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New insights into stance phase foot biomechanics using pedobarographic statistical parametric mapping

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Introduction

There is disagreement in the literature regarding the peak plantar pressure correlates of walking speed. Some studies report generalized increased pressures across the entire plantar surface [1] while others report decreases in lateral forefoot pressures and infer a medial shift in load with increased walking speeds [2]. The purposes of this study were: (a) To use statistical parametric mapping (SPM), a high resolution statistical technique, to clarify the pressure correlates of walking speed and (b) To corroborate SPM results with those of a traditional ten-region subsampling technique.

Methods

Ten subjects performed twenty trials of each of slow, normal, and fast walking in a fully randomized design. Plantar pressure data were collected using a Footscan 3D system (RSscan, Belgium). Walking speed was recorded with a six camera ProReflex system (Qualisys, Sweden). Peak pressure images were registered [3] using an optimal rigid body transform, and then between-subjects registration was performed using an optimum affine transform to ensure homologous structure overlap. The registered images were analyzed using pedobarographic SPM (pSPM), an adaptation of an established cerebral fMRI technique [4]. A parametric mass univariate general linear statistical model blocked SUBJECT effects and yielded a generalized SPEED regression statistic having the Student's t distribution. The original peak pressure images were also subsampled over ten anatomical regions using commercial software (Footscan 7, RSscan). These data were analyzed using the same linear model.

Results

pSPM analyses produced smooth and continuous statistical maps that exhibited positive correlation with walking speed over the heel and distal forefoot, but which also exhibited broad negative correlation over the midfoot and proximal forefoot (Figure 1A). The significance of these trends was confirmed across subjects (Figure 1B). Subsampling obscured these data, exhibiting negative correlation only in the lateral forefoot, and reversing the midfoot trend (Figure 1C).

Conclusion

pSPM analyses revealed novel information regarding stance phase foot biomechanics, suggesting that longitudinal arch collapse is actively reduced as a function of walking speed and that such prevention may be beneficial to propulsion, possibly through increased plantar aponeurosis tension. The data also demonstrate, critically, that traditional subsampling techniques can distort or reverse statistical trends due to regional conflation, procuring erroneous conclusions regarding foot function. Foot pressure image analyses should incorporate all pixel data wherever possible.

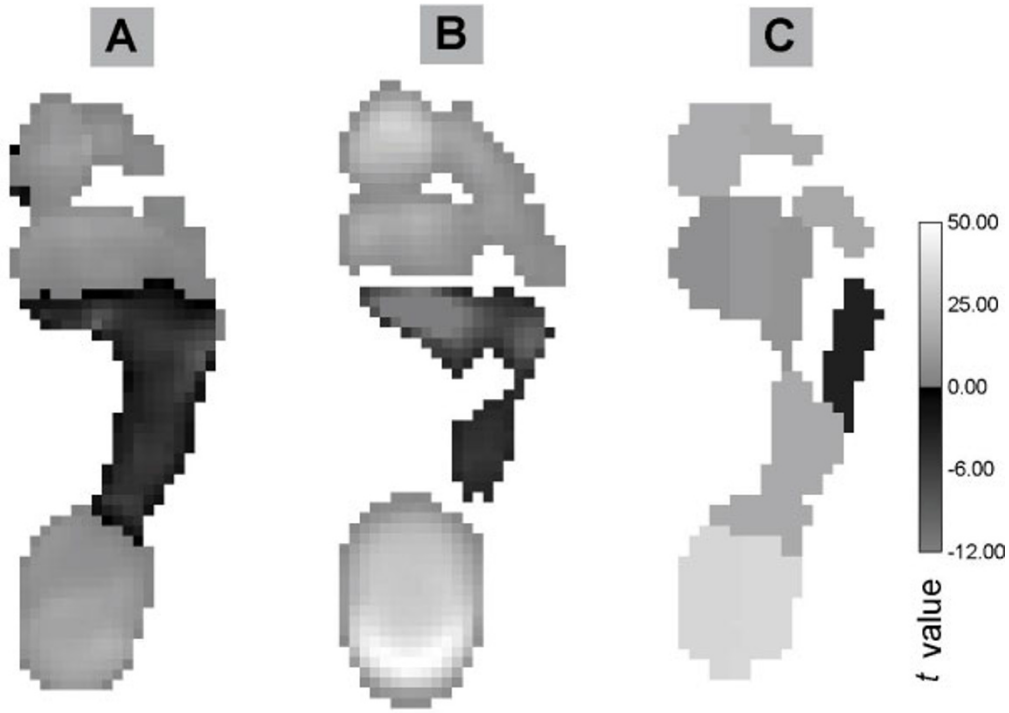

Figure 1
(A) pSPM results for an example subject, unmasked. (B) Between-subjects pSPM results, masked at $p < 0.001$; data were qualitatively identical even after a Bonferroni correction of $p < 5 \times 10^{-5}$. (C) Subsampling results, masked at a Bonferroni-corrected $p < 0.005$.

References

1. Taylor AJ, *et al.*: *Foot* 2004, **14:**49-55.
2. Rosenbaum D, *et al.*: *Foot Ankle Surg* 1997, **3:**1-24.
3. Maintz JBA, *et al.*: *Med Image Anal* 1998, **2(1):**1-37.
4. Friston KJ, *et al.*: *Hum Brain Mapp* 1995, **2:**189-210.