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Plantar soft tissue homogeneity in ulcerated vs non-ulcerated feet using strain elastography

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Background: Homogeneity (or in-homogeneity) of plantar soft tissues affects stress distribution inside the sole of the foot with significant implications in people with diabetic neuropathy as mechanical trauma is considered the main cause of foot ulceration in this population. While ultrasound strain elastography has been recently used to assess deformability of the plantar soft tissue (Lin et al., 2015; Matteoli et al., 2015), there is a paucity of studies assessing the homogeneity of plantar soft tissue using this data.

Aims: To propose a method to quantify the homogeneity of plantar soft tissues and to investigate the differences in heel pads homogeneity between ulcerated and non-ulcerated feet.

Methods: 5 diabetic (type-2) neuropathic patients with unilateral foot ulceration on the forefoot were included in this study. Strain elastography, (Esaote S.p.A., IT) was used to assess the deformability of the heel pad. A custom image-processing algorithm was developed to quantify changes in deformability between neighbouring pixels using central difference method. The average values and standard deviation of the aforementioned differences were calculated as non-homogenous indices along depth, breadth, and the oblique direction in the imaging plane.

Results: The ulcerated feet showed higher homogeneity, indicated by observed higher average deformability gradient in depth, breadth and oblique directions.

Summary: The homogeneity profile of plantar soft tissue in ulcerated feet appear to be different compared to non-ulcerated feet with possible implications in diagnosing tissue vulnerability and mechanical trauma in people with diabetic foot disease.

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Mechanical characterisation of porcine ankle cartilage

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Background: Ankle arthritis affects approximately 4% of the global adult population. There has been limited research to characterise the properties of ankle cartilage.

Aims: The aim of this study was to investigate the mechanical properties and thickness of porcine ankle cartilage from the tibio-talar joint.

Methods: Ankle tissue between 3 and 6 month old porcine legs was dissected. Osteochondral plugs of 8.5 mm diameter were taken from two locations on each of the tibial and talar joint surfaces (n = 6 for both studies). Cartilage thickness measurements were conducted using a needle-probe technique on an Instron 3365 (Instron, UK). Indentation testing, with a load of 0.24 N, was conducted for a period of one hour to assess deformation, and computational models were used to derive the elastic modulus and cartilage permeability.

Results: Cartilage thickness was significantly different across both joint surfaces, with a mean thickness of 0.8 mm for the tibial joint surface, and 1.0 mm for the talar joint surface (ANOVA, $p = 0.00001$). Overall, cartilage deformation across both surfaces showed no statistical significance. The talar ankle cartilage was typically higher in modulus and lower in permeability than the tibial cartilage, but this was not statistically significant (ANOVA, $p > 0.05$).

Conclusions: In comparison to previously reported data for porcine cartilage in the hip and knee, the ankle cartilage that was thinner, had a comparable modulus to the knee (lower than hip) and higher cartilage permeability. This study provides an initial model for the mechanical characterisation of ankle cartilage and will be followed with a similar human-tissue based study.

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Subtalar arthrodesis stabilization with angulated screw configuration is superior to parallel SC

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Problem Description: Screw placement for fixation in subtalar arthrodesis are recommended in different positions.

Design: The purpose of this study was to compare the stability of two established screw configurations (SC) for subtalar arthrodesis using a cyclic loading model.

Methods: Eight paired human cadaver hindfoot specimens underwent subtalar arthrodesis with either parallel or angulated SC. The instrumented specimens were subjected to a cyclic loading protocol (1000 cycles: ±5 Nm rotation moment, 50 N axial force). The joint range of motion (ROM) was quantified before and after cyclic loading, in the three principal motion planes of the subtalar joint using pure bending moments of ±3 Nm.

Results: After instrumentation, the angulated SC showed significantly less mean ROM compared to the parallel SC in internal/external rotation ($1.4 \pm 2.2^\circ$ vs. $3.3 \pm 2.8^\circ$, $P = 0.006$) and in inversion/eversion ($0.9 \pm 1.4^\circ$ vs. $1.5 \pm 1.1^\circ$, $P = 0.049$). After cyclic loading, the angulated SC resulted in significantly less mean ROM compared to the parallel SC in internal/external rotation ($3.3 \pm 4.6^\circ$ vs. $8.8 \pm 8.0^\circ$, $P = 0.006$) and in inversion/eversion ($1.9 \pm 2.3^\circ$ vs. $3.9 \pm 3.9^\circ$, $P = 0.017$). No significant differences in the mean ROM were found between the angulated and parallel SC in dorsal extension/plantar flexion.

Conclusion: The angulated SC resulted in decreased ROM in the subtalar arthrodesis construct after instrumentation and after cyclic loading compared to the parallel SC. The data from our study suggest that the clinical use of the angulated SC for subtalar arthrodesis might be superior to the parallel SC.

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