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IN VIVO HEEL PAD ELASTICITY INVESTIGATION: COMPARING MALES TO FEMALES

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Background: The interest in quantifying the mechanical properties of human soft tissues is an important aspect of diagnosing diseased tissues. Knowledge of the mechanical properties of heel pad tissue may be used in tools for screening patients for the purpose of preventing further complications in the foot (e.g., ulcers may be prevented in diabetics [1]) as well as of obtaining validated examination methods for medicolegal purposes. In order to investigate whether there are any differences between healthy and diseased heel pads when dealing with their biomechanics it is first necessary to establish a "normal" range of biomechanical parameters. Even though the heel pad biomechanics has been investigated for more than 25 years in healthy individuals as well as in subjects with pathological conditions, studies differ both in terms of method applied and population studied, and it is not feasible to compare the numerical results.

Aims: The present study concentrates on collecting a bank of "normal" data characterizing the heel pad biomechanics. Specifically, the heel pad elasticity of a group of healthy volunteers was measured with a compression device (Figure 1) and the difference between males and females was statistically investigated.

Methods: One hundred and twenty seven healthy subjects were enrolled (Figure 2) for compression tests. Only the dominant foot was tested, i.e., the foot normally used to kick the ball when playing football. All subjects declared to have never had injuries/truma to any of the feet. Subjects engaged in professional sport were not included in this study. A detailed description of both compression device (Figure 1) and procedure used for experimental tests can be found in [2]. All subjects underwent also ultrasound measurements, so that the unloaded heel pad thickness (UHPT) could be measured. The elastic modulus (E) was calculated from the stress-strain characteristics by averaging the modulus found in the first and last 30% parts (considered almost linear) of the loading curve. Student t-test was used for statistical analysis and a P-value less than 0.05 was chosen to indicate a statistical significance.

Results: The heel pad showed the typical non-linear visco-elastic behavior (Figure 3). The UHPT was found to be 14.6±1.98 mm and 15.8±1.92 mm for females and males, respectively. E was found to be 0.076±0.012 MPa for females and 0.085±0.015 MPa for males. Statistical analysis showed that there was a statistically significant difference for UHPT and E (P-value < 0.001).

Conclusions: This study showed a statistically significant difference between males and females in UHPT and E. Specifically, males had thicker and stiffer heel pads than females as also reported by [3], but in contrast with [4]. Thicker heel pads in men might be due to the greater growth hormone concentration, while in women the high level of estrogen might result in a lower stiffness [3,5,6].

References