

Variations in the origin and number of medial calcaneal nerve

Sharma S¹, Khullar M², Bhardwaj S³

¹Dr Sherry Sharma
Associate Prof, Dept of Anatomy,
Punjab Institute of Medical
Sciences, Jalandhar
²Dr Meenakshi Khullar
Asst Prof, Dept of Anatomy,
Guru Gobind Singh Medical
College, Faridkot
meenakshikhullar8@gmail.com
³Dr (Major) Sunil Bhardwaj
Medical Officer, PHC Thariewal
Block Majitha, Distt Amritsar
bhardwajsunil123@gmail.com

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Correspondence to:

Dr Sherry Sharma
bhardwajsherry2@gmail.com
09872830406

ABSTRACT

Variations of nerve are of anatomical, embryological and clinical importance. There adequate knowledge will help in increasing surgical precision and decreasing morbidity. In present study, the variation in the origin and number of medial calcaneal nerve (MCN) was studied. The material for present study comprised of 60 lower extremities belonging to 30 adult human cadavers obtained from department of Anatomy, GMC Amritsar. In the present study, number of MCN is highly variable. 1 MCN innervated 35%, 2 MCN innervated 40%, 3 MCN innervated 15%, 4 MCN innervated 8.3%, 5 MCN innervated 1.67%.

There were total 121 medial calcaneal nerves found in the present study. MCN originated from tibial nerve in 57 instances (47.10%), from bifurcation of tibial nerve in 30 (24.79%), from lateral plantar nerve in 32 (26.44%) and from medial plantar nerve in 2 instances (1.65%). Description of variation of origin of medial calcaneal nerve in medial aspect of calcaneus is required to establish an anatomical guide for diagnosis and therapy of some tarsal region diseases including tarsal tunnel syndrome, fixation of fracture with external nailing, medial displacement osteotomy and nerve block in podiatric medicine.

Key Words: Medial calcaneal nerve, tibial nerve, variations, tarsal tunnel syndrome, calcaneus, podiatric medicine

Introduction

Entrapment of the medial heel region nerves is often mentioned as a possible cause of heel pain. Knowledge of the innervation of medial heel region is not only important for diagnosis of heel pain but also for tarsal tunnel syndrome, soft tissue and bony ankle injury and secondary heel pain due to neuroma. Knowledge of fine anatomy of calcaneal nerve is necessary to ensure safe surgical intervention in medial heel region such as heel spur fracture, calcaneal stress fracture, plantar fasciitis and bursitis. Also decompression of tarsal tunnel can restore sensation to diabetic feet. Since the entrapment of medial heel region nerve is often mentioned as a possible cause of heel pain, surgical

compression of calcaneal nerve is used to treat recalcitrant heel pain.^[1]

This nerve most often innervates the skin of the posteromedial arch, where it is at risk for injury during calcaneal spur removal or plantar fasciotomy. Knowledge of the variations in location of the medial calcaneal nerves may prevent neuroma formation during surgery and provide insight into the variability of heel symptoms associated with tarsal tunnel syndrome.^[2] We have taken this topic for study as very little work has been done on this topic in North Indian cadavers.

Materials and methods

The material for the present study comprised of 60 lower extremities belonging to 30 (well embalmed) adult human cadavers of known sex obtained

from the Department of Anatomy, Government Medical College, Amritsar. The cadavers were serialized from 1 to 30 with suffix 'M' for male or 'F' for female and 'R' for right or 'L' for left. The tibial nerve and its branches were exposed as per the dissection steps provided by Cunningham's Manual of Practical Anatomy.^[3]

Vertical incision was made on the back of leg extending from lower angle of popliteal fossa to the heel and a transverse incision was made through the skin on distal part of heel. The incision was carried along the borders of foot. Skin and superficial fascia were stripped upward from back of leg and the terminal part of sural nerve was traced till tip of little toe. Small medial calcaneal nerves were found as skin was removed from medial side of

heel. The origin and possible multiplicity of calcaneal nerves was also noted.

Results

The first branch from the tibial nerve at the ankle is medial calcaneal nerve, which has numerous anatomic variations.^[4] It provides sensory innervations to most of the heel pad and to superficial tissue overlying inferior aspect of calcaneus.^[1]

In the present study, the number of medial calcaneal nerve is highly variable (Table: 1)

- 1 MCN innervated 21 limbs i.e. 35.00% cases.
- 2 MCN innervated 24 limbs i.e. 40.00% cases.
- 3 MCN innervated 9 limbs i.e. 15.00% cases.
- 4 MCN innervated 5 limbs i.e. 08.30% cases.
- 5 MCN innervated 1 limb i.e. 01.67% cases.

Table: 1 Percentage distribution of no. of medial calcaneal nerves

No. of nerves	No. of limbs with particular no. of Ns. [n (%)]		
	Right 30(100%)	Left 30(100%)	Total 60(100%)
1	11(36.67%)	10(33.33%)	21(35.00%)
2	12(40.00%)	12(40.00%)	24(40.00%)
3	04(13.33%)	05(16.67%)	09(15.00%)
4	02(06.67%)	03(10.00%)	05(08.33%)
5	01(03.33%)	-	01(01.67%)

An interesting variation was found in one instance. One heel was found to be innervated by 5 medial calcaneal nerves. Such a variation is not found in available literature. (Fig. 2)

Origin of the medial calcaneal nerve was highly variable. There were total 121 medial calcaneal nerves found in the present study. MCN originated from tibial nerve in 57 instances (47.10%), from bifurcation of tibial nerve in 30 (24.79%) (Fig. 1), from lateral plantar nerve in 32

(26.44%) and from medial plantar nerve in 2 instances (1.65%) (Fig. 3, Table: 2)

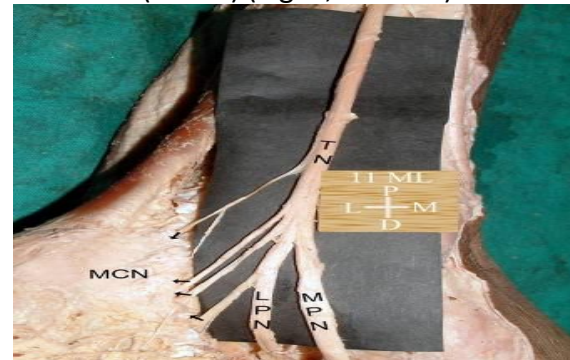


Fig. 1 – 04 MCNs, 01 from TN, 02 from bifurcation of TN and 01 from LPN

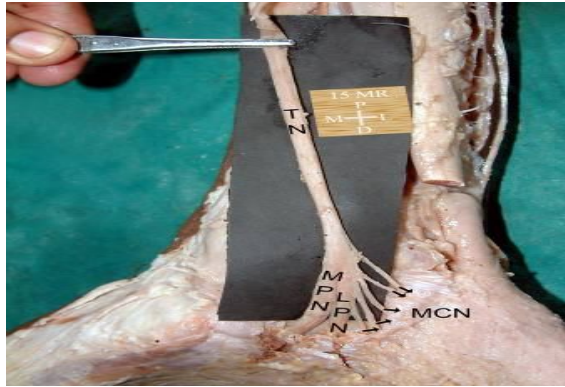


Fig.2 – 05 MCNs, 01 from TN, 02 from bifurcation of TN and 02 from LPN

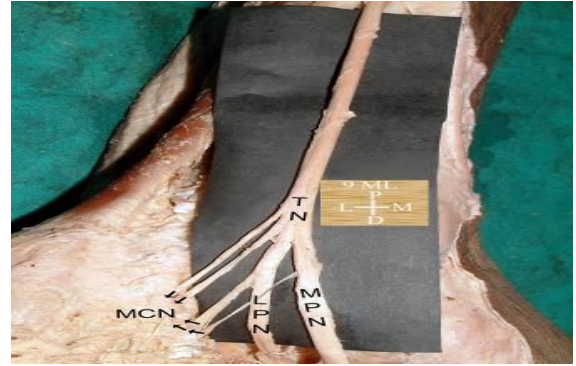


Fig.3 – 04 MCNs, 02 from bifurcation of TN, 01 from LPN and 01 from MPN

TN–Tibial Nerve, MCN–Medial Calcaneal Nerve
LPN–Lateral Plantar Nerve, MPN–Medial Plantar Nerve

Table: 2 Incidence of no. and origin of medial calcaneal nerves

Limb no.	No. of nerves	Right		Left	
		No.	Origin	No.	Origin
8,10,12,16,18,24,26,28, 29,30,9(right)	1	1	TN	1	TN
4,13,17,19,22,23	2	1	TN	1	TN
		1	B	1	B
1,6,20,21,25,27	2	1	TN	1	TN
		1	LPN	1	LPN
3,5(left),7,14	3	1	B	1	TN
		2	LPN	1	B
				1	LPN
5(right), 15(left)	3	2	LPN	1	TN
		1	MPN	1	B
				1	MPN
9(left)	4	-	-	2	TN
				1	B
				1	LPN
2,11	4	1	TN	1	TN
		2	B	2	B
		1	LPN	1	LPN
15(right)	5	1	TN	-	-
		1	B		
		3	LPN		

TN= Tibial Nerve

LPN= Lateral plantar nerve

B= Bifurcation of tibial nerve

MPN= Medial plantar nerve

Table: 3 Comparison of no. of medial calcaneal nerves (MCNs)

Author	Year	No. of limbs studied	No. of limbs with particular no. of MCNs.				
			1*	2*	3*	4*	5*
Dellon and Mackinnon ⁷	1984	-	(37%)	(41%)	(19%)	(3%)	-
Louisia and Masquelet ⁵	1999	15	2(13.33%)	9(60%)	2(13.33%)	2(13.3%)	-
Figen and Govsa ¹	2006	50	19(38%)	23(46%)	6(12%)	2(04%)	-
Present Study	2015	60	21(35%)	24(40%)	9(15%)	5(8.3%)	1(1.6%)

*1, 2, 3, 4, 5–No. of Medial Calcaneal Nerves i.e. 1 MCN, 2 MCNs, 3 MCNs, 4 MCNs, 5 MCNs

Discussion

The medial calcaneal nerve has not been greatly studied and none of its branches have been accurately described.^[5] Park and Del^[6] described 1 principal trunk for medial calcaneal nerve in 71% and 2 trunks in 29% limbs. Louisia and Masquelet^[5] demonstrated that 64% of feet that had surgery to decompress tarsal tunnel would have more than 1 origin for medial calcaneal nerve. (Table: 3) In the present study, the result is in near perfect consonance with previous studies.

Didia^[8] studied 16 cadavers and found that medial calcaneal nerve arose from tibial nerve in 62.5%, from bifurcation of tibial nerve in 18.75% and from lateral plantar nerve in 18.75%. He reported the same variability concerning point of emergence of medial calcaneal nerve and same constancy concerning distribution of branches to skin of medial and plantar aspects of heel.

Park and Del^[6] studied 14 feet and found that medial calcaneal nerve arose from tibial nerve in 58%, from division of tibial nerve in 21% and from lateral plantar nerve in 21% limbs. He confirmed that there was a constant distribution of the terminal branches of the medial calcaneal nerve and that this distribution was superficial. This

allows specific electrophysiological study of the medial calcaneal nerve. Govsa^[1] found that the medial calcaneal nerve originated from the tibial nerve in 11 out of 50; from the lateral plantar nerve and tibial nerve in 9 out of 50; from tibial nerve and medial plantar nerve in 6 out of 50; from lateral plantar nerve in 7 out of 50 and from tibial nerve, medial plantar and lateral plantar nerve in 6 out of 50 limbs.

Origin of the medial calcaneal nerve was highly variable. There were total 121 medial calcaneal nerves found in the present study. MCN originated from tibial nerve in 57 instances (47.10%), from bifurcation of tibial nerve in 30 (24.79%), from lateral plantar nerve in 32 (26.44%) and from medial plantar nerve in 2 instances (1.65%). (Table: 4) If the medial calcaneal nerve is entrapped in tarsal tunnel, the symptoms are localized to heel. These symptoms are classically aggravated by a variety of activities such as prolonged standing or walking and are relieved by rest and removal of shoes. In 35% to 40% of cases of tarsal tunnel syndrome, the calcaneal nerve is spared because it branches proximal to tarsal tunnel and runs superficial to flexor retinaculum, innervating sensation to heel. Isolated calcaneal neuropathy is rare.^[4]

Table: 4 Comparison of mode of origin of medial calcaneal nerve

Author	Year	No. of nerves found	No. of nerves with particular mode of origin [n (%)]			
			Tibial Nerve	Bifurcation of tibial nerve	Lateral plantar nerve	Medial plantar nerve
Didia ⁸	1990	32	20(62.50%)	06(18.75%)	06(18.75%)	-
Park and Del ⁶	1995	14	08(57.14%)	03(21.43%)	03(21.43%)	-
Lousia and Masquelet ⁵	1999	15	10(66.67%)	02(13.33%)	03(20.00%)	-
Present Study	2015	121	57(47.10%)	30(24.79%)	32(26.44%)	2(1.65%)

NSAIDs, shock absorbing heel cups, medial longitudinal arch supports, gastrocnemius stretching exercises, more appropriate shoe ware, alternative training routines in athletes and local steroid injections have been effective. The calcaneal nerves are at risk on the medial side during calcaneal osteotomy. Safe incisions can be suggested for surgical approaches to ankle fractures, retro-calcaneal bursitis, and correction of Achilles tendon rupture. The surgeon should be aware when operating on medial side of heel and careful dissection is mandatory. Completion of clinical process must be performed in a carefully controlled manner to reduce the risk of damage to medial calcaneal nerves and potential postoperative complications including pain, numbness and hematoma formation.^[1]

According to Ahuja and Thapa,^[9] patients having Plantar Fasciitis responded to treatment with MCN block at its origin. Cases of relapse respond to MCN block at its origin followed with Pulsed Radio Frequency (PRF). The case still having persistence of mild pain on follow up could be due to additional MCN nerves in the heel which were spared during block placement.

Conclusion

The medial calcaneal nerve has not been greatly studied and none of its branches have been accurately described. In our dissections, the rate of occurrence of medial calcaneal nerve in medial heel was 100%. In the present study, the result is in near perfect consonance with previous studies. One heel was found to be innervated by 5 medial calcaneal nerves. Such a variation is not found in available literature. In present study medial calcaneal nerve arose mostly from tibial nerve which is comparable to previous studies.

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