First Ray Mobility and Position device – MAP1st: Providing Reliable Patient Data for Improved Clinical Foot Evaluation

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Summary

Hyper/hypo First Ray Mobility (FRM) is associated with many painful foot pathologies and used in over 90% of regular foot exams for treatment planning, including surgical techniques. However, current manual evaluation methods are subjective; there are no commercial devices that give reliable FRM measurements. We developed the First Ray Mobility and Position (MAP1st) prototype, the first portable, automated, user-friendly device that provides reliable FRM measurements. Mean intra- and inter-reliability among 58 healthy and 44 pathological feet were 0.85 and 0.70, respectively. There was a negative relationship (R = -0.404; p = 0.001) between FRM and peak pressure beneath the 1st MTP joint. MAP1st provided reliable FRM measurements for improved diagnosis and enhanced treatment planning.

Introduction

Hyper/hypo FRM has been associated with hallux valgus (HV), hallux rigidus (HR), tarsometatarsal osteoarthritis (OA), metatarsalgia, lesser metatarsal stress fractures, plantar fasciitis, planus and cavus foot types, and diabetic foot ulceration [1-8]. FRM is assessed manually in over 90% of clinical foot exams to determine treatment plans. Current manual methods are subjective, inconsistent, and lack a commercially available tool with inter-rater reliability [2]. We developed MAP1stV2 (Figure 1) to provide reliable and objective FRM measurements for improved diagnoses and treatment planning for pathological feet [2]. The aim was to determine the reliability of MAP1stV2 for measuring FRM and its utility for predicting regions of high plantar stress.

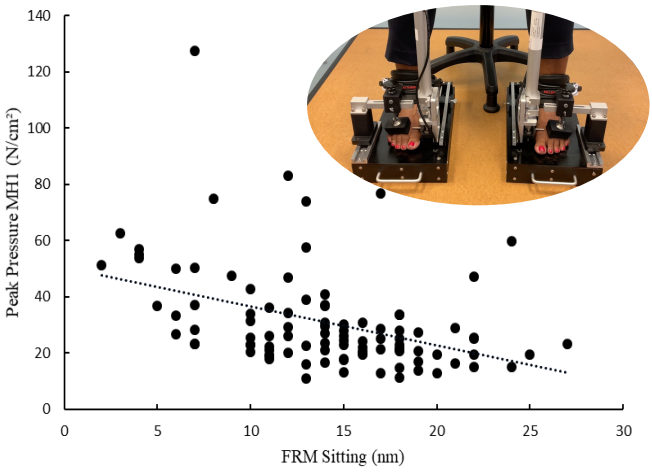
Methods

This IRB-approved cross-sectional study included 51 subjects, with 29 asymptomatic (15 bilateral planus, 10 bilateral rectus, 1 bilateral cavus, 3 mixed foot types) and 22 pathological (11 HV, 11 HR) subjects. Structural foot measurements while sitting and standing (Arch Height Index (AHI), FRM, FRP, Arch Height Flexibility, and functional foot parameters (peak plantar pressures at the hallux, 1st metatarsophalangeal (MTP) joint, and 2nd MTP joint) at self-selected walking speed while barefoot were collected from each subject. Foot type was determined for each individual using AHI. FRM and FRP was measured using MAP1stV2, for left and right feet, while sitting and standing. Two raters were assessed to determine intra and inter-rater reliability of MAP1stV2. The reliability analysis was performed for each foot separately using an ICC(2,1) two-way random analysis with absolute agreement. Multivariate regression models were constructed for predicting medial forefoot pressures. All statistical analyses were performed using SPSS (IBM V28.01).

Results and Discussion

MAP1stV2 gave mean intra- and inter-rater reliability of 0.85 and 0.70, respectively. Univariate regression showed a negative relationship (R = 0.404; p = 0.001) between FRM and peak pressure beneath the 1st MTP joint (Figure 1). Multivariate models predicted hallux, 1st and 2nd MTP peak pressures, including the afore-mentioned foot structure, function and anthropometrics foot metrics.

Figure 1: The relationship between FRM loading of the 1st metatarsal head. R = 0.404; p = 0.001



Conclusions

MAP1stV2 demonstrated good intra- and inter-rater reliability and was able to predict regions of high plantar pressure. Hence, MAP1st could be used in clinical settings to help health care professionals obtain reliable FRM data, improve diagnoses, and enhance treatment planning.

Acknowledgments

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