Weight Bearing vs Non-Weight Bearing Shear Wave Elastography of the Plantar Fascia

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INTRODUCTION: Shear wave elastography (SWE) is a technique for quantifying soft tissue stiffness and shows promise in assessing ligament and tendon properties in many foot and ankle disorders. The plantar fascia (PF) plays a key role in load transfer and foot arch stability and is suspected to be one of the first structures affected by age related arch degeneration. SWE may offer a non-invasive method for monitoring ligament degeneration over time. One of the challenges in using SWE to evaluate ligaments is the large variability that occurs with different loading conditions., weight bearing is an easily reproducible physiologic load and may by a simple technique for controlling variability. In this pilot study, we aim to compare baseline variances in SWE measurement of PF comparing weight bearing to non-weight bearing conditions in normal healthy feet.

METHODS: This study was approved by our institutional review board, and informed consent was obtained from all participants. Two healthy adult participants underwent SWE of the PF under two conditions: weight bearing (standing) and non-weight bearing (sitting). During the weight bearing condition, an ultrasound probe with SWE capability was positioned beneath the foot using a custom-built platform with an opening to allow the probe to be placed on the plantar surface of the foot. In the non-weight bearing condition, the same ultrasound probe was used to examine the PF with the patient in the supine or seated position on an examination table. Three trained operators performed three scans at 3 regions of interest for each condition. Quantitative SWE data were calculated using software integrated into the ultrasound system (Supersonics AIExplorer). The mean and variance were calculated for each combination of subject, operator, and condition.

RESULTS SECTION: Two participants were included in this preliminary study. Participant A demonstrated a mean shear wave velocity of 15.3 m/s in the non-weight bearing condition and 14.0 m/s in the weight bearing condition. Participant B demonstrated a mean of 15.7 m/s in the non-weight bearing condition and 14.3 m/s in the weight bearing condition (Figure 1). Variability differed between participants: Participant A showed a variance of 1.05 (non-weight bearing) and 1.11 (weight bearing), while Participant B showed a variance of 8.82 (non-weight bearing) and 6.07 (weight bearing – Figure 2).

DISCUSSION: This study supports the feasibility of using SWE to assess plantar fascia stiffness under different loading conditions. Unlike prior studies, which reported increased shear wave velocities with loading, both participants in our study showed a consistent decrease in mean values during weight bearing, observed across multiple operators. These differences may be related to the type of loading, the platform used, examiner variability, or other yet unknown causes, underscoring the need for additional scanning. Continued work with larger groups and standardized protocols will be important to refine this methodology and evaluate its potential for monitoring plantar fascia and ligament health.

SIGNIFICANCE/CLINICAL RELEVANCE: Age related degeneration of the arch supporting structures contributes to a number of common foot and ankle disorders including flatfoot, bunions, midfoot arthritis, and plantar fasciitis. SWE may provide a non-invasive technique for early detection of arch degeneration that could signal the need for intervention which could prevent deformity and disability.

IMAGES AND TABLES:

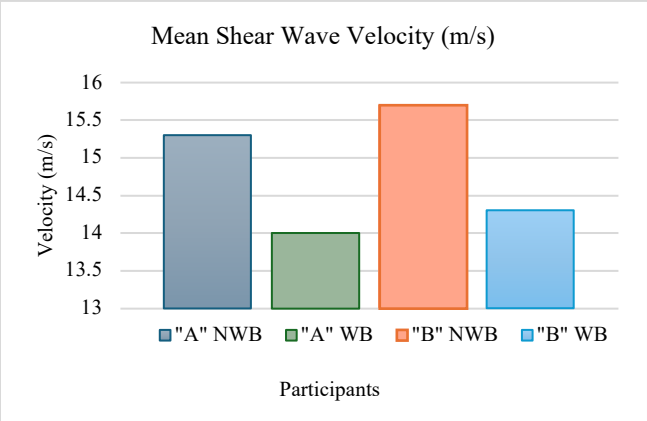

Figure 1: Histogram of the mean shear wave velocities (in m/s) for each participant, comparing non-weight bearing values (NWB) to weight bearing (WB).

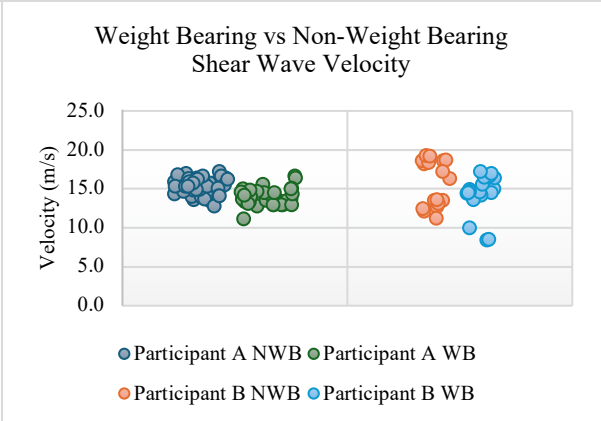

Figure 2: Jitter plot displaying all measured shear wave values for each participant. This plot allows visualization of the variance between all measurements, comparing non-weight bearing (NWB) to weight bearing (WB).