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TOPOGRAPHIC ANATOMY OF THE TIBIAL NERVE AND ITS TERMINAL BRANCHES IN RELATION TO THE POSTERIOR TARSAL TUNNEL

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ABSTRACT

The tibial nerve is one of the terminal branches of the sciatic nerve. It travels on the posterior aspect of the leg and terminates under the flexor retinaculum. Here it is present in an osseofibrous tunnel, in this tunnel it might be entrapped and the condition is known as known as tarsal tunnel syndrome[1]. In the present study, we will provide knowledge of the arrangement of structures in the tarsal tunnel and will also study the various points of termination of the tibial nerve.

INTRODUCTION

The Tibial nerve and its terminal branches are at risk of entrapment in the posterior tarsal tunnel.[1] The tibial nerve runs through the posterior tarsal tunnel, which is a narrow passageway inside the ankle that is bound by the calcaneum and flexor retinaculum.[1] Damage to the tibial nerve typically occurs when the nerve is compressed as a result of consistent pressure. This is known as tarsal tunnel syndrome.[1] In this, the patients may experience pain, numbness, or tingling sensation. This pain can be felt anywhere along the distribution of the tibial nerve. This can be sharp, shooting pain, pins and needles, an electric shock, or a burning sensation. Pain and other symptoms are often aggravated by physical activity.[9] But if the condition is long-standing, some people even experience pain or tingling at night or while resting. If tarsal tunnel syndrome is left untreated, it can result in permanent and irreversible nerve damage. In severe, long-term cases, a surgery called the tarsal tunnel release may be recommended.[3] During this procedure, the surgeon will make an incision from behind the ankle down to the arch of the foot. They will release the ligament, relieving the nerve. The results of surgeries for tarsal tunnel syndrome are variable because of the poor understanding of the detailed anatomy of the tarsal tunnel and potential sites of nerve compression. Information regarding the same can help in endoscopic decompression surgeries for tarsal tunnel syndrome with minimal exposure of the region to be operated.

Knowledge regarding these variations can also help anaesthetists give ultrasonography-guided ankle blocks without puncturing the blood vessels. Thus, in the present study, we observed the variations in the level of terminal branches.

MATERIAL AND METHODS

We performed our study in forty (20 right and 20 left) formalin-fixed adult cadaveric lower limbs, irrespective of sex, in the Department of Anatomy, IGMC Shimla, Himachal Pradesh, India. To expose the tarsal tunnel and structures within it, we followed the steps given in Cunningham's dissection manual. The flexor retinaculum was identified, divided at its anterior end, and reflected posteriorly to visualize the structures in the posterior tarsal tunnel. All the structures in the posterior tarsal tunnel were cleaned and photographed.

Figure No1: The Flexor Retinaculum.

Now the point of termination of the tibial nerve was identified and the distance between the reference line and the termination of the tibial nerve was noted.

The level of division of the tibial nerve was classified based on this line.
Type I, Bifurcations proximal to the reference line but in the tarsal tunnel i.e., within 2cm range.
Type II, Bifurcations at the level of the reference line.
Type III, Bifurcations distal to the reference line.

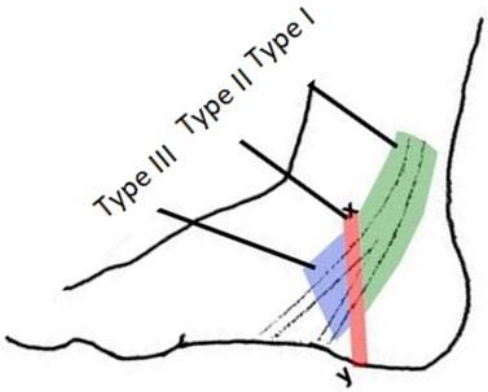


Figure No 2: Termination of Tibial Nerve & The Reference Point (Diagrammatic Presentation).

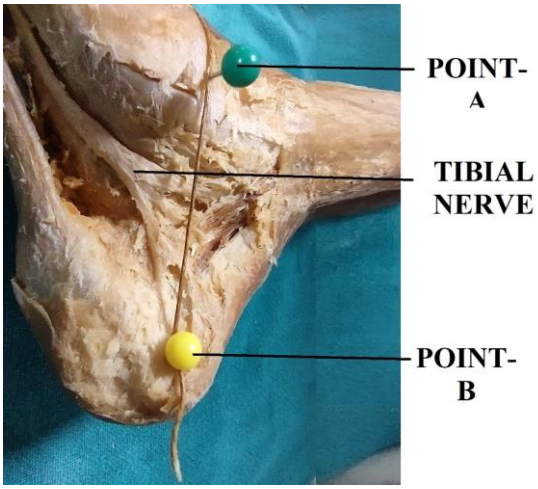
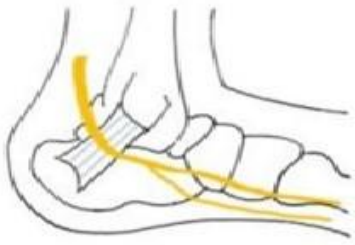


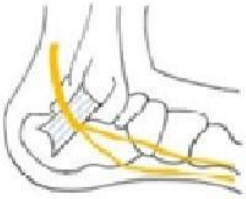
Figure No 3: Termination of Tibial Nerve and and The Reference Point.

Awari P et al[1] further divided Bilge O et al[4] classifications into seven types as follows:

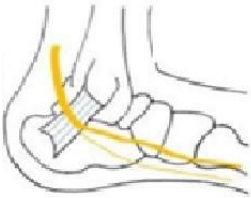
Type 1, Distal to the MMCA.



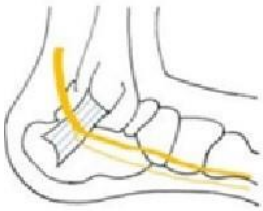
Type 2, At to the MMCA.



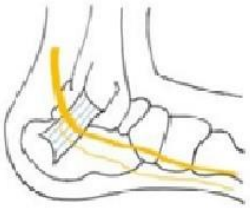
Type 3, Bifurcations 1mm to 5mm above (proximal) to the reference line.



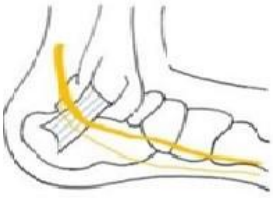
Type 4, Bifurcations 6mm to 10mm above (proximal) to the reference line.



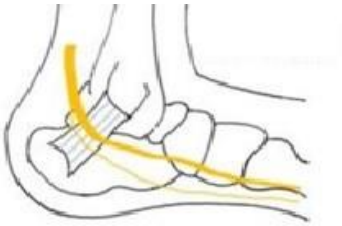
Type 5, Bifurcations 11mm to 15mm above (proximal) to the reference line.



Type 6, Bifurcations 16mm to 20mm above (proximal) to the reference line.



Type 7: Bifurcations 20mm above (proximal) to the reference line.



OBSERVATIONS AND RESULTS

We studied the location of the division of the tibial nerve in the posterior tarsal tunnel as per two classifications present in the literature:-

1) Classification by Bilge O et al[4]
2) Classification by Awari P, Vatsalaswamy P[1]

1) Classification given by Bilge O et al[4]

Table No. 1: Number of Cases of Different Types of Divisions of The Tibial Nerve, Classification By Bilge O Et Al.[4]

TYPE OF DIVISION	NUMBER OF CASES	TOTAL NO. OF CASES	PERCENTAGE
TYPE I	33	40	82.5%
TYPE II	5	40	12.5%
TYPE III	2	40	5%

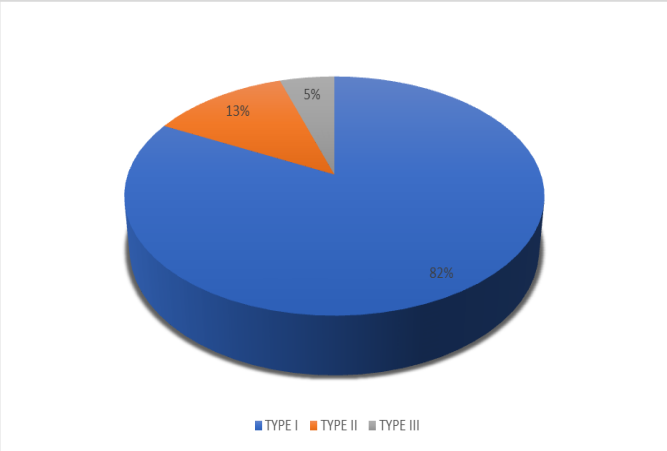


Figure No. 4: Pia Chart Showing Different Types Of Divisions Of Tibial Nerve, Classification By Bilge O Et Al.[4]

2) Classification given by Awari P, Vatsalaswamy P.[1]

Table NO2: Number of Cases of Different Types of Divisions of Tibial Nerve Classification By Awari P, Vatsalaswamy P[1]

Type of division	Numbers	Total no. of Cases	Percentage
1	1	40	2.5%
2	0	40	00%
3	7	40	17.5%
4	16	40	40%
5	9	40	22.5%
6	2	40	5.0%
7	5	40	12.5%

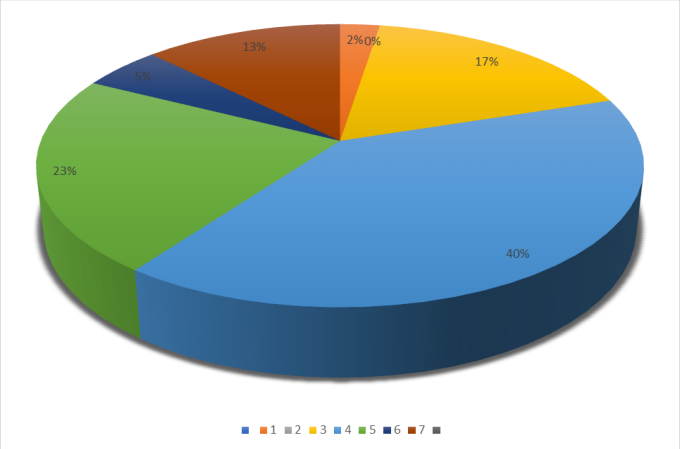


Figure No 5: Pia Chart Showing Different Types Of Divisions Of Tibial Nerve Classification By Awari P, Vatsalaswamy P.[1]

DISCUSSION

In the present study we were able to appreciate the flexor retinaculum but it was thinner than the flexor retinaculum in the hand. The tibial nerve fattening was seen at the point of terminal division and posterior tibial blood vessels were superficial to it in thirty-nine dissected specimens (in one specimen the posterior tibial vessels were absent). This might be the most common factor for the compression of the tibial nerve. Thick strands of fibrous tissue extending from under surface of flexor retinaculum to the bones forming medial wall of the tunnel were dividing the PTT in individual compartments for tendons and neurovascular bundle. The tibial nerve and the blood vessels were in the same compartment separated from the flexor tendons. Because of the unyielding nature of this fibrous tissue surrounding the neurovascular bundle; the tibial nerve becomes immobile and prone to traction injuries or compression by space occupying lesions.

We studied the site of division of the tibial nerve in the posterior tarsal tunnel as per two classifications present in literature: -

1) Classification by Bilge O et al.[4]
2) Classification by Awari P, Vatsalaswamy P.[1]

1) Classification by Bilge O et al[4]: We followed the method of Bilge O et al to study and classify the location of division of the tibial nerve in the posterior tarsal tunnel. Bilge O et al[4] used a reference line extending from the tip of medial malleolus (MM) to medial tubercle of calcaneum (C) called as 'Medio- Malleolar Calcaneal axis' (MMC axis) to classify the site of division of tibial nerve into three types.

Type I Division proximal to the reference line but in the tarsal tunnel, Type II Division at the line and Type III Division distal to the posterior tarsal tunnel, type IV for the nerve dividing above the flexor retinaculum i.e., 2cm or more proximal to MMCA.

We took the mid -point of 'Medio- Malleolar Calcaneal axis' (MMC axis) as reference line with the help of non-stretchable thread. Then identified the termination of tibial nerve in relation to this reference line. We measured the distance between the reference line and the point of termination of tibial nerve. All the measurements were taken with the help of vernier clipper in millimetres. During dissection of forty embalmed lower limbs (twenty right and twenty left) we found 33 limbs (82.5%) showed Type I, 5 limbs (12.5%) showed Type II and 2 limbs (5%) limbs showed Type III division of tibial nerve in posterior tarsal tunnel.

All the previous studies on the topography of tibial nerve and its terminations show that Type I and II are the most common types. There were approximately 10% cases of Type IV where the division is proximal to flexor retinaculum. In the study by Louisia et al (1999)[5] on French population, 27% of specimens showed Type IV division. This discrepancy can be explained by small sample size. The branching of tibial nerve distal to the reference line is very rare. Most of the authors did not find any case. However, Bilge O et al (2003)[4], Joshi et al (2006)[6] and Fernandes et al (2006)[7]observed few cases. In our study also 5% specimen showed Type III branching.

Our findings are more or less same as those described in literature i.e. most common type is I and type II. The knowledge about the site of terminal division of tibial nerve within the tarsal tunnel is important for surgeons and orthopaedics while performing the surgical procedures in the area of flexor retinaculum of lower limb, to avoid the injury to tibial nerve. Our study will provide the knowledge of variations of terminal divisions of tibial nerve in posterior tarsal tunnel in Himachali polulation.

Table no 3: Comparison of Percentage of Feet Showing Various Types of Division of Tibial Nerve In Posterior Tarsal Tunnel Amongst Various Studies.

Sr. no.	Authors	No. of cases	Ethnic groups	Bifurcation in PTT	Bifurcation distal to PTT	Bifurcation proximal to PTT
				Type I (<2 cm proximal to the reference line and Type II (at the line)	Type III (Distal to the posterior tarsal tunnel)	Type IV (Dividing above the flexor retinaculum)
01	Horwitz et (1938)[8]	100	New York (American population)	96%	---	4%
02	Dellon et al (1984)[9]	31	(American population)	94%	---	6%
03	Davis et al (1995)[10]	20	Maryland (American population)	90%	---	10%
04	Louisia et al (1999)[5]	15	French Population	73%	---	27%
05	Heimkes et al	60	Germany	100%	---	---

	(1987)[11]					
06	Havel et al. (1988)[12]	68	Tolado, Ohis (American population)	93%	---	7%
07	Ndiaye et al. (2003)[13]	20	Senegal, West Africa	90%	---	10%
08	Bilge O et al (2003)[4]	50	Turkish Population	96%	4%	---
09	Joshi et al (2006)[14]	112	Indian population	99.90%	0.89%	---
10	Fernandes at al (2006)[7]	30	Brazilian Population	86.70%	3.30%	10%
11	Torres at al (2012)[15]	18	Brazilian Population	88%	---	12%
12	Alvaro Iborra et al (2012)[16]	24	Portugal	91.70%	---	8.30%
13	Present study	40	Himachali Population (Indian Population)	95%	5%	---

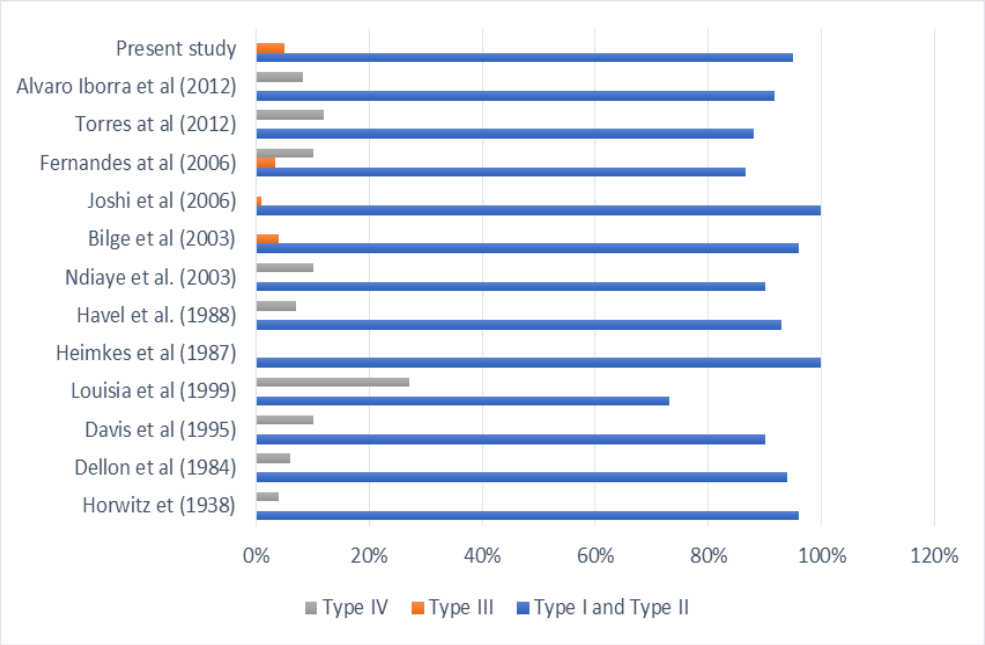


Figure No 6: Comparison of Percentage of Feet Showing Various Types of Division of Tibial Nerve In Posterior Tarsal Tunnel Amongst Various Studies.

2) Classification given by Awari P, Vatsalaswamy P[1]: - Further the same findings were classified into seven categories as per classification by Awari P, Vatsalaswamy P[1].

Table No 4: Categories and Types of Termination Division of Tibial Nerve.

Category by Awari P, Vatsalaswamy P[1]		**Equivalent types by Bilge O et al[7]**
Type	**Location of terminal division of TN in relation to MMCA**	
Type I	Distal to the MMCA	Type III
Type II	At the MMCA	Type II
Type III	Above the MMCA	Type I
Type IV		
Type V		
Type VI		
Type VII	More than 20mm above MMCA	Type IV

Out of forty embalmed cadavers (twenty right and twenty left) dissected specimens we found 1 (2.5%) Type I, 00 (00%) Type II, 7(17.5%) Type III, 16(40%) Type IV, 9 (22.5%) Type V, 2 (5%) Type VI and 5(12.5%) Type VII.

I was unable to find more about this classification in literature. So, I am comparing my results with Awari P et[1] study in Indian population. Most common site of division is 6-10 mm above MMCA followed by 11-15 mm. So, it can be concluded that the division of tibial nerve into medial & planter nerve occurs in the PTT under the flexor retinaculum.

The branching above the flexor retinaculum was compared to the cases seen by Awari P et al[1] and Type III is rare in both classifications. Entrapment of tibial nerve in PTT is very common. Knowledge about common and rare levels of terminal division of tibial nerve may help the surgeons to localize tibial nerve and its branches precisely for endoscopic release with minimal handling of surrounding structures.

CONCLUSION

The present study will be of great clinical importance for surgeons as well as for patients to decrease morbidity.

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