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# The Key Role of the Lateral Malleolus in Displaced Fractures of the Ankle\*

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**ABSTRACT:** The reason why late degenerative arthritis developed in some patients who had sustained displaced bimalleolar fractures of the ankle was investigated. The roentgenograms indicated that incomplete reduction of the lateral malleolus and a residual talar tilt were present. When bimalleolar fractures were created in cadavera the talus could be anatomically repositioned only when the lateral malleolus was accurately reduced. Fifty-three patients with bimalleolar fractures were treated by anatomically fixing the lateral malleolus with a four-hole plate. There was an anatomical reduction of the talus and medial malleolus in each instance and there were no late cases of degenerative arthritis when these patients were followed for from six months to nine years. We concluded that the lateral malleolus is the key to the anatomical reduction of bimalleolar fractures, because the displacement of the talus faithfully followed that of the lateral malleolus.

It has generally been accepted that reduction of the medial malleolus is of paramount importance in treating unstable bimalleolar fractures of the ankle<sup>1,2</sup>. It is further usually believed that even if the lateral malleolus is intact stability of the ankle is lost when the medial malleolus is fractured, especially if the fracture is transverse and at the level of the joint<sup>3</sup>. Most relevant publications emphasized that reduction of the medial malleolus should be anatomical and that once it is achieved there is complete reduction of the displaced talus<sup>4,5,8,10,12,16,19,22,25,26</sup>. It was also stated that any residual talar displacement can be corrected by manually reducing the lateral malleolus after the medial malleolus has been securely fixed in place<sup>11</sup>. In following patients who had sustained displaced abduction-external rotation bimalleolar fractures of the ankle, we became aware that a number of the patients had late degenerative changes in the ankle. The arthritis had its onset one to eight years after the injury. The present study was undertaken in an attempt to determine why this complication occurred.

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## Materials and Methods

### *Laboratory Studies*

Ankles from fresh cadavera were stripped of skin, muscles, and tendons, and two heavy Kirschner wires were inserted transversely through the talus parallel to the ankle joint. These wires were used to stabilize the foot and to measure rotatory and sagittal displacements of the talus. Four individual specimens were used for each set of experiments and each maneuver was repeated five times. Four separate studies were done, to assess the effects on ankle stability after: (1) isolated division of the deltoid ligament, (2) isolated division of the fibular collateral ligaments, (3) transverse osteotomy of the medial malleolus at the level of the joint with all ligaments intact, and (4) short oblique osteotomy of the lateral malleolus with all ligaments intact. The amount of rotatory displacement was measured with a protractor and determined by the amount of rotation of the Kirschner wires from the longitudinal axis of the tibia and fibula. Varus deformity was measured by noting the angle between the tibial plafond and the wires. The final result was expressed as the mean of the values obtained from each of the individual observations.

In a fifth series of experiments, after the pins had been inserted the medial malleolus was osteotomized at the level of the joint line and an oblique osteotomy was performed on the lateral malleolus to simulate an external rotation-abduction fracture. The ankle was placed in valgus and 30 degrees of external rotation to create the deformities seen on the initial roentgenograms of such injuries. Manual reduction was then attempted by applying a varus stress and internally rotating the ankle, as would be done clinically.

### *Clinical Material*

Fifty-three patients who had sustained abduction-external rotation injuries of the ankle were studied. There were thirty-one women and twenty-two men. The age range was from nineteen to eighty-six years, with an average of thirty-four years. Open fractures were not included in this series. Forty-two patients had a bimalleolar fracture and eleven had a fracture of the lateral malleolus and a tear of the deltoid ligament, as evidenced by lateral talar shift. This latter group was treated by open reduction and inter-

nal fixation of the lateral malleolus using a four-hole plate. The deltoid ligament was not repaired. The stability and quality of reduction of the fracture were assessed roentgenographically.

The first seventeen patients in this series with bimalleolar fractures had the medial malleolus reduced and fixed with a screw in the conventional manner, in order to determine whether primary reduction of the medial malleolus would reposition the talus. Intraoperative roentgenograms were then obtained. In fourteen patients there was an incomplete reduction of the talus and lateral malleolus. In these patients the screw in the medial malleolus was removed, following which the lateral malleolus was exposed through a separate incision and accurately reduced with a four-hole plate without replacing the screw in the medial malleolus. In the three patients in whom intraoperative roentgenograms revealed that the talus was anatomically reduced, the screw in the medial malleolus was left in place but a four-hole plate was also applied to the lateral malleolus. Postreduction roentgenograms were obtained in all cases.

In order to determine what effect primary anatomical reduction of the lateral malleolus would have on these displaced fractures, in ten patients in this series the lateral malleolus was exposed and reduced under direct vision. The reduction was held in place with a blunt periosteal elevator and intraoperative roentgenograms were made to observe the position of the talus and medial malleolus. A four-hole plate was then applied to the lateral malleolus and intraoperative stress roentgenograms were made to test the stability of the ankle.

Postoperatively, in all cases the extremity was elevated in a canvas sling suspended from a Balkan frame for five days. A below-the-knee cast was then applied and the patient was allowed to walk, non-weight-bearing, on crutches. A below-the-knee walking cast was applied after four weeks.

The patients were followed for six months to nine years (from 1966 to 1975), with an average of 5.5 years. Twenty-nine patients were followed for more than six years.

## Results

### *Experimental Findings*

When the deltoid ligament alone was divided, no instability of the ankle resulted. Resection of the medial malleolus at the level of the joint line allowed about 10 degrees of rotatory displacement of the ankle but very little valgus instability. When only the fibular collateral ligaments were divided there was approximately 30 degrees of external rotatory instability and marked talar instability (Figs. 1-A and 1-B). Resecting the lateral malleolus produced marked rotatory and valgus instability, and this increased as progressively greater force was applied.

When abduction-external rotation fractures were created and manual reduction was attempted by applying varus stress and internally rotating the ankle, the talus

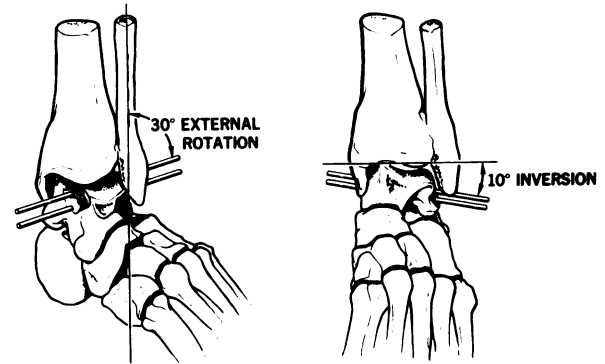


FIG. 1-A

Anterior view of displacement, with the fibula intact but the foot obliquely positioned. The vertical line represents the axis of the fibula.

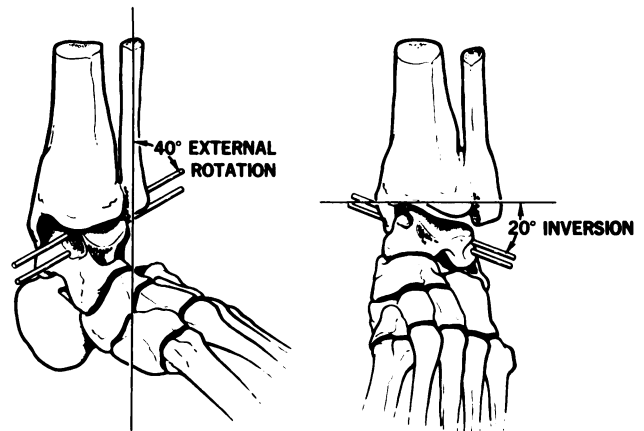


FIG. 1-B

The distal end of the fibula has been resected.

began to move into position but its progress was arrested because the lateral malleolus began to impinge on the proximal fibular fragment, preventing further internal rotation. Securely fixing the medial malleolus with a screw did not improve the position of the talus. However, when the ankle was forcefully internally rotated after the medial malleolus had been fixed, the talus could be anatomically repositioned; but this occurred by stretching the lateral malleolar ligament complex. When the internal rotatory force was discontinued the talus resumed its displaced position.

### *Clinical Findings*

In the fifty-three patients in whom the lateral malleolus was accurately reduced and fixed with a four-hole plate, postreduction roentgenograms revealed an anatomical reduction of the talus. In the seventeen patients who had primary fixation of the medial malleolus, fourteen (as already mentioned) showed evidence of a residual talar tilt. When the screw was removed and the lateral malleolus was anatomically reduced, the talus and medial malleolus were seen to be accurately repositioned (Figs. 2-A through 2-D). No instability was demonstrated on the stress roentgenograms when the lateral malleolus was reduced and fixed with a four-hole plate (Figs. 3-C and 4-B).

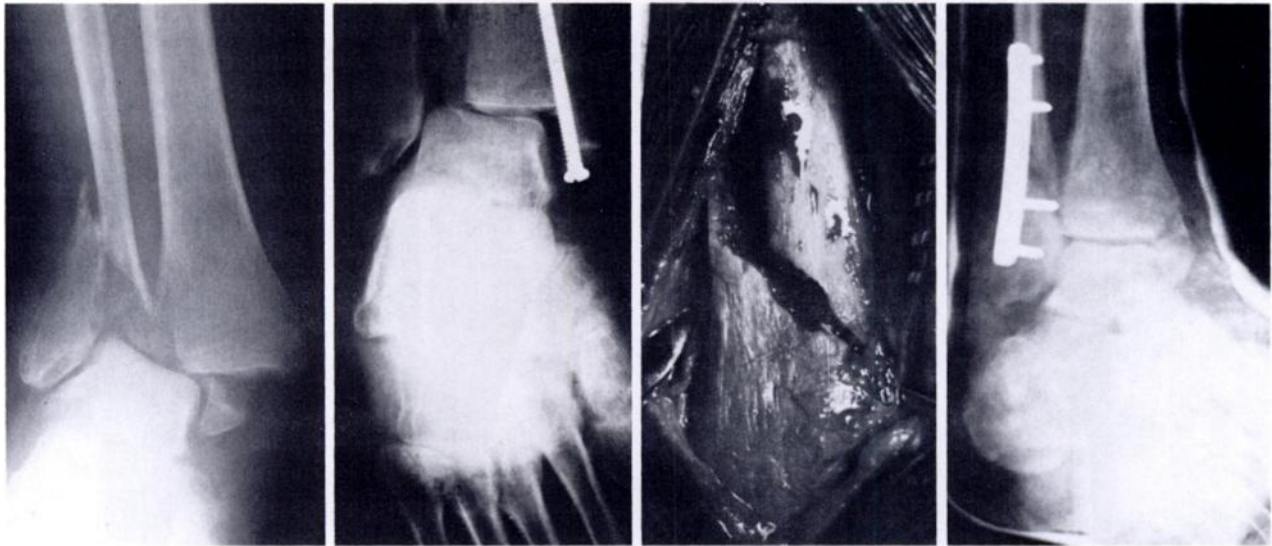


FIG. 2-A

FIG. 2-B

FIG. 2-C

FIG. 2-D

Fig. 2-A: Anteroposterior roentgenogram showing a displaced bimalleolar fracture.

Fig. 2-B: Intraoperative roentgenogram of the same ankle. An attempt was made to reduce the talus manually and the medial malleolus is fixed with a screw. Although the repositioning of the medial malleolus is accurate, there is residual talar displacement and incomplete reduction of the lateral malleolus.

Fig. 2-C: Intraoperative photograph of the same ankle, demonstrating incomplete reduction of the lateral malleolus.

Fig. 2-D: Postreduction roentgenogram. The screw was removed from the medial malleolus and a four-hole plate was applied over the distal part of the fibula after the lateral malleolus was anatomically reduced. The talus is in its normal position and the medial malleolus has been reduced. The radiolucent area between the medial malleolus and the tibia is due to traumatic loss of bone.

There was no instance of periosteal or posterior tibial-tendon interposition preventing reduction of the medial malleolus. There was no evidence of late degenerative arthritis, the talus remained in its anatomical position, and there were no cases of non-union. There were two infections which were treated by closed suction-irrigation, and the fractures eventually united after four and five months.

One patient had a superficial skin slough over the plate, but the wound did not become infected and closed by secondary intention. The total immobilization time averaged ten weeks.

All patients experienced swelling of the ankle after the cast was removed, but this resolved in an average of three weeks. Seven patients still had mild asymptomatic

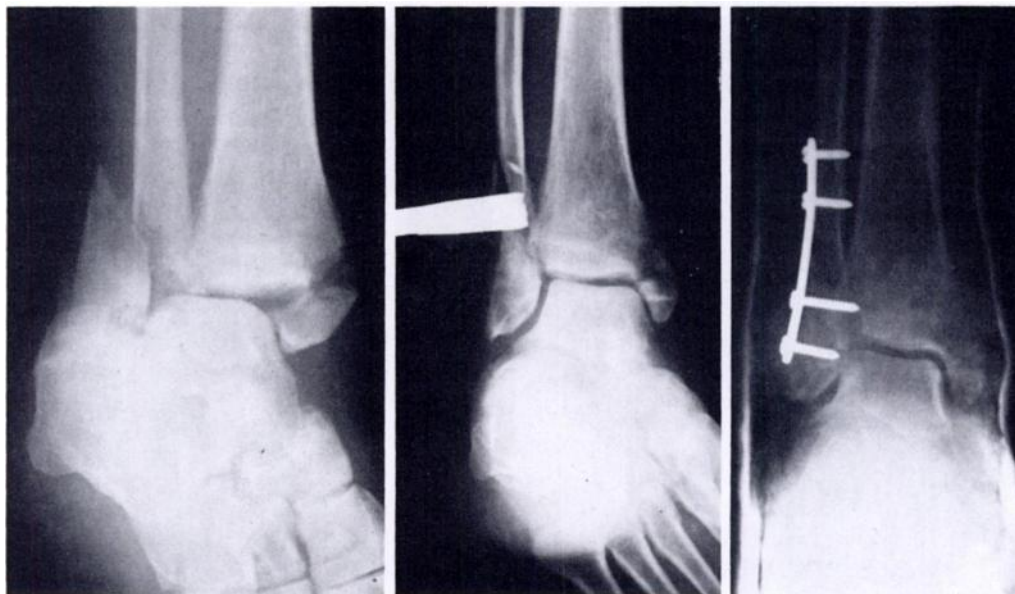


FIG. 3-A

FIG. 3-B

FIG. 3-C

Fig. 3-A: Oblique roentgenogram of a right ankle showing a displaced bimalleolar fracture.

Fig. 3-B: Intraoperative roentgenogram showing repositioning of the talus and medial malleolus by accurately reducing the lateral malleolus and holding it in position with a blunt periosteal elevator.

Fig. 3-C: Postoperative roentgenogram. An anatomical reduction was achieved by the application of a four-hole plate.

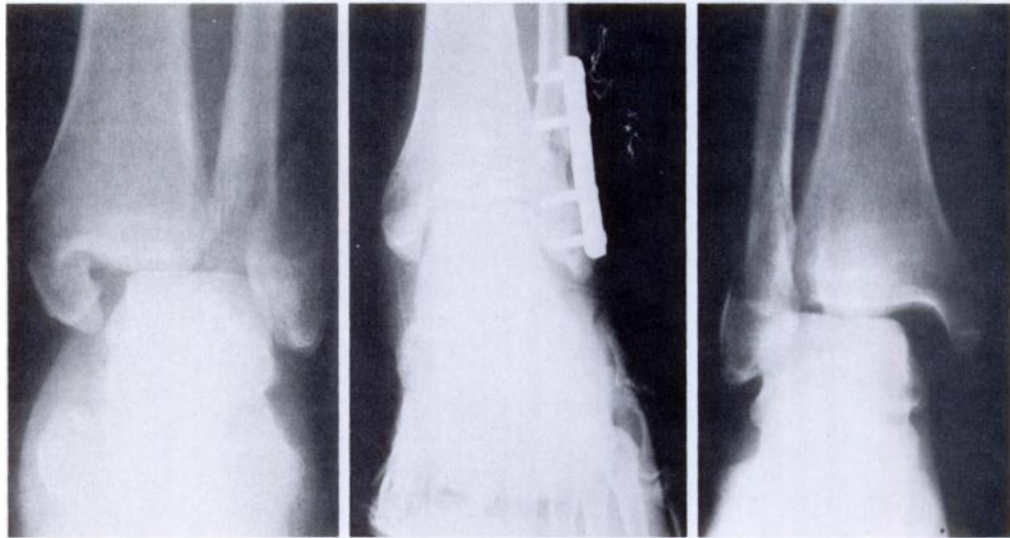


FIG. 4-A

FIG. 4-B

FIG. 5

Fig. 4-A: Anteroposterior roentgenogram of a displaced bimalleolar fracture.

Fig. 4-B: Intraoperative roentgenogram of the same fracture. An anatomical reduction was achieved by reducing the lateral malleolus and applying a four-hole plate. A valgus and external-rotation stress was applied. The ankle retains its stability despite the fact that the medial malleolus was not fixed.

Fig. 5: Anteroposterior roentgenogram of the ankle of a patient who had sustained a fracture of the lateral malleolus and a tear of the deltoid ligament, with lateral and rotatory talar displacement. The talus follows the displacement of the lateral malleolus.

swelling. Forty-nine patients became ambulatory without support. Three patients had walked with a cane prior to the accident and continued to do so after their fractures had healed. Thirty-eight patients regained a full range of painless motion within six weeks after cast removal. Nine of the remaining fifteen patients lacked 10 degrees of dorsiflexion one year postoperatively. Six patients lacked an average of 10 degrees of full plantar flexion: four were asymptomatic, but two continued to complain of pain on walking. Roentgenograms revealed demineralization of the tarsal bones suggestive of Sudeck's atrophy. With the exception of these two instances, all patients were able to resume their normal preinjury activities.

### Discussion

Unsatisfactory long-term results of treatment of displaced bimalleolar ankle fractures were reported by others. Cedell reviewed the results of treatment of over 400 abduction-external rotation fractures. He postulated that late pain, swelling, and degenerative changes were due to persistent laxity of the anterior tibiofibular ligament. Phillips and associates reported that 44 per cent of thirty-six bimalleolar fractures treated conservatively continued to cause pain. Several authors<sup>14,15,17,21,24</sup> demonstrated that incomplete reduction of the lateral malleolus was the most common fault in the treatment of these fractures. In all of the symptomatic patients reported in the literature, it was found that there was incomplete reduction of the lateral malleolus and residual talar tilt.

The cadaver studies showed, surprisingly, that division of the deltoid ligament or medial malleolus did not create an important degree of instability of the ankle. This observation fits in well with the clinical findings of a low frequency of ankle instability when the deltoid ligament is

ruptured or lax, and the paucity of communications appearing in the literature describing late reconstruction of the deltoid ligament may also correlate with these observations. On the other hand, lateral ligament laxity is a well established clinical entity and a number of effective surgical techniques to restore ankle stability have been described<sup>7,13</sup>.

It was of interest to observe experimentally why anatomical reduction of a displaced bimalleolar fracture could not always be achieved manually. Impingement of the lateral malleolus on the proximal fibular fragment prevented the talus from resuming its anatomical position.

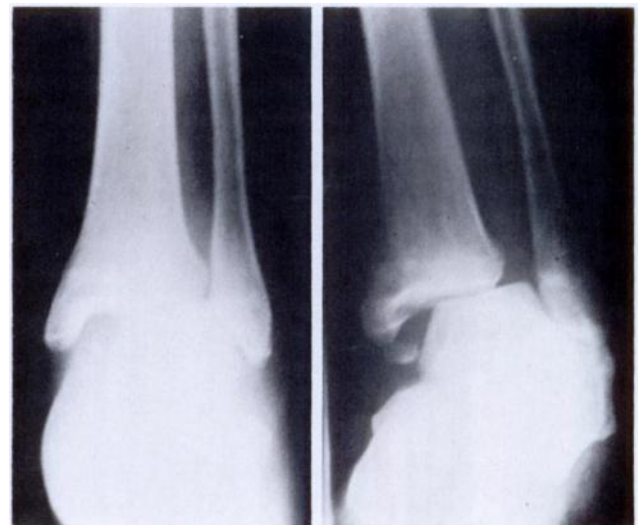


FIG. 6

Anteroposterior and oblique roentgenograms of the ankle of a patient who sustained a tear of the deltoid ligament and a diastasis of the inferior tibiofibular joint. The talus follows the displacement of the lateral malleolus.

Secure fixation of the medial malleolus with a compression screw did not improve the displaced position of the talus, and the talus could be anatomically reduced only by forced abduction and internal rotation of the ankle; but this occurred by stretching the lateral collateral ligament complex. The lateral malleolus, however, still maintained its displaced position. On discontinuation of the manual force, the talus resumed its displaced position.

In reviewing our clinical material of other injuries to the ankle which involved talar displacement with fracture only of the lateral malleolus or talofibular diastasis, not included in the series described, we found that in many instances the talus followed the lateral malleolus (Figs. 5 and 6). These observations strongly suggest that in unstable bimalleolar fractures, or those fractures in which the lateral malleolus is fractured and the deltoid ligament is torn, the talus remains attached to the lateral malleolus. Reducing the medial malleolus alone may prevent anatomical repositioning of the talus, because in some cases the lateral malleolus cannot be accurately reduced when it impinges on the proximal fibular fragment. Repositioning of the talus can be achieved by forcibly internally rotating the

ankle in such cases, but this stretches the fibular collateral ligament. When external immobilization is discontinued, the lateral ligaments remain in a stretched position and slight to moderate talar instability, which predisposes to the development of late degenerative arthritis, may be the result.

On the basis of these studies it would appear that the lateral malleolus is the key to the anatomical reduction of displaced bimalleolar fractures, and that restoring the integrity of the lateral malleolus establishes stability of the ankle<sup>18,23</sup>. This does not necessarily lessen the importance of the medial malleolus in contributing congruity to the medial aspect of the ankle, but it does serve to emphasize that the lateral malleolus should no longer be ignored or disregarded in the treatment of these injuries.

There was no instance in our fifty-three cases in which soft-tissue interposition prevented replacement of the medial malleolus when the lateral malleolus was reduced<sup>9</sup>. One can only assume that this complication is not as common as is generally believed. Perhaps the interposing tissues are replaced in their original sites by the talus as it resumes its anatomical position.

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