Influence of 4-Week Exercise Program on Clinical and Biomechanical Measures of Foot Function

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Background

- The significance of foot muscle function associated with flat feet is unclear.
- It is reported that flat feet have significantly decreased lateral forefoot pressure during ambulation with increased midfoot contact area and increased pressure under the big toe. [1,3]
- There are passive mechanisms in the foot that support the arch during static standing, but cannot produce energy for dynamic activity.[4]
- The two most plausible explanations for energy generation of the midfoot for dynamic activity are muscle contributions or recoil of stretched soft tissue (i.e. plantar fascia and other ligaments) or a combination.[2,4,5]
- No studies to date evaluate the ability of foot muscle training to alter foot pressure patterns in participants with flat feet.

Therefore, the overall purpose of the proposed study is to compare foot posture, foot pressure patterns, and foot muscle strength before and after 4 weeks of foot muscle training. A second purpose is to compare the baseline (before training) scores of the participants to control participants that have neutral foot posture on the FPI.

Methods

Participants:
- 8 experimental subjects with asymptomatic flat feet
- 9 control subjects with normal feet

- The *inclusion* criteria include:
  - Age 18 to 50 years old
  - FPI of ≥ 6
  - Free of foot and ankle associated pain for the last 6 months
- The *exclusion* criteria include:
  - Any musculoskeletal or nervous system injuries of either limb in the last 6 months
  - Diabetic neuropathy affecting the foot and ankle
  - BMI > 40
  - Current foot disorders including hallux rigidus, bunions and plantar fasciitis

Tests & Measures performed on each participant:
- Foot pressure data collected with PEDAR foot measurement system
- Navicular Drop Test
- Arch Height Index
- Foot Posture Index
- Paper Pull Test using force plate
- Single Leg Heel Raise Test (max height and total # of heel rises)

Outcomes

Experimental Group

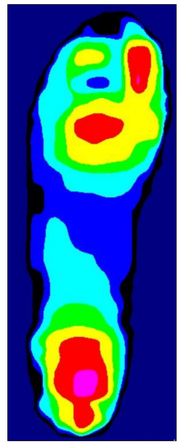
Picture 1: Experimental Subject 6

Control Group

Picture 2: Control Subject 3

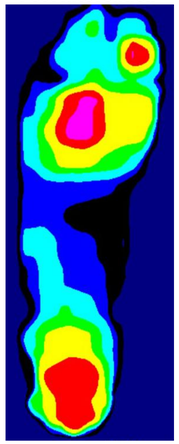
Foot Pressure Data

Pre-Intervention



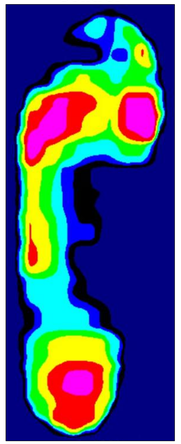
Picture 3: Foot Pressure Mapping, Experimental Subject 6

Post-Intevention

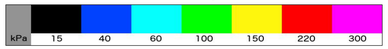


Picture 4: Foot Pressure Mapping, Experimental Subject 6

Control

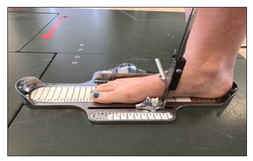


Picture 5: Foot Pressure Mapping, Control Subject 4



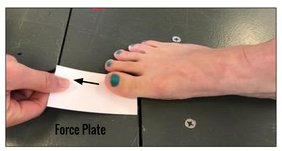
Arch Height Index

Picture 6: Arch Height Index Measurement Device, anterior view of right foot from seated position

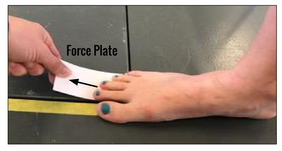


Picture 7: Arch Height Index Measurement Device, medial view of right foot from standing position

Paper Pull Test



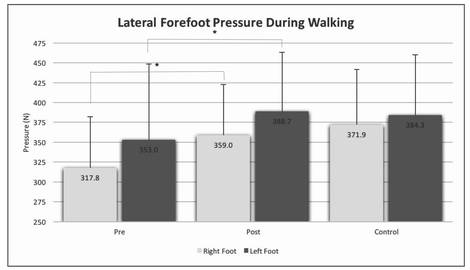
Picture 8: Paper Pull Test of right great toe using force plate to determine great toe muscle strength



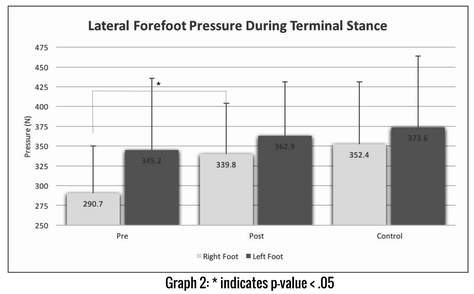
Picture 9: Paper Pull Test of right lateral toes using force plate to determine lateral toes muscle strength

Results

Foot Pressure

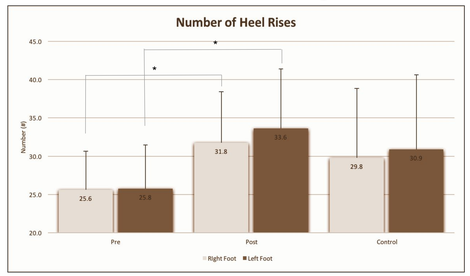


Graph 1: * indicates p-value < .05



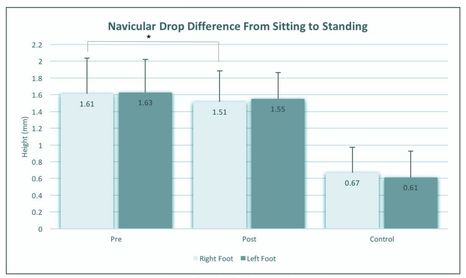
Graph 2: * indicates p-value < .05

Foot Muscle Strength



Graph 3: * indicates p-value < .05

Foot Posture



Graph 4: * indicates p-value < .05

*****All statistical analyses data based off of one-tailed t-tests*

Discussion

- Heel rise repetitions increased significantly in the intervention group by an average of 27.3% bilaterally.
- Lateral forefoot pressure during walking significantly increased bilaterally post-intervention. Previous studies have shown a correlation between higher arch height and increased lateral forefoot pressure.
- Lateral forefoot pressure at terminal stance increased post-intervention to less than a 4 newton difference from controls.
- Pre- and post-intervention strength values measured by the Paper Pull Test showed a trending increase in force generation.
- Bilateral navicular drop trended in the direction of the control group, with the right foot revealing a significant change.

Weaknesses of study:
- Underpowered study due to low sample size of 10 experimental participants, with 2 participants excluded due to FPI score < 6.
- Intervention period not long enough to experience true physiological muscular adaptations.
- No follow-up completed to assess long-lasting effects of the intervention.
- Moderate compliance level with interventions, 67.3% overall (33.4-91.9%).

Conclusion

- The findings of this study support the hypothesis that a 4-week foot muscle training program can affect foot posture, foot pressure data and foot muscle strength in people with asymptomatic flat feet.
- More research will be needed to assess the effects of a muscle training program on symptomatic flat feet as well as the effects of this training on more functional tasks.

References

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