

Statement of Purpose

The purpose of this study is to define boundaries and objectively quantify the dimensions of the anatomical bands of the plantar fascia at the defined surgical level of an in-step plantar fasciotomy. In addition to our primary purpose, we attempt to objectively define an intra-operative, quantitative amount for plantar fascia resection.

Methodology & Hypothesis

A cadaveric study of the plantar fascia (PF) dimensions was carried out utilizing five randomly selected fresh frozen specimens from a local region within Pennsylvania. A U-shape incision was made from anterior medial to posterior and then continuing to anterior lateral. The skin and subcutaneous tissue were reflected anteriorly creating a full thickness flap for adequate visualization of the plantar fascia (Figure 1).

The anatomic boundaries of the plantar fascia's medial, central, and lateral bands were defined prior to study for accuracy and consistency (1,2,4,5,10):

Medial Band: The medial band of the plantar fascia originates from the calcaneal process and covers abductor hallucis. Its medial border is defined by the most medial terminating strand of fascia and its lateral border is the medial intermuscular septum/groove. Its thickness is typically less than the central band.

Central Band: The central band of the plantar fascia originates from the medial calcaneal process. Its medial border is defined by the medial intermuscular septum/groove and its lateral border is defined by lateral intermuscular septum/groove. The central band spans distally terminating into five digitations.

Lateral Band: The lateral band of the plantar fascia originates from the lateral calcaneal process. Its medial border is defined as the lateral intermuscular septum/groove and the lateral border is a thickened band connecting the lateral calcaneal process to the 5th metatarsal styloid process.

The PF was transected at specific levels based on prior in-step plantar fasciotomy (IPF) literature. Three transections of each band were performed at the PF insertion as well as two and three cm distal to PF insertion. The thickness and width at each transection was measured using a metric ruler performed by main author (J.Z.). The mean width and mean thickness with standard deviation was calculated at each transection using a standard deviation calculator (<https://www.easycalculation.com/statistics/standard-deviation.php>).

We hypothesize the central band will have a greater mean thickness and lesser mean width compared to the medial band and all mean band width measurements will increase distal to their insertions. These measurements will help guide surgical approach to resection and increase reproducibility of the IPF technique.

Procedural Dissection

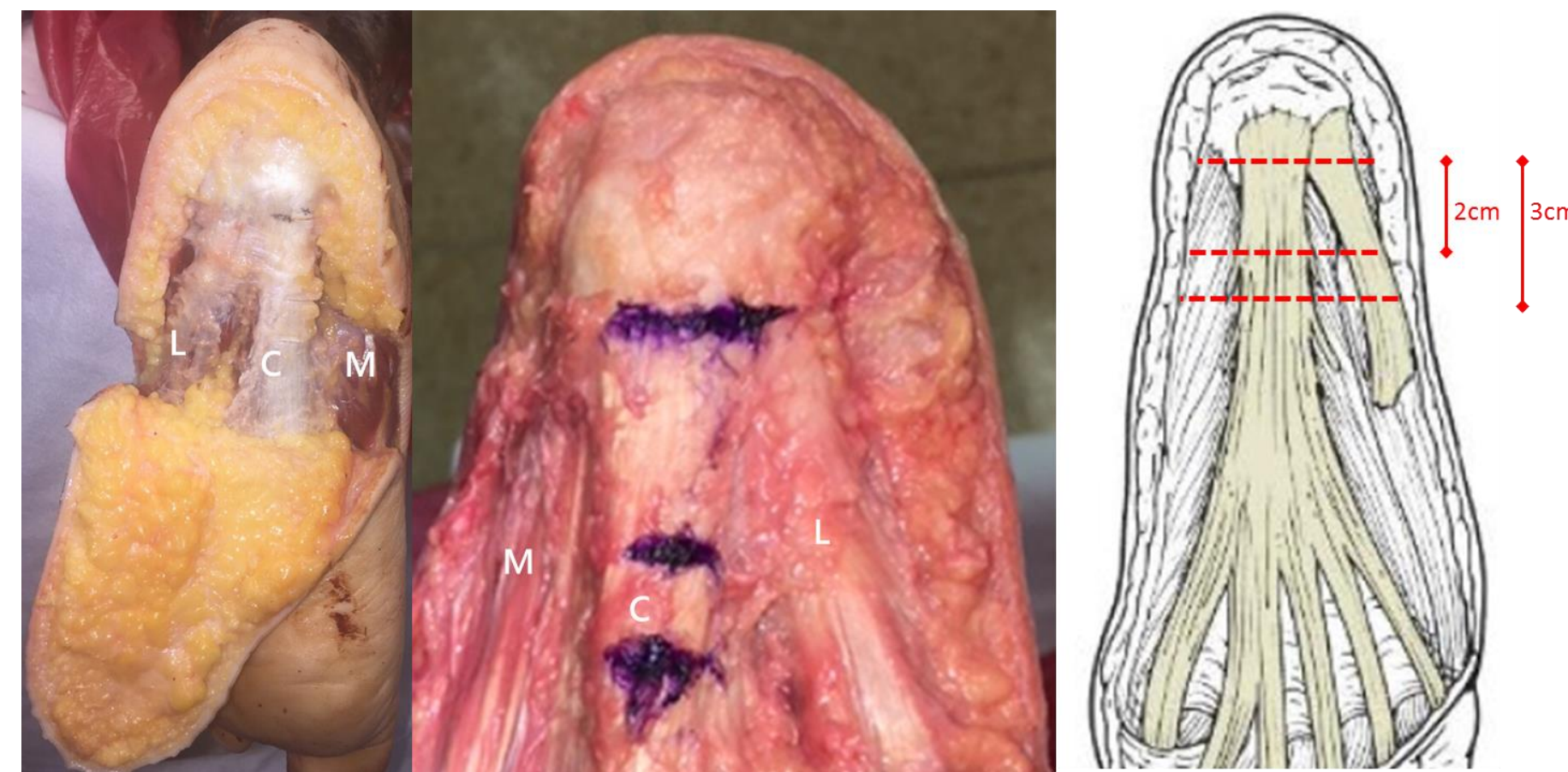


Figure 1. U-shaped incision about the heel with full thickness flap and exposure to plantar fascia with marking of levels of transection

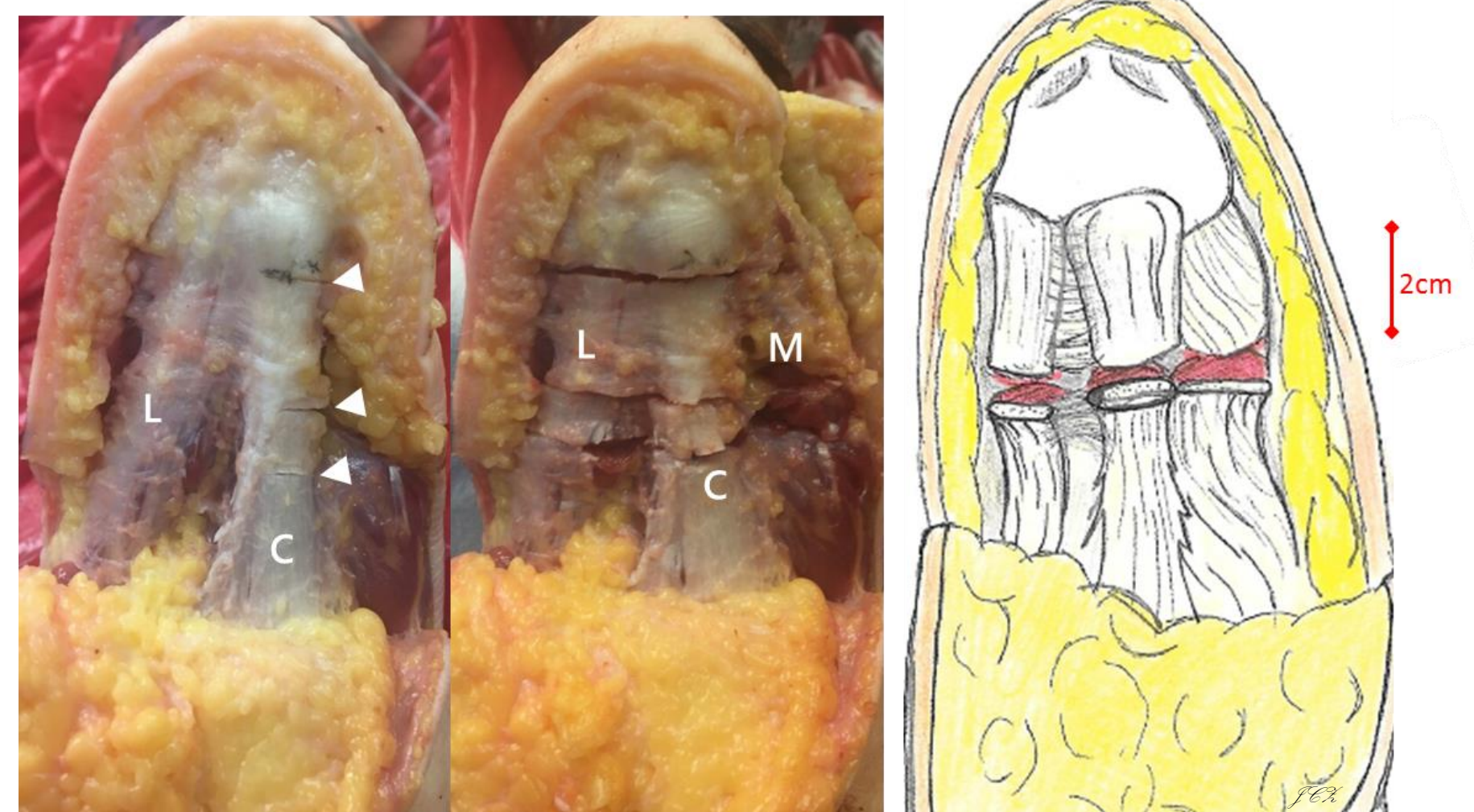


Figure 2. Measurement of width and thickness at insertion, 2cm, and 3cm distal to insertion of plantar fascia

Literature Review

First described by Kahn et al. in 1985, a plantar medial transverse incision of the heel was utilized to transect the proximal plantar fascia for a plantar fasciotomy (1). In 1987, Ward and Clippinger described a longitudinal medial plantar IPF, which required a long curvilinear incision to the posterior aspect of the medial longitudinal arch (2). The incision began immediately anterior to the mid-portion of the heel pad and extended to the mid-portion of the medial longitudinal arch. Ward et al. advocated an oblique orientation aligning the incision with the longitudinal skin stress lines, thereby decreasing the chance of wound dehiscence.

Literature Review cont.

This approach was modified by Braly in 1994 by creating an incision distally and medially to the heel pad in the proximal arch region (3). The exposure allows one to visualize the plantar fascia 2-3cm from its insertion.

Past literature has also advocated for incising the medial 2/3rd of the entire plantar fascia while leaving the lateral 1/3rd fascia intact (1-3). More recently, however, Barrett et al. in 1995 suggested only releasing the medial 1/3rd of the plantar fascia, which appeared to significantly decrease lateral column destabilization (4). Also in 1995, Perelman et al. commented after considering the anatomy felt the etiology of plantar fasciitis to be more consistent with inflammation and irritation of the medial portion of the central band (5). To our knowledge, there has not been a gross anatomical study performed for the anatomical dissection of the IPF.

In regards to an endoscopic plantar fasciotomy (EPF), there has been one cadaveric anatomical study (6). The authors documented the thickness and width of the medial, central, and lateral bands without defining the anatomical boundaries of the fascia or the specific distance from insertion. They found the mean widths of the plantar fascia to be: 13.48mm for the medial band; 4.54mm for the central band; and 10.77mm for the lateral band. Their mean thickness of the plantar fascia were: 4.45mm for the medial band; 1.57mm for the central band; and 2.54mm for the lateral band.

Results

Each band of the plantar fascia showed increased mean width from insertion to a point 3cm distal to insertion. The mean thickness decreased in each fascial band from its insertion to 3cm distally.

The mean width of the plantar fascia 2cm distal to its insertion was greatest in the medial fascial band at 28mm (+/- 2.74) from the other two bands.

Table 1. Medial Fascial Band		
Level of PF	Mean Width (mm)	Mean Thickness (mm)
Insertion	18.4 +/- 2.70	3.6 +/- 0.48
2cm	28.0 +/- 2.74	3.3 +/- 0.31
3cm	32.3 +/- 3.20	2.8 +/- 0.24

Table 2. Central Fascial Band		
Level of PF	Mean Width (mm)	Mean Thickness (mm)
Insertion	18.0 +/- 2.35	7.5 +/- 0.65
2cm	19.8 +/- 2.08	5.2 +/- 0.99
3cm	24.3 +/- 4.58	3.8 +/- 0.13

2cm from the insertion of the plantar fascia the central band was the thickest of the three bands measuring 5.2mm (+/- 0.99).

Mean width was least in the lateral fascial band at 15.4mm (+/- 2.41).

Table 3. Lateral Fascial Band		
Level of PF	Mean Width (mm)	Mean Thickness (mm)
Insertion	12.1 +/- 1.43	4.5 +/- 0.49
2cm	15.4 +/- 2.41	3.3 +/- 0.59
3cm	19.0 +/- 1.06	1.8 +/- 0.27

Analysis & Discussion

While the IPF was described as early as 1985, the average width of the PF bands, when considering an IPF, has not been studied. One previous study did examine the gross anatomy of the PF in respect to EPF (6). However, there is no documentation as to what specific distance from the PF insertion the EPF would be performed. The authors are unaware of any study that defines mean width and thickness of the PF at specific distances from its insertion on the calcaneus.

The previously described IPF incisions did not document a specific measurement from the distal aspect from the heel pad (1-3). However, Perelman in 1995 documented a measurement of 1.5cm distal to the anterior aspect of the plantar heel fat-pad, correlating to an underlining PF 2-3cm from its insertion (5). Our study correlates this planned incision anatomically to approximately 2-3cm of the PF from its insertion into the calcaneal tuberosity.

Each band of the PF increases width as it extends distally. The medial band has the greatest width at 3cm distal to the calcaneal insertion, which correlates to its insertion overlying the abductor hallucis (Table 1). The central band was found to be the thickest band at both its insertion and at 3cm, measuring 7.5mm (+/- 0.65) and 3.8mm (+/- 0.13) respectively (Table 2). This may be related to its strength required to support all digits and by also providing slips to each metatarsal phalangeal joint. The width of the central band was intermediate in size compared to the medial and lateral bands. The lateral band of the PF is thicker at the insertion compared to the medial band, but it progresses to become thinner and narrower compared to the medial band at 3cm, acting as the calcaneal cuboid ligament (Table 3). The authors believe these measurements correlate to the descriptive anatomy and functionality previously documented (2,3,5-7).

Perelman et al. discussed the importance of appreciating a more appropriate anatomical location for plantar fasciitis. After reviewing the anatomy, they postulated that plantar fasciitis is caused by inflammation and irritation of the medial portion of the central band as it is pulled from the attachment of the calcaneus (4). The authors agree with this statement and were able to appreciate the medial portion of the central band to have a strong functional pull from the medial tubercle of the calcaneus. Considering this etiologic explanation, and the anatomy seen during our dissection for an IPF, the central band of the PF should be specifically considered for incision during surgical intervention. Once dissection to the level of the PF medial groove is achieved through the in-step incision, the central band should be incised at approximately 2-3cm distal to the fascial insertion.

Discussion remains in literature whether the IPF should traverse 2/3rd or 1/3rd of the fascia. Recommendations within consulted textbooks is also unclear (7,8). Given the more common complication of lateral column destabilization, the authors recommend a more conservative incision involving 1/3rd of the central band. This surgical technique can be quantified given the recent data obtained in this study. The mean central band width at 2cm and 3cm was 19.8mm (+/- 2.08) and 24.3mm (+/- 4.58) respectively (Table 2). It can be considered that 1/3rd of these widths can be a utilized measurement when making an IPF 6.6mm (+/- 0.7) and 8.1mm (+/- 1.5). This quantified measurement could serve as a guide for performing an IPF. Further studies should be considered to understand the optimal fasciotomy width of the PF bands during an IPF.

References

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