THE EFFECT OF MUSCLE IMBALANCE ON FOOT PRESSURE IN PEDIATRIC PATIENTS

[1]Michael El-Shammaa, [1]Nicholas Gryfakis, [1]Kelly Lenard, [2]Nathan Lashley, [2]Louis Santangelo, [1]Luciano Dias
[1]Motion Analysis Center, Children's Memorial Hospital, Chicago, IL
email: melshammaa@childrensmemorial.org; web: www.childrensmemorial.org/depts/motionanalysis/
[2]College of Podiatric Medicine, Finch University of Health Sciences, Chicago Medical School

INTRODUCTION

Foot pressure data is frequently collected during gait analysis. Analysis of this data is typically done by dividing the foot pressure into regions with a mask that is not customized to the shape of the individual foot. Previous studies have successfully used these generic foot masks to evaluate varus and valgus foot deformities [1]. The effect of posterior tibialis [2] and anterior tibialis [3] dysfunction on foot pressure data has also been examined in vitro. This study examined average peak foot pressure on patients with a strength imbalance between a major evertor and invertor of the foot.

METHODS

Five able-bodied subjects (ten limbs; mean age = 11.8 yrs) and 15 patients with a mean age of 10.5 yrs (12 cerebral palsy, 1 pdd, 1 lipoma, and 1 clubfoot) were included. The same physical therapist measured all patients' muscle strengths. A minimum difference in muscle strength grade of 1 (on the 0 to 5 scale) between the peroneus brevis (evertor) and the posterior tibialis (invertor) was observed for inclusion. The patients were divided into 2 groups. Group 1 (n=7 limbs) showed greater posterior tibialis strength. Group 2 (n=10 limbs) showed greater peroneus brevis strength.

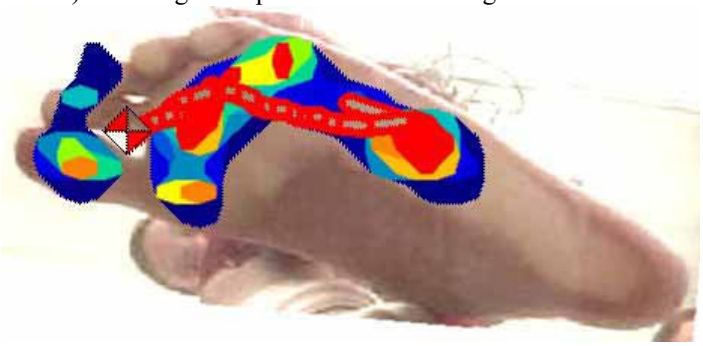

Figure 1: Foot pressure overlay with plantar surface picture

Barefoot pedobarograph data was collected for all subjects using a Tekscan, Inc. FMAT pressure mat. A static photo of the plantar surface of the foot was taken for each subject while in bilateral self selected weight bearing. The peak foot pressure data was overlaid on the static image of each patient's foot as seen in Figure 1. This facilitated a more thorough evaluation by displaying the peak pressure relative to the individual shape, size and anatomical landmarks of the foot. Simultaneous gait analysis data was collected on select subjects (as needed) to verify that the foot progression angle of the image matched the foot progression angle of the foot pressure. The long axis of the foot, from the center of the heel to the 2nd interspace was rotated to vertical and used to create the medial/lateral division. The foot was then divided at 32.9% and 62.3% of the overall foot length from the posterior aspect to give the midfoot and forefoot sections. The four regions evaluated were the medial midfoot, medial forefoot, lateral midfoot, and lateral forefoot. The average (over the area) peak pressure of each region was normalized to the maximum peak pressure of the entire foot. The ratio of medial to lateral average peak pressure was examined for the midfoot and for the forefoot.

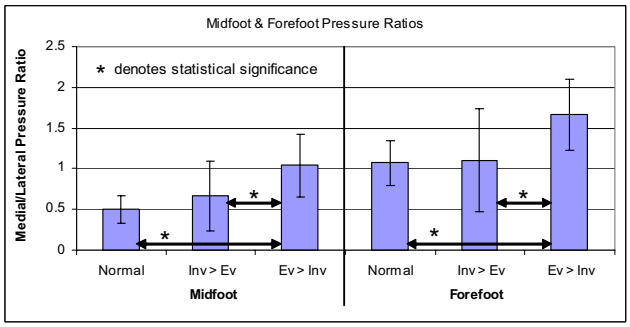

Figure 2: Medial/lateral pressure ratios for the midfoot and forefoot.

RESULTS AND DISCUSSION

Group 1 (Inv. > Ev.) showed an average posterior tibialis strength of 3+/4- and an average peroneus brevis strength of 2+. Group 2 (Ev. > Inv.) showed an average peroneus brevis strength of 3 and an average posterior tibialis strength of 2-.

Figure 2 shows that the medial to lateral ratio was not statistically different between the normal group and the Inv. > Ev. group, for both the midfoot ($p = 0.38$) and the forefoot ($p = 0.91$). The normal ratio is approximately 0.5 for the midfoot (the medial midfoot shows approximately half the mean peak pressure as the lateral midfoot), and approximately 1.0 for the forefoot (same mean peak pressure for both medial forefoot and lateral forefoot). The Ev. > Inv. group showed significantly increased mean peak medial pressure for both the midfoot ($p = 0.001$) and the forefoot ($p = 0.002$).

CONCLUSIONS

The overlaid image of the plantar surface of the foot is a useful tool in orthotic fabrication, foot pressure analysis and research. These results show that a foot evertor/invertor strength imbalance can have a significant effect on foot pressure data. In subjects where the posterior tibialis is significantly stronger than the peroneus brevis, the pressure ratio is not significantly affected; however, when the posterior tibialis is significantly weaker than the peroneus brevis, there is a significant shift of pressure towards the medial aspect of the forefoot and midfoot. This may be an important factor when considering the implications of a surgery that may weaken the posterior tibialis. Future studies will focus on the effects of an imbalance between other muscle groups.

REFERENCES

1. Chang CH, et al. *J Pediatric Orthopedics*,**22**, 813-818, 2002
2. Inhauser CW, et al. *J Clinical Biomech*, **19**, 161-169, 2004
3. Wulker N, et al. *Foot & Ankle Int*, **24**(8), 623-9, 2003

ACKNOWLEDGEMENTS

Children's Memorial Hospital Motion Analysis Center Research and Education Fund, Claudia Kelp-Lenane.