

2017

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**Category:** Midfoot/Forefoot,Sports

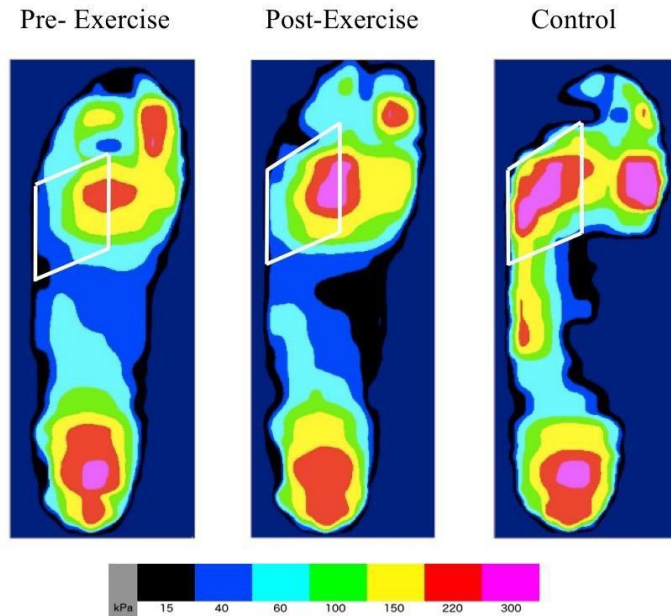
**Keywords:** exercise, flatfoot, plantar pressure

**Introduction/Purpose:** Muscle training muscle control for barefoot running (i.e. doming seated[DS] and standing[DSt]) and post foot and ankle injury (i.e. seated plantar flexion and inversion[SPFI]) are common. Although studies demonstrated improvement in foot posture (validated foot posture index [FPI]) immediately following a 4-week exercise program this was not assessed in people with flatfoot. Also, more rigorous assessment of foot function is lacking (i.e. foot posture, strength, and plantar pressure during walking). There is clearly a need for more rigorous clinical data on the effect of foot exercises. The purpose of this pilot study was to assess the immediate effect of a 4-week exercise program on a comprehensive assessment of foot function to evaluate the potential for a more rigorous clinical trial.

**Methods:** Eighteen individuals, 8 with a severe flatfoot (SFF), measured by FPI ( $> 6/12$ , average= $8.4\pm 0.7$ ), age= $27.8\pm 6.9$ , 7 females and 1 male) and 9 age/gender matched controls (AMC) with a normal foot (FPI=0-5, average= $2.2\pm 2.0$ ) participated. The SFF group completed 3 foot exercises (DS, DSt, SPFI) 5 days/week twice daily. The SFF group were assessed before and after 4 weeks of exercise (called weekly for exercise progression). The control participants were tested once. Testing sessions included plantar pressure during a controlled walking cadence (110 bpm) (average of 5 steps over 40 feet). Masks were applied (medial/lateral toes and forefoot, heel, midfoot) and specific variables calculated (peak pressure, percent mean pressure) during stance phase. Clinical tests included heel rise repetitions, navicular drop, and paper pull test (peak force). T-tests were used to assess the effects of pre to post in the SFF group and between the SFF group and AMC pre and post exercise.

**Results:** Two clinical tests significantly improved from pre to post in the SFF group (heel rises increased on right =  $6.1\pm 3.7$ ,  $p<0.01$ , left =  $7.9\pm 6.1$ ,  $p<0.01$ , and navicular drop indicated less arch lowering on the right ( $p=0.4$ ) and left ( $p=0.06$ )), however, the paper pull test was not significant. Lateral forefoot mask for percent total mean pressure was lower in the SFF group pre exercise versus AMC (right  $p=0.02$ , left  $p=0.07$ ). However, pre to post exercise the lateral forefoot mask for peak plantar pressure increased (left  $p=0.014$ , right  $p=0.02$ ) and percent of total mean pressure also increased (right  $p=0.04$ , left  $p=0.07$ ) in the SFF group. Post exercise the SFF group lateral percent total mean pressure was no longer significant compared to controls.

**Conclusion:** This data suggests that 4 weeks of foot only exercises (no ankle exercises) improved walking (Figure 1) and increased ankle strength (heel raise ability). Previous studies have not included rigorous assessment of foot function after foot exercises. This pilot data extends previous studies by suggesting foot muscle control may directly influence foot function during walking (i.e. plantar pressure). A power analysis using this data supports the conclusions with a larger sample of approximately 20-30 people. This pilot data supports the pursuit of a more rigorous trial of the positive effect of foot exercises in patients with severe flatfoot.



**Figure 1:** The mean plantar pressure was averaged across 5 steps and masks were applied (the lateral mask is shown – white box). An individual plantar pressure trial for a participant with severe flatfoot pre-exercise (Left) and post exercise (Middle) contrast with an age/gender matched control participant (Right). Note the marked increase in lateral forefoot mean plantar pressure in the lateral mask post exercise (Middle), which resulted in partially normalizing the plantar pressure pattern(Right).