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Mobility of the ankle mortise

A roentgen stereophotogrammetric analysis

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In 7 adult volunteers, a roentgen stereophotogrammetric technique was used to analyze the tibiofibular relationship during active unloaded movements of the ankle. The greatest movements were observed during plantar to dorsiflexion with an average widening of the ankle mortise of 1.0 mm and an average dorsal translation of the fibula of 0.9 mm. No significant rotation of the fibula could be revealed.

Because the mobility of the ankle mortise in normal adults has so far not been fully elucidated, it is difficult to evaluate the mobility of previously injured ankles. The aim of this investigation was to measure the unloaded mobility of the ankle mortise in healthy adults using roentgen stereophotogrammetric analysis (Selvik 1974).

Patients and methods

The study was approved by the Ethics Committee at Karolinska Institute, Stockholm.

The study comprised 7 adult volunteers (mean age 33 years) with normal previously uninjured ankles. A few weeks before the examination tantalum bone markers, diameter 0.8 mm, were inserted into the distal tibia, the lateral malleolus and the talus under local anesthesia (Figure 1). Roentgen stereophotogrammetric analysis (RSA) was undertaken according to previously detailed descriptions of the technique (Selvik 1974, Kärrholm et al. 1984).

The examinations took place with the person in the supine position. The investigated unloaded ankles were moved by the volunteers themselves without external force from the neutral position to maximum plantar flexion, dorsiflexion, supination and pronation. All the exposures were analyzed with the foot at approximately 20 degrees of internal rotation. Computed calculations determined the three-dimensional coordinates for each tantalum marker of the ankle and recorded the translation and rotation of each segment including at least three markers well spread and not collinear. The error of calculation is about 50 micrometers and 0.1–0.2 degrees (1 SD) for translations and rotations, respectively (Selvik 1974).

The mobility between the tibia and the fibula was analysed as translation and rotation of the fibula in relation to the tibia.

The total translation was divided into three components (Figure 1): 1) Along the longitudinal axis, i.e., parallel to the longitudinal axis of the tibia, implying a distal or proximal translation of the fibula in relation to the tibia. 2) Along the transverse axis, i.e., perpendicular to the longitudinal axis and running through the medial and lateral malleolus, implying a widening or narrowing of the ankle mortise. 3) Along the sagittal axis, i.e., perpendicular to the longitudinal and the transverse axes, implying a ventral or dorsal translation of the fibula in relation to the tibia.

The rotation of the fibula around the longitudinal axis in relation to the tibia was described as inward rotation if the most lateral point of the lateral malleolus moved in a forward direction and outward rotation if it moved backward.

Results

The greatest movements were observed during plantar to dorsiflexion with an average widening of the ankle mortise of 1.0 mm (max. 1.9 mm) and an average dorsal translation of the fibula of 0.9

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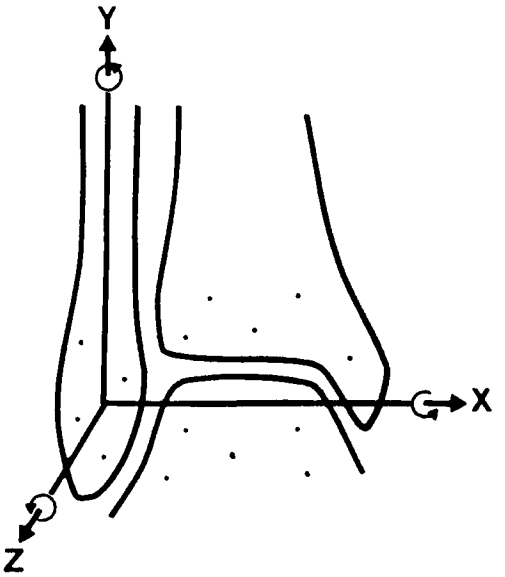

Figure 1. The ankle mortise with tantalum bone markers and the coordinate system.

Table 1. Mobility of the fibula in relation to the tibia. Mean values (1 SD)

	Neutral/ plantarflexion	Neutral/ dorsiflexion	Plantar/ dorsiflexion	Supination/ pronation
Widening of the ankle mortise (mm)	−0.7 (0.3)	+0.3 (0.2)	+1.0 (0.5)	0.0 (0.3)
Distal translation of fibula (mm)	+0.1 (0.2)	0.0 (0.2)	−0.1 (0.1)	0.0 (0.1)
Ventral translation of fibula (mm)	+0.2 (0.4)	−0.6 (0.6)	−0.9 (0.7)	0.0 (0.2)
Inward rotation of fibula (degrees)	0.0 (1.0)	+0.1 (0.4)	+0.1 (0.9)	0.0 (0.6)
Total talar rotation (degrees)	26 (8.6)	25 (11)	50 (12)	12 (8.9)

mm (max. 1.6 mm). The average translations of the fibula during supination and pronation never exceeded 0.2 mm (max. 0.7 mm).

The rotation of the fibula along the longitudinal axis during plantar/dorsiflexion and supination/pronation was found to be very small and in no case exceeded 2 degrees (Table 1). The rotation of the fibula along the sagittal and transverse axes, i.e., valgus/varus and dorsal/ventral tilting were also analysed (data not shown). This rotation was so minute that it could easily be explained by the previously mentioned translations of the fibula, i.e., widening of the mortise or ventral/dorsal translation of the fibula, respectively.

Discussion

Grath (1960) examined the widening of the ankle mortise. He used callipers and by measuring externally he found that most part of the widening occurred when the foot was moved from maximum plantar flexion to the neutral position, with only a slight extra widening as the foot was moved further to maximum dorsiflexion. Similar results were found by Kärrholm et al. (1984) in a study of children with previously injured ankles. In agreement with these studies, our results underline that a widening of the ankle mortise up to 2 millimeters seems to be within normal limits.

The translation of the fibula along the longitudinal axis during plantar/dorsiflexion was generally less pronounced and showed a greater individual variation, which accords with the results presented by Kärrholm et al. (1985).

It has been assumed that the fibula rotates around its longitudinal axis during active movements of the ankle (Lindsjö 1981). No such rotation could be revealed in the present study.

References

Grath G B. Widening of the ankle mortise. A clinical and experimental study. Acta Chir Scand (Suppl) 1960;263.

Kärrholm J, Hansson L I, Selvik G. Changes in tibiofibular relationships due to growth disturbances after ankle fractures in children. J Bone Joint Surg (Am) 1984 Oct;66(8):1198–210.

Kärrholm J, Hansson L I, Selvik G. Mobility of the lateral malleolus. A roentgen stereophotogrammetric analysis. Acta Orthop Scand 1985 Dec;56(6):479–83.

Lindsjö U. Operative treatment of ankle fractures. Acta Orthop Scand (Suppl) 1981;189:1–131.

Selvik G. A roentgen stereophotogrammetric method for the study of the kinematics of the skeletal system. Thesis, University of Lund, Lund, Sweden 1974.