FOREFOOT PLANTAR PRESSURES IN MILD, MODERATE AND SEVERE HALLUX VALGUS

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INTRODUCTION

Hallux valgus (HV) has been linked to functional disability and increased falls risk in older adults,[1,2] but mechanisms underpinning this functional disability are unclear. Previous studies have reported conflicting findings regarding plantar pressures in HV.[3] Most plantar pressure studies to date have not considered the severity of HV or the presence of foot pain in their analyses.

STUDY AIM

This study investigated forefoot plantar pressures in adults with mild, moderate, and severe HV compared to controls, while considering age, gender, body mass index and foot pain as covariates.

METHODS

Sixty adults with HV (7 men, 53 women) and 30 controls (5 men, 25 women) were recruited for this study (Table 1). Volunteers were excluded if they had any previous foot or ankle fractures or surgery, hallux limitus, neurological condition, inflammatory disease or a history of falls. This study was approved by the institutional Medical Research Ethics Committee, and all participants gave written informed consent.

Weight-bearing dorsoplantar radiographs were obtained for all participants. The HV angle was measured and radiographs were assessed for signs of first metatarsophalangeal joint (MTPJ) osteoarthritis (OA).[4] Control participants had an HV angle <15˚ on both feet. HV participants (defined as HV angle >15˚) were allocated to mild, moderate or severe groups using cluster analysis, based on the HV angle of the more severe foot. Self-reported foot pain was assessed using the Manchester Foot Pain and Disability Index (FPDI) pain subscale.[5] Foot Posture Index was measured as an indicator of foot pronation or supination in relaxed stance.[6]

The Novel Pedar-X® system was used to capture in-shoe plantar pressure data. Participants were asked to bring a pair of walking shoes suitable for fitting the Pedar insoles. Participants walked at a self-selected comfortable speed along a 10m flat walkway, and five trials were completed. The first and last steps of each trial were removed, leaving an average of 23 steps for analysis. Five forefoot regions were identified using a relative mask based on prior work by Putti et al.[7]: 1) hallux, 2) lesser toes, 3) first metatarsal head, 4) second metatarsal head, and 5) third to fifth metatarsal heads (Figure 1). Peak pressures (kPa) and pressure-time integrals (kPa*s) were calculated. Multiple analysis of covariance and pairwise comparisons (p<0.05, Bonferroni adjustment) were used to investigate differences between groups, adjusting for age, gender, BMI and foot pain.

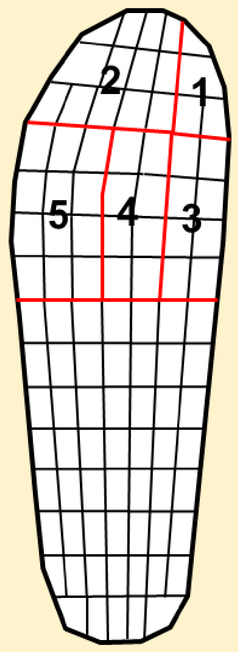

Figure 1. Pedar mask indicating 5 forefoot regions for analysis

RESULTS

Participant characteristics are outlined in Table 1. A significant reduction in hallux peak pressure and pressure-time integral was evident in moderate (peak pressure -90.8kPa, p<0.001) and severe HV (peak pressure -106.2kPa, p<0.001) compared to the control group (Figure 2). This finding was significant after adjusting for covariates, including foot pain. However, our study found no significant differences in forefoot plantar pressures between participants with mild HV and controls (p>0.05). Furthermore, no significant differences were found between groups in other forefoot regions (p>0.05).

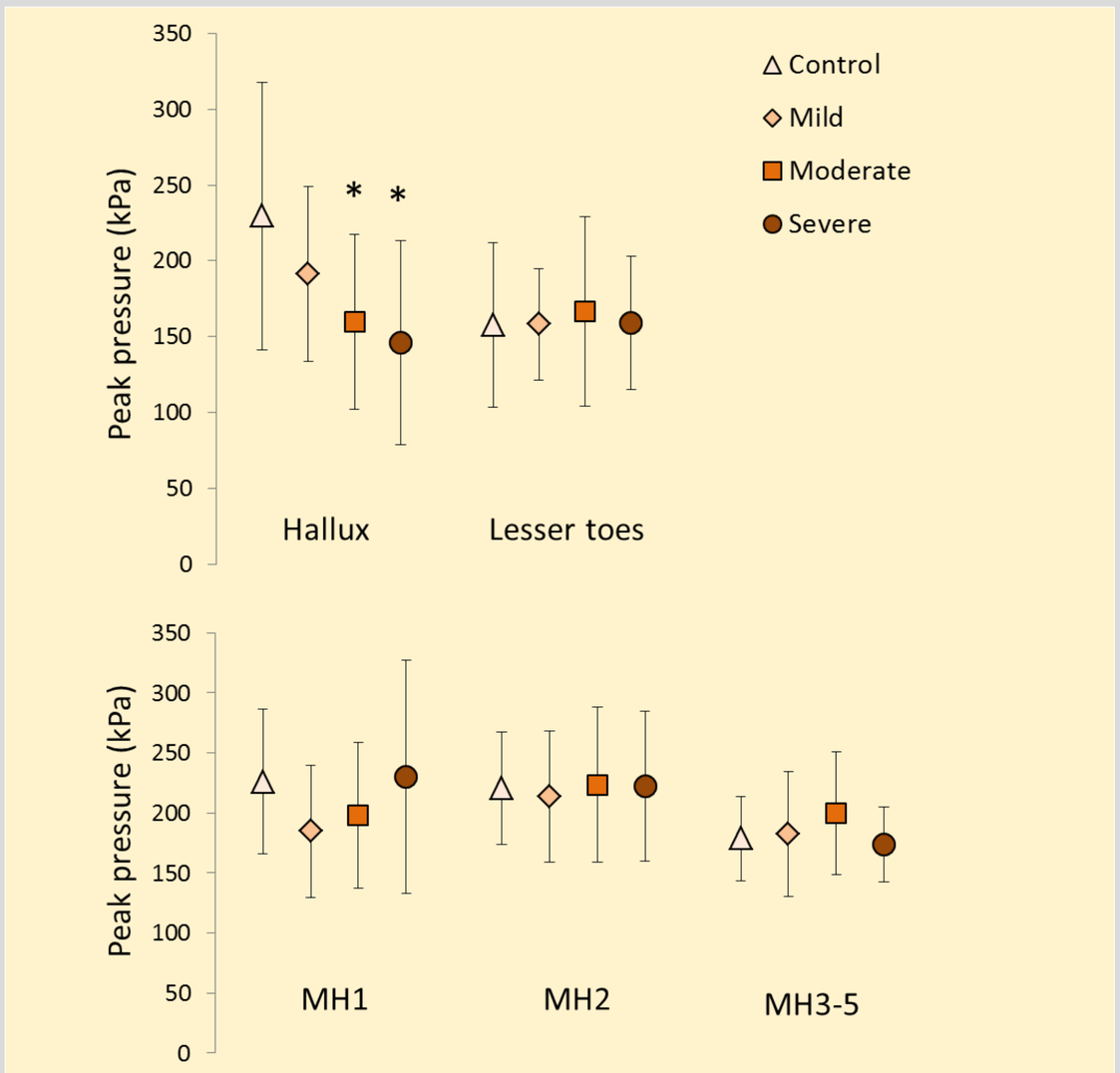

Figure 2. Peak pressures under the hallux, lesser toes, first metatarsal head (MH1), second metatarsal head (MH2) and metatarsal heads three to five (MH3-5) in participants with mild, moderate and severe hallux valgus compared to controls. * Indicates a statistically significant difference (p<0.001)

DISCUSSION AND CONCLUSIONS

- Moderate to severe HV is associated with reduced hallux plantar pressures during walking, which may indicate less effective toe-off.
- Those with mild HV had similar loading patterns to control participants, indicating that toe-off may not be affected until HV deformity progresses to a moderate or severe state.
- Future studies are needed to investigate whether early intervention strategies, such as foot orthoses, exercises or manual therapy, can alter deformity and associated functional changes in HV.

Table 1. Participant characteristics for HV groups compared to controls

	Control (n=30)	Mild HV (n=21)	Moderate HV (n=25)	Severe HV (n=14)
Men:Women (n)	5:25	2:19	5:20	0:14
Age (years)	44.2±15.3	50.3±14.1	50.3±16.6	55.4±13.8
BMI (kg/m^2)	24.7±4.3	23.6±4.2	26.3±3.9	25.2±4.6
HV angle (˚)	9.8±3.5	21.1±3.0*	30.8±2.3*	39.9±5.4*
First MTPJ OA (n present)	2	1	4	6*
Foot pain (FPDI score 0 to 10)	0 (0–2)	3 (0–6)*	3 (0–8)*	3 (0–7)*
Foot Posture Index (score range -12 to 12)	4.4±3.0	5.7±3.6	6.9±2.9*	7.8±1.9*

*Significant difference compared to control group (based on ANOVA, Pearson's Chi-squared or Kruskal-Wallis rank test)

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