they may be removed without marked loss of function in the foot.

3. *Compound, Crushing, and Gunshot Fractures of these Bones.* One should be guided by the same rules as apply elsewhere in the treatment of such injuries of the extremities.

CASE I.—*Compression Fracture of Os Calcis; Secondary Necrosis of Skin; Acute Septic Infection; Amputation of Leg.*—J. L., engaged as painter in the Stewart Building, of Chicago, was working at the level of the eighth floor of the elevator shaft, when his scaffolding was struck by a neighboring elevator cage during its ascent, and patient was thrown to the bottom of the shaft, a distance of eighty feet. He stated that he had tried to grasp some of the ironwork of the floors when falling, and this probably broke to some extent the force of the fall. He fell directly upon the sole of the left foot, and was conveyed to an adjacent hospital. I did not see this patient until the second day after the injury. Prior to that time the treatment had consisted of simply placing the limb on a splint, immobilizing it. No effort had been made to disinfect the skin. When seen by me on the second day after injury, his temperature was normal, the surrounding tissue around the ankle-joint was enormously swollen, and there were evidences of deep-seated hæmorrhages. The foot was so painful that it was impossible to make any examination, and an X-ray was not at my disposal. I was unable to get any crepitus by gentle manipulation. The surrounding skin was disinfected, and the patient placed on long splint with foot at right angle. Suddenly, upon the eighth day after the injury, the patient's temperature, which had been normal up to that time, rose to 103° F.; pulse, 140; and there were local evidences of an acute infection. Amputation was advised on account of the severity of the infection, and proved to have been the wiser plan. Examination of the amputated limb showed that there was an extensive infection of the cellular tissue of the entire foot and lower third of the leg. There were also evidences of extensive contusions of the soft parts, the os calcis was broken into many pieces, and there was a slight chipping of the cartilaginous surface of the astragalus. There were no fractures of the malleoli, and the patient made an excellent recovery.

This case illustrates how compression fractures of the os calcis arise, and shows the importance of making a diagnosis of the condition at as early a time as possible, in order to avoid what must have undoubtedly been the chief etiological factor in producing the sepsis in this case, and that is the secondary necrosis of the skin through impingement of the fragments upon it. Had this case been recognized at once as one of compression fracture of the os calcis, and a careful search made for fragments which might interfere with the circulation of the skin, I have no doubt that we could have avoided the unfortunate necessity of amputation.

CASE II.—E. W., aged forty-eight years, was admitted to my service in the Cook County Hospital with a diagnosis of a severe contusion of the foot and sprain of the ankle-joint, having fallen forty feet from a shed and landing on his feet. Examination showed the enormous swelling around the ankle-joint and obliteration of the depressions which normally exist in front, below, and behind the malleoli. We were suspicious, on account of the severe pain and the enormous amount of swelling, of a fracture of the os calcis or astragalus, and an X-ray was taken. It showed, as can be seen by reference to Fig. 3, an extensive comminution of the os calcis, confirming our previous suspicions. The skin of the foot and leg was carefully disinfected, and the limb placed in a removable cast, which was left on about four weeks. From the second week on massage was given, and at the end of the fourth week passive motion of the ankle-joint was begun. The patient was advised to use the cast for another month, being allowed to place a gradually increasing amount of weight on the limb at the end of six weeks.

This case illustrates the value of early diagnosis of such fractures, and the typical treatment as has been carried out by the author.

CASE III is the case of Dr. Sidney McLeod, of South Chicago, who had heard of my interest in this class of cases, and was kind enough to send me X-rays of this Case III, and also of a case similar to my Case IV.

CASE III.—G. G., aged thirty-five years; laborer; fell from the back porch of a second story, lighting upon his feet. Dr.



FIG. 3.—Illustrates Case III. Compression fractures of the astragalus and os calcis. Note the two fragments of the astragalus (a) and the comminution of the os calcis (c).



FIG. 4.—Illustrates Case III. Compression fracture of os calcis. a. Astragalus. c. Fragments of os calcis outlined in white; the heavy white lines are the spaces between fragments.

McLeod found great discoloration, crepitus, and the other usual signs of fracture. He placed the foot in a cast after the swelling had subsided. A skiagraph taken six weeks after the fracture is shown in Fig. 4, and illustrates again the same class of fracture as is shown in Case II of my own series, namely, a splitting of the os calcis into a number of fragments, the planes of fracture being diagonal or oblique to the long axis of the bone.

CASE IV.—Mrs. C. V. A., aged fifty-two years, on October 20, 1903, was getting out of her carriage, and had one foot on the step of the latter and the other (injured one) on stepping-stone, when her horse, which was headed south, was run into by a runaway horse. The shaft of the Stanhope buggy to which this second horse was attached ran into Mrs. V. A.'s horse, and knocked it over. In falling, her horse threw her backward and fell directly upon her foot and leg. She was wearing a French-heeled shoe, and her foot was held as in a vise between the stone and a low circular iron fence to the north of it. She states that as soon as the horse fell upon her, she experienced an excruciating pain in the left heel, and then fell backward into the grass-plot. She was referred to me by Dr. M. L. Goodkind, with the diagnosis of a fracture of the os calcis.

Upon examination, patient was unable to extend foot. Just above the heel there was a sharp projection, which felt firm, like a fragment of bone. It was just beneath the skin. The latter was very thin over it. A diagnosis was made by both Dr. Goodkind and Dr. Schram and myself of a fracture of the os calcis. Our theory was that the foot had been caught so as to fix the heel, and her fall backward had caused a fracture by muscular violence.

Operation, on October 22, 1903, at Chicago Baptist Hospital. After most thorough disinfection, and with Esmarch applied, an incision was made from the junction of the lower and middle one-third of the leg along its median posterior aspect to the lower border of the heel. The fragment which had projected was found to be a portion of the os calcis, about half an inch thick, which had been pulled upward by the tendo-Achillis and tilted upon edge. It was also found that the tendo-Achillis had been torn loose from this fragment with the exception of its posterior edge. The foot being forcibly extended by an assistant, the small fragment of the os calcis was sutured to the main portion of the bone by mattress sutures of kangaroo tendon (U and L of Fig. 5).

The ends of these sutures were then passed through the lower border of the tendo-Achillis, and the latter brought somewhat closer to the posterior aspect of the os calcis than normal. In addition, it was more firmly sutured to the periosteum of the main fragment of the os calcis by a number of sutures of medium catgut. Normal temperature followed operation. First change of dressings on November 3, 1903. Primary union of cutaneous wound. Silkworm-gut sutures removed. Limb again placed in plaster cast, with foot in extreme extension.

The wound healed by first intention, and the functional result has been as nearly perfect as could be wished for. She is able to extend and flex the foot as fully as on the normal side.

This case illustrates the importance of making a diagnosis of a tearing-off of a portion of the os calcis, on account of the danger of secondary necrosis over the point where the fragment impinges on the skin. Secondly, the treatment instituted here is, to my mind, the ideal one, when seen early enough by the surgeon, or even at a later period. I would, however, advise against converting such a fracture into a compound one, that is, cutting down upon the point of fracture and suturing the fragments with kangaroo tendon or some other material which will hold the bones together for a sufficient length of time, in those cases in which there is no fragment close under the skin, and in which extension of the foot brings the fragments closely together, as well as in that class of cases where aseptic surroundings cannot be secured. Unfortunately, I was obliged to take the patient to a hospital where there was no X-ray apparatus, so that it was impossible to secure a picture of the condition before operation, and the diagnosis was made entirely upon the palpation of a fragment projecting just above the tendo-Achillis, and immediately under the skin. Through the kindness, however, of Dr. McLeod, I am able to give an exact reproduction of the conditions existing in my patient before operation, owing to the fact that he was fortunate enough to secure an X-ray of an almost identical case (Fig. 6), as follows:

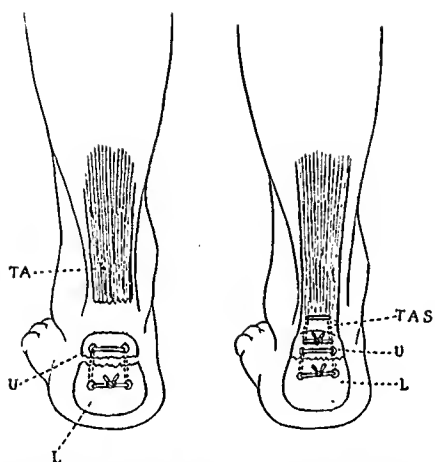


FIG. 5.—Method of suturing fragments and tendo-Achillis in Case IV. TA. Tendo-Achillis before suturing. TAS. Same after suturing. U. Upper fragment. L. Lower fragment.

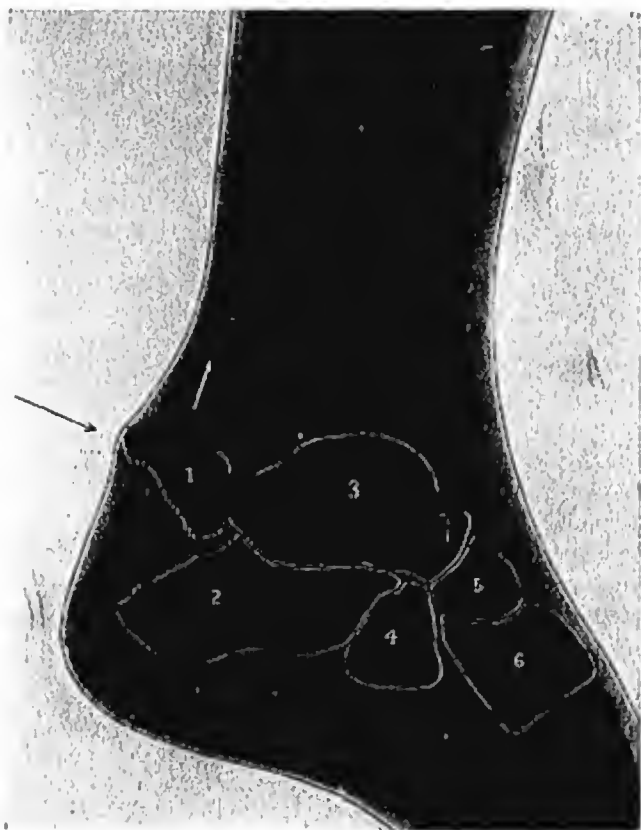


FIG. 6.—Illustrates Cases IV, and V. Tearing fracture of os calcis when heel was fixed. White arrow indicates direction of traction of tendo-Achillis. 1. Upper or torn-off fragment. 2. Main portion of os calcis. 3. Astragalus. 4. Cuboid. 5. Scaphoid. 6. Cuneiform.

CASE V.—*Fracture of Os Calcis by Muscular Contraction, causing a Tearing off of a Large Fragment of the Os Calcis from the Main Portion of the Bone.*—Mrs. R., aged sixty-two years, while walking on a sidewalk, stepped on a rotten board, allowing the heel to go through it with practically no resistance. She fell forward, throwing all of the body-weight on the ball of the foot. When first seen by Dr. McLeod immediately after the accident, the detached fragment was almost through the skin. She would not consent to operation until two days had elapsed, when an area of skin as large as a quarter, lying just over the fragment, became necrotic. She was taken to the South Chicago Hospital, where the X-ray shown in Fig. 6 was taken. Dr. McLeod made a straight incision over the tendo-Achillis and os calcis, brought the two fragments of the os calcis together with an ivory spike, reinforced by two heavy sutures of catgut. In order to suture the skin, it was necessary to cut away necrotic tissue. Good bony union resulted, but the tendo-Achillis became somewhat necrotic, but the final result has been satisfactory.