PLANTAR ENTHESOPATHY: ENTHESIS MORPHOLOGY IS CORRELATED WITH THE ENERGY DISSIPATION RATIO OF THE HEEL PAD DURING GAIT

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INTRODUCTION

Thickening of the plantar fascial enthesis is a common sonographic indicator of enthesopathy and, in diabetes, has been linked with elevated pressure beneath the foot during walking [1,2]. However, little is known regarding the properties of the intervening soft tissue (ie the plantar fat pad) and its relation to the morphology of the fascial enthesis. This study investigated whether heel pad properties were related to the thickness of the plantar fascial enthesis in individuals with and without unilateral plantar enthesopathy.

METHODS

Nine subjects (age, 48 ± 13 years; height, 1.69 ± 0.11 m; weight, 82.6 ± 10.7 kg) with unilateral plantar heel pain and nine asymptomatic controls, individually matched on age, sex and body weight (age, 46 ± 12 years; height, 1.67 ± 0.09 m; weight, 80.1 ± 10.4 kg) participated in the study. Subjects with heel pain presented with focal tenderness localised to the calcaneal insertion of the plantar fascia, which was exacerbated with weight-bearing following unloaded rest.

Sagittal sonograms of the fascial enthesis of the symptomatic, asymptomatic and a matched control foot were acquired with a variable frequency 12-5 MHz linear array transducer (HDI 5000, ATL, Washington, USA). A multifunction fluoroscopy unit (Shimadzu, Kyoto, Japan) synchronised with a pressure plate (EMED-SF, Novel GmbH, Munich, Germany) was used to obtain stress-strain data for the heel pad while subjects walked at their preferred speed. The initial thickness and compressive strain of the fat pad were estimated from dynamic lateral radiographs, while the compressive stress was derived from peak pressure data. Principal visco-elastic parameters were estimated from stress-strain curves, including the energy dissipation ratio; the ratio of energy loss during the load–unloading cycle relative to the strain energy stored during loading.

RESULTS AND DISCUSSION

Fascial entheses of symptomatic feet were significantly thicker than those of asymptomatic limbs, which in turn, were significantly thicker than those of control feet (*P*<.05).

There was no significant difference in the thickness, peak stress, peak strain or secant modulus of the heel pad in subjects with and without heel pain. However, fat pads of symptomatic feet had a significantly lower energy loss due to hysteresis than asymptomatic and control feet (Table 1).

Thickness of the fascial enthesis was not significantly correlated with peak stress, strain or modulus of symptomatic, asymptomatic or control heel pads (r, -0.39 – 0.07). However, a moderate correlation (r=0.72, *P*<.05) was observed between the thickness of the fascial enthesis and energy dissipation ratio of the symptomatic heel pad (Fig 1).

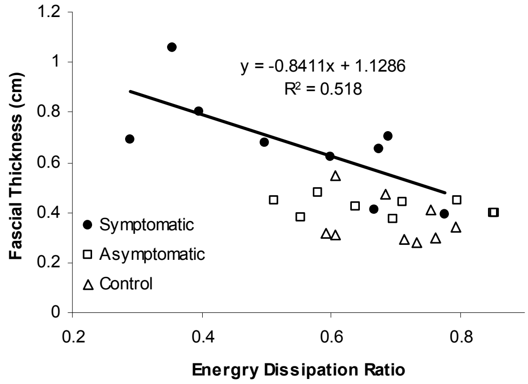

Figure 1: Sagittal thickness of the plantar fascial enthesis as a function of the energy dissipation ratio of the heel pad.

Reduced energy loss (hysteresis) through the heel pad has the potential to alter the vibration experienced by other rearfoot structures during heel contact. Thus, aberrant fat pad function could conceivably result in thickening of the fascial enthesis. Future research, however, must ascertain if fat pad change precedes or follows fascial thickening and whether either factor is related to the clinical feature of pain.

REFERENCES

1. Gibbon WW, et al., *Skeletal Radiol.* **28**:21–26, 1999.
2. Giacomozzi C, et al., *Clin Biomech.* **20**:532-539, 2005.

Table 1: Sagittal thickness of the plantar fascial enthesis and properties of symptomatic, asymptomatic and control heel pads

	Control	Asymptomatic	Symptomatic
Entheseal Thickness (mm)	3.6 ± 0.9	4.2 ± 0.4*	6.7 ± 2.0 *
Heel Pad Thickness (mm)	19.1 ± 1.9	19.4 ± 1.7	19.3 ± 1.7
Peak Stress (kPa)	246 ± 41	249 ± 30	244 ± 22
Peak Strain	0.43 ± 0.05	0.45 ± 0.08	0.39 ± 0.09
Secant Modulus (kPa)	580 ± 145	571 ± 176	647 ± 128
Energy Dissipation Ratio	0.69 ± 0.08	0.69 ± 0.13	0.55 ± 0.17 *

* Indicates significantly different from all other conditions (*P*<.05)