

Principal Components Analysis to Assess Plantar Loading in Patients with Midfoot Arthritis and Matched Control Subjects

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INTRODUCTION

- Tarsometatarsal (midfoot) arthritis is a challenging problem due to its high potential for chronic foot pain and functional disability.
- Foot pain is associated with regional plantar loading [1]. Increased magnitude and duration of regional plantar loading may contribute to the development of foot pain, in patients with midfoot arthritis.
- In addition, underlying pain and pathology in patients with midfoot arthritis may also change the relationship of regional plantar loading between foot areas, defined as regional plantar loading pattern.
- We proposed that principal component analysis (PCA) can discern patterns of regional plantar loading [2] and help obtain a better understanding of changes in regional plantar loading patterns due to midfoot arthritis.

The purpose of this study is to use PCA to compare regional plantar loading patterns between patients with midfoot arthritis and asymptomatic control subjects.

METHODS

Subjects: 50 subjects participated in this study, 30 with midfoot arthritis and 20 asymptomatic control subjects, matched in age, gender and BMI.

Inclusion criteria for midfoot arthritis group:

- presence of pain on the dorsum of the foot, localized to the tarsometatarsal region and aggravated by weight bearing.
- radiographic evidence of degenerative changes at 1 or more tarsometatarsal joints.

Exclusion criteria for midfoot arthritis group :

- injury or surgery of the lower extremity within the past 6 months
- conditions that may affect walking
- use of assistive devices

	Age (years)		BMI (kg/m ²)		Male : Female
Arthritis	62	7	29.7	5.7	2:28
Control	58	8	29.3	4.3	1:19

Table 1. Demographic characteristics of both groups

Plantar Loading Data Acquisition: Plantar loading data were obtained using an Pedar-X system (Novel Inc, St Paul, MN) at 90 Hz. Subjects in arthritis group walked at self-selected speed during data collection, while subjects in control group walked at the speed determined by their matched subjects in arthritis group. A minimum of 10 steps were collected for each subject using midgait protocol.



Data Analysis: The foot was divided into 6 masks: heel, medial and lateral midfoot, medial and lateral forefoot, and great toe. Plantar loading data were measured in each mask. The outcome variable was average pressure, defined as the mean of the highest pressure sustained in each sensor for all sensors within each mask and expressed in kilopascals (kPa).

Statistical Analysis: Principal component analysis (PCA) was used to assess regional plantar loading patterns, using average pressure in six masks, in patients with midfoot arthritis and asymptomatic control subjects. "Eigenvalue greater than one" criterion was used to retain components [3]. Independent sample *t*-test was used to compare the regional plantar loading in each masks between midfoot arthritis and control group.

RESULTS

	Midfoot Arthritis		Control	
	Component 1	Component 2	Component 1	Component 2
Heel	0.49	0.73	0.18	0.84
Medial Midfoot	0.16	0.85	0.82	0.27
Lateral Midfoot	0.14	0.82	0.92	-0.09
Medial Forefoot	0.81	0.27	-0.07	0.62
Lateral Forefoot	0.85	0.01	0.78	0.16
Great toe	0.67	0.28	0.34	0.88

Anterior-Posterior Strategy in Patients with Midfoot Arthritis

Medial-Lateral Strategy in Control Subjects

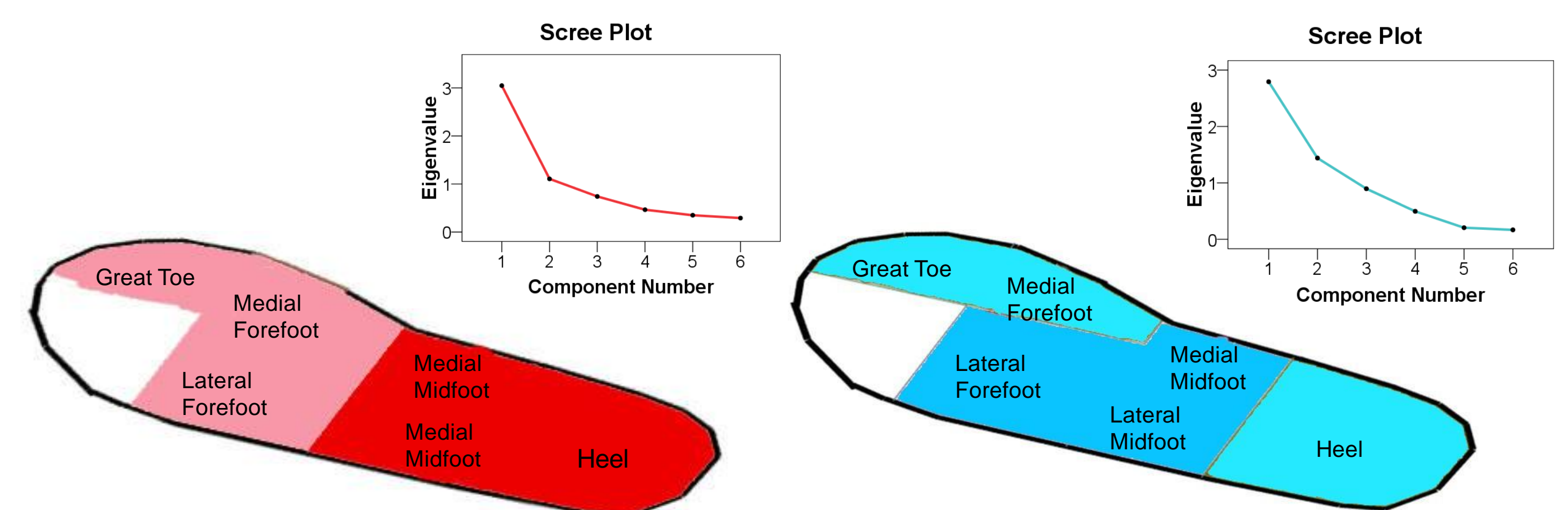


Figure 1. Component matrix with varimax rotation indicated a two-component solution in both, patients with midfoot arthritis and control subjects. Foot masks with the greatest contribution to each component are highlighted. While both groups showed a two-component solution, an examination of foot masks suggests that patients with midfoot arthritis show different plantar loading patterns (structures) compared to control subjects.

anterior-posterior loading pattern in patients with midfoot arthritis
medial-lateral loading pattern in control subjects.

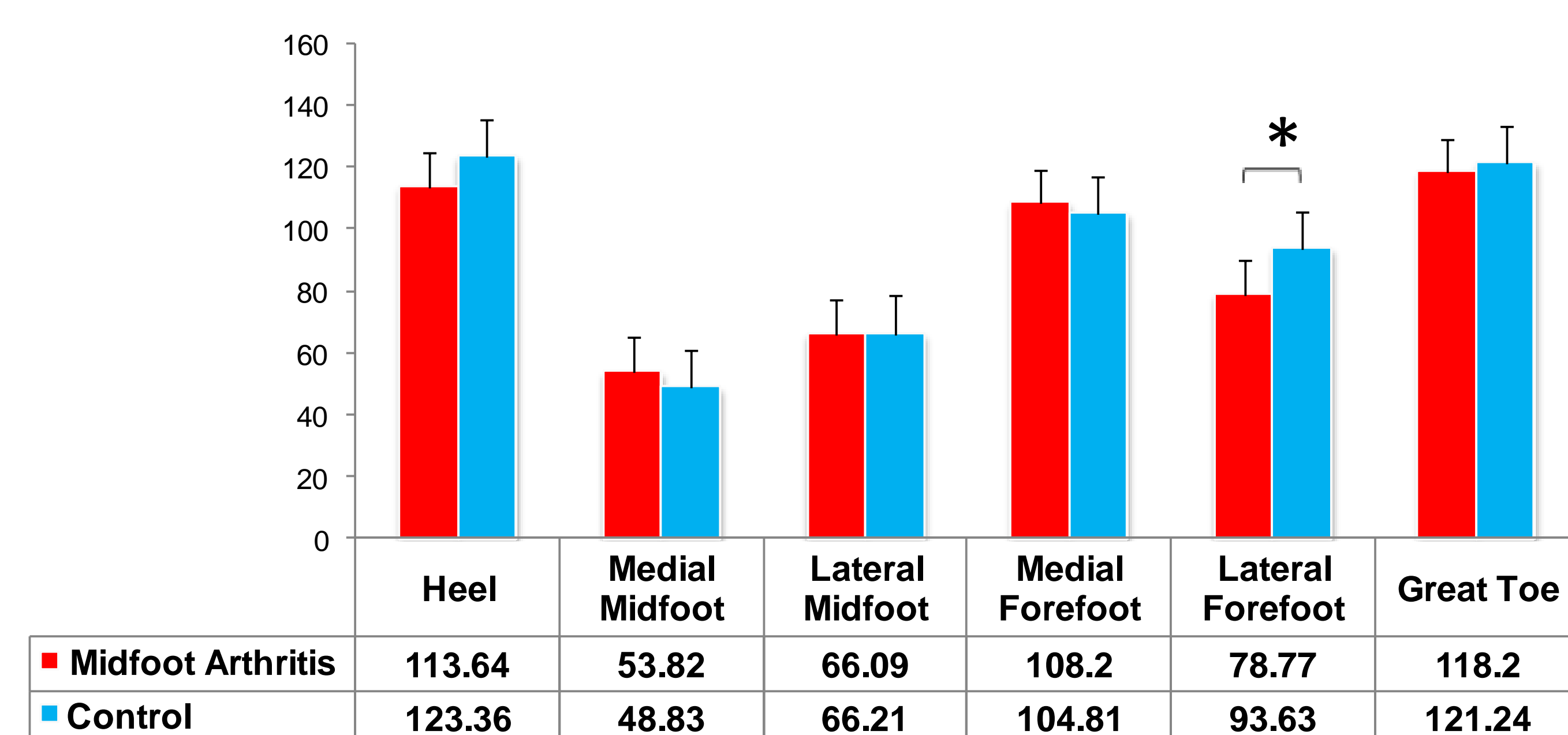


Figure 2. Mean average pressure in six masks in patients with midfoot arthritis and control subjects indicated that patients with midfoot arthritis sustain significantly lower lateral forefoot average pressure, compared to control subjects (**p* < .05)

CONCLUSIONS AND DISCUSSION

- The key findings of this study indicate that patients with midfoot arthritis show different plantar loading patterns compared to control subjects. The difference in loading pattern may stem from structural and functional changes, occurring due to underlying pain and pathology.
- PCA is a valuable tool to investigate the plantar loading patterns in clinical populations. An improved understanding of loading pattern may help develop new assessment and intervention strategies.

References

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Acknowledgements

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