Do Patients with Insertional Achilles Tendinopathy Have Different Morphologic and Radiographic Alignment Features of the Foot?

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BACKGROUND

- Insertional Achilles tendinopathy (IAT) associated with calcification and degeneration of the insertion is a common disorder.
- Presently, there is little understanding of the etiology, pathogenesis, and biomechanics of this disease entity, although excessive tension at the Achilles insertion associated with calcaneus abnormalities have been considered a contributing factor.
- Multiple imaging modalities have been used to investigate a possible correlation between calcaneus morphology and IAT. However, no prognostic criteria have yet been found.

OBJECTIVE

The goal of this study was to evaluate the size of the calcified enlargement of the Achilles insertion using a newly developed angular measurement, pathologic Achilles insertion angle (PAIA)[1] (Figures 1-2), and compare it among groups with different hindfoot and arch height alignment features.

METHODS

- Medical records of 85 patients with symptomatic IAT were retrospectively reviewed.
- Weightbearing lateral Xray images were used for morphological and radiographic analysis.
- The PAIA was used for the morphological evaluation. It is based on a mechanism of mapping and curve fitting and represents the extent of the enlarged Achilles insertion. (Figures 1-2)
- A lateral view of subtalar joint alignment (LVSJA), which reflects the alignment of the hindfoot (neutral, varus or valgus), the calcaneal Pitch angle, and the ratio of the Medial Cuneiform Base Height/Cuboid Height as well as the ratio of the Medial Cuneiform Base Height/Fifth Metatarsal Height, which reflect the arch height features were assessed.
- The comparison of PAIA among the three groups of LVSJA, as well as the correlation between PAIA and arch height ratios were also studied. Statistical analysis was performed using SAS 9.4.

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RESULTS

Figure 1. Lateral weightbearing images of 40 control feet were used to determine the size of the calcaneus and contour of the tuberosity. The shape of the calcaneus was mapped onto part of a circle the Standard Circle (SC) whose center and radius were statistically fitted and scaled in relation to the height and width of the calcaneus. Green dots are the preliminarily established bone anatomical markers. Red and blue dots denote the insertion and superior parts of the calcanei outlined. X and Y axis of the figure are normalized by calcaneus height and width (A); Overlap between the standard curve and the weightbearing XR image of a foot with IAT (B); Parameterization of the standard circle indicates that the center of the SC is away from the anterior end of the calcaneus by 41% of its width, and above the weightbearing point by 45% the height of the calcaneus. The radius of the standard curve is approximately 42% the diagonal of the smallest rectangle containing the calcaneus (C).

- There were 38 males and 47 females with a mean age 54.59 (range 34-80), pitch angle 21.37 degrees (range 12.18-33.20) and PAIA 12.56 degrees (range 2.45-29.79).
- The LVSJA showed that 59 patients had a neutral hindfoot (69.41%), 14 had a varus (16.47%), and 12 (14.12%) had a valgus hindfoot.
- Among these three subgroups, there were significant differences of the calcaneus Pitch angle, and the Medial Cuneiform Base Height/Cuboid Height between the valgus and varus hindfoot groups, and the valgus and neutral hindfoot groups, but not the varus and neutral hindfoot groups.
- No difference was found in the Medial Cuneiform Base Height/Fifth Metatarsal Height between any two of the three subgroups.
- The PAIA difference between the neutral and varus hindfoot groups was significantly larger than the others. There was no significant correlation between PAIA and the calcaneal Pitch angle, as well as the two arch height indexes. (Tables 1-2)

Hindfoot Alignment Comparison	Difference Between PAIA Means	95% Confidence Limits	
Neutral - Valgus	0.494	-3.046	4.034
Neutral – Varus*	4.020	0.697	7.343
Valgus - Varus	3.526	-0.871	7.924

Table 1. Measurements of Arch Height for the three subgroups in the group of patients with IAT.

	N	Medial Cuneiform Base Height/Cuboid Height	Medial Cuneiform Base Height/Fifth Metatarsal Height	PAIA (degree)
Neutral Hindfoot	59	1.69 ± 0.28*	2.69 ± 1.73	13.29±5.38
Varus Hindfoot	14	1.96 ± 0.38*	3.42 ± 1.78	9.27±4.78
Valgus Hindfoot	12	1.52 ± 0.26*	2.25 ± 0.74	12.80±7.47

Table 2. Comparison between means of PAIA among neutral, valgus and varus hindfoot groups.
*: Statistically significant difference detected.

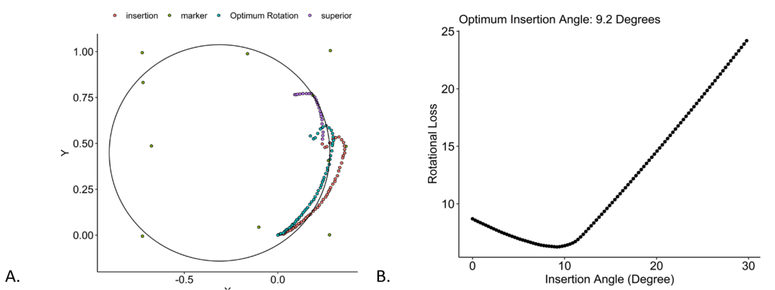

Figure 2. The diseased posterior calcaneal tuberosity of a patient with IAT was outlined and compared to its respective standard circle (SC). An angle was calculated by which the diseased calcaneus curve was rotated around the weightbearing point to fit the SC. This angular measurement was defined as the Pathologic Achilles Insertion Angle (PAIA) in another of our studies (reference 1). Figures 3A and 3B show the simulated optimal rotation of which insertion angle is calculated to minimize the gross rotational loss from the standard circle. In figure 3A, purple and red dots are the outlined diseased posterior calcaneal tuberosity and the teal dots are the simulated movement of the posterior tuberosity to the SC with the PAIA calculated from the loss plot (figure 3B).

CONCLUSIONS

- This study is the first to include the morphology of the calcaneus, the hindfoot and arch height features of the foot in assessing symptomatic IAT.
- It has found that in this cohort patients with a varus hindfoot had a much smaller calcified enlargement of the Achilles insertion than those with a neutral hindfoot.
- Further investigation with a larger sample size to study possible correlations among clinical symptoms, calcaneus morphology, and alignment of the feet will be helpful to guide both diagnosis and treatment of IAT in particular when the patient has combined malalignment issues in the hindfoot and midfoot.

REFERENCES

1. Wanjun Gu, Mingjie Zhu, Melissa Carpenter, Kenneth Hunt, Mark S Myerson, Shuyuan Li. The Pathologic Achilles Insertion Angle (PAIA): A Novel Angular Measurement to Guide Both Evaluation and Treatment of Insertional Achilles Tendinopathy. 2022 AOFAS Annual Meeting. (under review).