Changes in Tibiotalar Area of Contact Caused by Lateral Talar Shift

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ABSTRACT: **A carbon black transference technique was used to determine the contact area in twenty-three dissected tibiotalar articulations, with the talus in neutral position and displaced one, two, four, and six millimeters laterally. The greatest reduction in contact area occurred during the initial one millimeter of lateral displacement, the average reduction being 42 per cent. With further lateral displacement of the talus the contact area was progressively reduced but the rate of change for each increment of shift was less marked.**

Fractures or ligament injuries about the ankle may result in widening of the medial part of the mortise as seen on roentgenograms [2]. Long-term follow-up studies after ankle injuries have shown that significant residual talar displacement predisposes to an unsatisfactory result [1,3,6]. In an effort to explain such unsatisfactory results, we postulated that the area of contact between the articular surfaces of the tibiotalar joint is altered and may contribute to the poor result. We therefore attempted to measure the changes occurring in this contact area as the talus is displaced laterally in the ankle mortise.

Materials and Methods

Twenty-three lower extremities amputated for peripheral vascular disease were studied. Any specimen with infection or gangrene involving the articular cartilage of the ankle joint was not used.

The fibula was removed and all soft tissues about the ankle were excised, including the ligaments and capsule. The tibia was transected five centimeters above the ankle joint. The anatomical unit to be tested thus included the distal end of the tibia and the talus as separate components, with both completely free of all soft-tissue attachments.

To determine the area of contact, the distal tibial articular surface was coated with powdered carbon black and rearticulated with the talus, which was placed in neutral position with respect to plantar flexion, dorsiflexion, and medial and lateral tilt. A compression clamp mounted on a bathroom scale was used to deliver an axially-directed load of seventy kilograms on the joint for thirty seconds. When the load was released, a deposit of carbon black was present on the talus, marking the area of contact with the distal end of the tibia. The outline of the deposit was traced on wax wrapping paper placed on the talus, and then transferred to graph paper to measure the area of contact by counting the enclosed squares.

Carbon black does not leave a permanent stain on the cartilage and therefore permits repeated examinations of the same specimen. The contact area between the talus and the tibia was determined with the talus first in normal relationship to the tibia and then with it laterally displaced one, two, four, and six millimeters (Fig. 1).

To maintain the exact displacement during testing, metallic spacers milled to the appropriate width were placed between the talus and medial malleolus, with the leading edge of the spacer flush with the anterior border of the articular cartilage. Each spacer was fixed in place by means of a threaded central extension that was passed through a drill hole in the medial malleolus and held securely with a nut tightened against the medial aspect of the malleolus. In this way, the position of the spacer and its apposition to the articular surface of the medial malleolus was maintained during each test.

With respect to position, the talus was adjusted so that it was as near neutral as could be determined by inspection based on the tibiotalar relationship while the foot was in neutral position prior to removal of the soft tissues. The design of the compression device ensured that when each specimen was retested it was in the same degree of plantar flexion-dorsiflexion and of medial-lateral tilt for each increment of lateral displacement.

Results

The contact areas (range, mean, and standard deviation) are listed in Table I. The considerable variation in the areas of contact can be explained by the normal biological variations in the different specimens. This variation renders the measured contact areas of little value when comparing the changes in area in different specimens. Therefore, the measured contact areas with each increment of lateral displacement were expressed as percentages of the area obtained with no displacement.

The mean decrease in contact area was 42 per cent with one millimeter of lateral talar shift, 14 per cent with between one and two millimeters, 9 per cent with between two and four millimeters, and only 3 per cent with between four and six millimeters.

With no talar displacement, the area of tibiotalar contact extended across the breadth of the talus and was wide on the lateral side and narrow on the medial side. Once the talus was displaced laterally, contact was only apparent on

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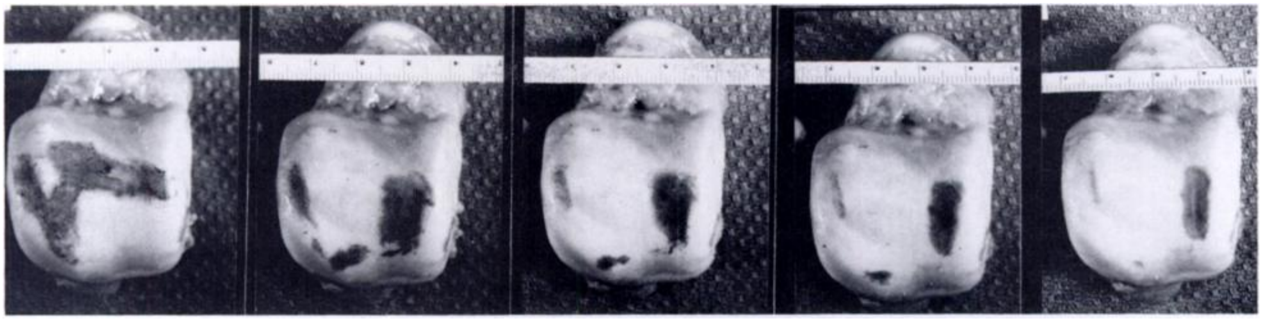

FIG. 1

A left talus viewed from above, showing the contact areas with zero, one, two, four, and six millimeters of talar displacement (from left to right). Note the rapid decrease in contact area and the change in its pattern. With no displacement the major area of contact is on the lateral side but with lateral displacement the major contact is on the medial side.

the medial and lateral prominences of the talus, there being no demonstrable contact in the mid-portion. Also, the pattern of contact was reversed so that the medial contact area was broad and the lateral contact area was narrow (Fig. 1).

Discussion

The findings in this study expand those in a previous investigation [4], in which the talus was tilted laterally 2 and 4 degrees and displaced laterally two millimeters. A marked decrease of the tibiotalar contact area was noted but no measurements were recorded.

TABLE I
TIBIOTALAR CONTACT AREA

Lateral Talar Displacement (*mm*)	Range (cm^2)	Mean (cm^2)	Standard Deviation (cm^2)
0	2.3 - 6.7	4.40	1.21
1	1.0 - 5.0	2.50	0.95
2	1.1 - 3.3	1.89	0.50
4	0.9 - 3.0	1.53	0.59
6	0.7 - 2.5	1.37	0.45

The unsatisfactory clinical results sometimes associated with slight widening [5] of the ankle mortise and the 42 per cent reduction in the area of contact between the tibia and talus with one millimeter of lateral displacement emphasize the importance of restoring the normal roentgenographic relationship of the talus to the medial malleolus after ankle injuries. Since the stress per unit area increases as the total contact area decreases, a decrease in contact area may be a factor contributing to a poor result after ankle fracture or dislocation when talar displacement is one millimeter or more.

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