



## The peroneus brevis tendon at its insertion site on fifth metatarsal bone



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### ABSTRACT

**Background:** The differences at the attachment site of peroneus brevis (PB) to the fifth metatarsal bone is important in terms of the forces exerted on the bone and hence the mechanism of fractures involving this structure. In this study, we investigated the anatomical properties of PB at the insertion site to the base of fifth metatarsal bone, its possible intertendinous connections with peroneus tertius (PT) and their possible effects on the fracture occurrence at the bony attachment site.

**Methods:** The length and the width of PB tendons at their mid- and end-points were measured and classified according to the insertion types. Besides, the length and the width of the base of fifth metatarsal bone were assessed. The slips extending from the PB tendons and their relationship with PT were also evaluated. The data was compared statistically with each other and between the right and left sides.

**Results:** The length of PB tendon was measured  $79.57 \pm 15.40$  mm on the right side;  $81.48 \pm 14.31$  mm on the left. The width of PB tendon at the mid-point was  $4.46 \pm 0.80$  mm on the right side;  $4.42 \pm 0.94$  mm on the left. The width of the tendon at its insertion point was measured  $14.85 \pm 3.40$  mm and  $15.16 \pm 3.42$  mm on the right and left sides respectively. PB was divided into three types according to its attachment to base of fifth metatarsal bone (5thMB). Type I, Type II and Type III were observed at the rates of 59.5%, 28.6% and 11.5% respectively. It was observed that the slips to the bone were extending more commonly from PB than from PT and that the large majority of them were single having their insertions on the base of the proximal phalanx of the fifth toe.

**Conclusions:** Knowing the width and insertional types of PB aids in understanding the mechanism of fractures at the site of bony attachment. The existence of slips may help the surgeon in the procedures involving PB or the lateral side of the forefoot.

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## 1. Introduction

The anatomy of the PB tendon at its insertion site on the base of fifth metatarsal bone (MB) is important in terms of surgeries involving lateral side of the foot [1,2]. Peroneal (fibular) muscles are the ones running in the eversion motion of the foot. Peroneus brevis (PB) has its insertion on the base of the fifth MB. It is known that intensive contractions of the muscles and sudden and severe motions of the extremities may lead to avulsion fractures at the attachment sites of tendons. Avulsion fractures of the base of fifth MB are among the frequently encountered fractures in orthopedic practice.

Here, we aimed to study the detailed anatomy of the PB tendon at its insertion area on the base of fifth MB in cadavers and we aimed to discuss its clinical importance for to determine the possible etiological factors of avulsion fracture. The PB tendon has also been analyzed on MR imaging in a limited number of patients with fractures located at the base of fifth MB to evaluate which the tendon type is more likely to be associated with these fractures.

## 2. Materials and methods

### 2.1. Anatomy

A total of 45 lower extremities of the cadavers fixed by 10% formalin were included in the study. Both sides of lower extremities of 17 cadavers (male 15, female 2; years of 64–78;

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**Table 1**

The measurements attributed to the PB tendon in whole embalmed cadavers.

Case number	Gender	Right			Left			Case number	Gender	Right			Left		
		Width at insertion	Length	Width of tendon proper	Width at insertion	Length	Width of tendon proper			Width at insertion	Length	Width of tendon proper	Width at insertion	Length	Width of tendon proper
1	M	14.58	109.66	3.91	18.09	106.17	3.44	10	M	16.66	94.48	5.02	15.94	91.75	3.71
2	M	14.22	106.41	5.53	15.12	97.85	4.66	11	M	16.79	80.34	3.93	15.99	76.47	4.26
3	M	22.18	96.26	4.71	23.22	96.82	4.82	12	M	16.18	83.30	3.69	20.69	79.80	5.17
4	F	13.95	62.68	5.75	13.10	55.01	5.43	13	M	19.19	84.80	5.13	18.40	79.32	4.78
5	M	12.54	81.62	4.08	16.36	93.83	6.14	14	M	12.63	67.97	5.28	12	57.47	3.76
6	M	13.09	78.02	4.64	13.88	84.03	4.70	15	F	8.40	73.39	3.29	10.03	80.46	2.93
7	M	15.81	57.94	6.19	12.42	62.22	4.98	16	M	13.04	90.23	4.12	15.37	96.00	5.12
8	M	23.01	84.18	4.81	19.20	88.92	4.74	17	M	15.71	77.84	4.93	<sup>a</sup>	<sup>a</sup>	<sup>a</sup>
9	M	13.55	89.66	4.83	13.31	90.80	5.96								

<sup>a</sup> The sides which could not be measured.

mean age 67) and 11 isolated lower extremities of with an unknown age and sex were included in the study.

There was no recorded history of trauma at the time of the death of the cadavers. No structural impairment or pathology related to the bones or soft tissues were observed. An incision was made from the level of the lateral malleolus of the cadavers toward the level of the fifth metatarsophalangeal joints. Dissection was advanced following the tendons and ended on reaching the attachment of the PB on the bone. Owing to the importance of the slips in the orthopedic practice, we also made the morphometric analysis of these structures.

The measurements were made from the following points:

- 1) The widest part of the tendon of PB (PBiw) at its insertion: the distance between the tip of the base of fifth MB and the most medial attachment side of the tendon.
- 2) The tendon length from musculotendinous junction to the insertion site (PBtl) [3].
- 3) The width of the PB tendon at its mid-point (PBtw).

### 3. Imaging

For five patients (three males, two females; years of 32–55; mean age 45) of whom the base of fifth MB fractures was identified on their radiographies, magnetic resonance (MR) imaging (1,5 T, Siemens, Sonata) was planned. The images were obtained with T2-weighted (TR/TE = 3573/70) fast spin-echo and T1-weighted (TR/TE = 500/17) fast spin-echo sequences for to evaluate the integration of the PB tendons and their structure at the attachment site on the bone.

**Table 2**

The measurements attributed to the PB tendon in isolated limbs.

Case number	Gender	Side	Width at insertion	Length	Width of tendon proper
1	M	Right	9.87	97.19	4.09
2	<sup>a</sup>	Right	14.09	64.29	3.29
3	<sup>a</sup>	Right	11.21	78.18	4.01
4	M	Right	11.84	52.01	4.94
5	M	Right	16.18	79.69	3.75
6	<sup>a</sup>	Right	13.56	63.92	3.27
7	<sup>a</sup>	Right	17.40	55.74	3.90
8	M	Left	13.30	76.74	3.14
9	<sup>a</sup>	Left	13.70	82.48	2.86
10	F	Left	9.79	63.22	4.07
11	<sup>a</sup>	Left	13.14	70.28	3.81

<sup>a</sup> Cases with gender unknown to the department.

### 4. Results

The measurements related to the PB which were taken on the cadavers were shown in Tables 1 and 2. The mean values of the measurements, the classification related to the attachment of the tendon and the cases with slips were displayed in Tables 3–5.

We have classified the tendon insertion characteristics of the PB as shown in Table 4a (Figs. 1 and 2).

In 13 of 45 lower extremities (8 right, 5 left) a single slip and in five of 45 lower extremities (2 right, 3 left) a double slip was observed. According to this evaluation, the average widths and

**Table 3**

The highest, the lowest, means and standard deviation results of the measurements performed.

Parameters	Side	The highest value (mm)	The lowest value (mm)	Mean value (mm)	Standard deviation
PBiw	Right	23.01	8.40	14.85	3.40
	Left	23.22	9.79	15.16	3.42
PBtl	Right	109.66	52.01	79.57	15.40
	Left	106.17	55.01	81.48	14.31
PBtw	Right	6.19	3.27	4.46	0.80
	Left	6.14	2.86	4.42	0.94

Note: PBiw: the widest part of the tendon of PB; PBtl: the tendon length from musculotendinous junction to the insertion; PBtw: the width of the PB tendon at its mid-point.

**Table 4**

(A) The classification for the tendon of the PB. (B) Summary of the classification of the tendon of the PB according to the insertional properties.

(A)				
TYPE		Right	Left	Total
I	Ia	10 (23.8%)	10 (23.8%)	20 (47.6%)
	Ib	3 (7.1%)	2 (4.8%)	5 (11.9%)
II	IIa	4 (9.5%)	3 (7.1%)	7 (16.7%)
	IIb	3 (7.1%)	2 (4.8%)	5 (11.9%)
III	IIIa	–	2 (4.8%)	2 (4.8%)
	IIIb	2 (4.8%)	1 (2.4%)	3 (7.1%)
42 (100%)				
(B)				
Type		Right	Total	Left
Tip I		13	12	25 (59.5%)
Tip II		7	5	12 (28.6%)
Tip III		2	3	5 (11.9%)
42 (100%)				

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