SUBTALAR JOINT KINEMATICS IN HEALTHY INDIVIDUALS USING COMPUTED TOMOGRAPHY

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INTRODUCTION

Kinematic profiles of the ankle joint are useful for evaluating pathological joint motion and provide a foundation for the understanding of surgical procedures. No reliable technique exists for accurate in vivo measurements of subtalar joint (SJ) motion. The purpose of this study was to assess normal range of SJ motion in a loaded state using computed tomography (CT).

METHODS

Twenty healthy volunteers (10 m, 10 f) with a mean age of 26,3 yrs (range 22-35 yrs) signed informed consent. CT images of the right foot were acquired in neutral position for bone segmentation of the talus and calcaneus. An external load was applied to force the unconstrained foot in eight different extreme positions; dorsiflexion^{max}, anterolateral^{max}, eversion^{max}, posterolateral^{max}, plantarflexion^{max}, posteromedial^{max}, inversion^{max} and anteromedial^{max}. CT images were acquired in each position using a low-dose technique. After bone contour matching, the positions and orientations of the helical axes were determined for the motions of the calcaneus relatively to the talus between the opposite extreme foot positions. The helical axes were represented in talus-specific anatomic planes as defined by its geometric principle axes.

RESULTS AND DISCUSSION

For inversion^{max}-to-eversion^{max} of the foot, the helical axes of the SJ were found to have a mean inclination from the XY-plane of 49.4±4.3 deg. (Figure 1). The mean deviation of the axes from the XZ-plane was -2.7±7.9 deg. The mean rotation about the helical axes was 37.3±5.9 deg. with a mean translation of 2.3±1.1 mm. Considerable variation of helical axes parameters were found for the motion from dorsiflexion^{max}-to-plantarflexion^{max} (Table 1). In contrast to inversion^{max} and eversion^{max} positions of the foot, dorsiflexion^{max} and plantarflexion^{max} positions were not considered to result in true locking end-positions for the SJ. Helical axes values for the two motions between the intermediate extreme postions were close to the values for inversion^{max}-to-eversion^{max} (Table 1). Despite some apparent differences between subjects, the intersubject variability of the helical axes was smaller than was expected from previous studies.[1,2,3] This finding might be due to studying motions between extreme positions of a loaded foot, resulting in true locking end-positions for the SJ.

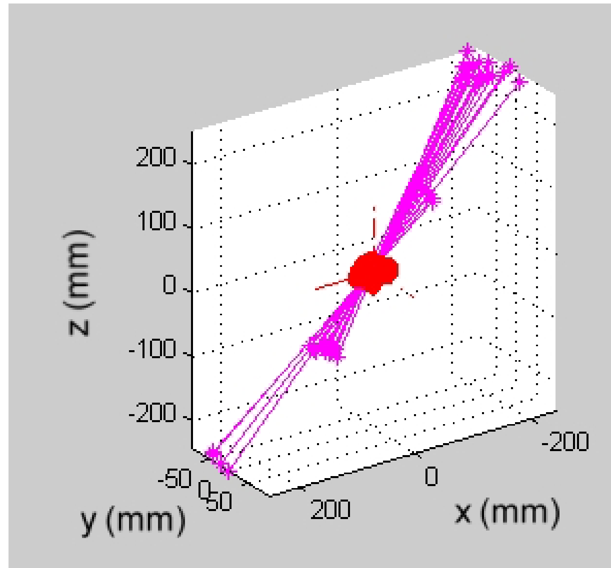

Figure 1. 3D-representation of the helical axes for subtalar motion from inversion^{max}-to-eversion^{max} of 20 normal right feet. The fixed talus (red) and its principle axes are shown in the center. The helical axes are clipped by a bounding box.

CONCLUSIONS

For motions with a considerable inversion and eversion component, the helical axes were reproducible between the different subjects. The largest mean rotation was found for motion between inversion^{max}-to-eversion^{max}. Dorsiflexion^{max} and plantarflexion^{max} positions of the foot were not considered to result in true locking end-positions for the SJ.

REFERENCES

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Table 1: *Mean values for the helical axes for the subtalar motions between the opposite extreme foot positions.*

	Inclination (deg)	Deviation (deg)	Rotation (deg)	Translation (mm)
Inversion^{max}-to-eversion^{max}	49.4 (4.3)	-2.7 (7.9)	37.3 (5.9)	2.3 (1.1)
Anteromedial^{max}-to-posterolateral^{max}	49.6 (4.4)	-0.3 (9.2)	35.5 (5.7)	2.8 (1.1)
Anterolateral^{max}-to-posteromedial^{max}	50.7 (4.2)	-9.1 (7.9)	29.7 (5.1)	1.1 (0.6)
Dorsiflexion^{max}-to-plantarflexion^{max}	37.1 (38.6)	-12.3 (38.1)	7.4 (6.0)	1.8 (2.2)