

Morphological Study of Variations in Higher Division of Sciatic Nerve and its Relation to Piriformis Muscle.

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ABSTRACT

The sciatic nerve is the branch of sacral plexus. It usually appears in the gluteal region below piriformis muscle. It divides into tibial and common peroneal nerve at the apex of popliteal fossa. The higher division of sciatic nerve and its variant relation to piriformis muscle has challenging role in clinical diagnosis and treatment, in sciatica and other complaints of hip regions. The aim of study was to detect the possible variations in higher divisions of sciatic nerve in relation to piriformis muscle. The study was carried out on 104 lower limbs of 52 embalmed adult human cadavers (46 males and 6 females) which were used for routine undergraduate dissection in the department of anatomy, RMC, Loni. The higher division of sciatic nerve and relationship to piriformis muscle are classified according to Beaton and Anson classification. The normal relationship between piriformis and sciatic nerve i.e. Type1 as per Beaton and Anson classification was observed in 94 limbs (90.40%) and variations in 10 limbs (9.60%). The most common variation was Type 2 i.e. division of nerve between and below the undivided piriformis muscle was in 5 limbs (4.80%). In one limb instead of tibial nerve, five roots of tibial nerve emerge below piriformis muscle and further join to form tibial nerve. Accessory bellies of piriformis were observed in 4 limbs. The study might help in diagnostic and therapeutic medical practices of orthopedic, radiology, physiotherapy, anesthesia etc.

Key words: *Sciatica, tibial nerve, common peroneal nerve, gluteal region, piriformis syndrome.*

Introduction:

Sciatic nerve is the thickest nerve in the body. Its formation is in pelvic cavity by joining of tibial and common peroneal component. It passes through greater sciatic foramen into gluteal region below piriformis muscle. It divides into tibial and common peroneal nerve at a variable level. The most common is at the superior angle of popliteal fossa. Rarely in the pelvic cavity or in the gluteal region or in the lower part of popliteal fossa [1].

Piriformis, the key muscle of the gluteal region originates from the pelvic surface of the sacrum from 2nd to 4th sacral segments [1] Beaton and Anson classified the relationship between piriformis and sciatic nerve in six categories, in which one shows normal relationship and other five are considered as anomalous category [2].

Knowledge of variations of sciatic nerve and its variant relation to piriformis is important during surgical procedures in gluteal regions to minimize the injuries to the nerves in this region [3]. Also, variation of sciatic nerve may contribute to piriformis syndrome, sciatica [4].

Material and methods:

Sample size: sample size was determined by OpenEpi software at 95% confidence level, the calculated sample size was 43.

(Source: Results from OpenEpi, Version 3, open source calculator--SSPropor)

The study was carried out on 104 Gluteal regions of 52 embalmed adult human cadavers (46 males and 6 females) which were used for routine undergraduate dissection in the department of anatomy, RMC, Loni after permission of institutional ethical committee. The gluteal regions were dissected by reflection of skin and superficial fascia and gluteus maximus muscle. Piriformis muscle, sciatic nerve, obturator internus with two gemelli, quadratus femoris muscle were identified and fascia over it was removed for proper visualization of sciatic nerve. The exit of sciatic nerve from pelvis and its entire course was observed for any variations, and its relation to piriformis muscle were noted. According to Beton and Anson classification, the percentages of anomalous relationship of piriformis and sciatic nerve were noted and compared with previous studies.

Results and discussion: In present study, out of 52 cadavers, we observed variations of sciatic nerve in 7 cadavers (5 males and 2 females). In three cadavers' variations are bilateral and in remaining four cadavers they are unilateral.

Table no 1: showing number of limbs having normal pattern of sciatic nerve and variations with percentage.

	Male 46 cadavers (92 limbs)			Female 6 cadavers (12 limbs)			Total cadavers 52 (104 limbs)		
	Normal	Variations		Normal	Variations		Normal	Variations	
		Right	Left		Right	Left		Right	Left
Number of limbs	86	3	3	8	2	2	94	5	5
Percentage	93.48%	3.26%	3.26%	66.66%	16.67%	16.67%	90.40%	4.80%	4.80%

In one male cadaver (no 8), bilateral sciatic nerve variation, with separate both tibial and common peroneal nerve throughout their course with split piriformis muscle were observed. The common peroneal nerve passes between the split piriformis muscle and the tibial nerve passes below the muscle (Fig. 1&2).

In one female cadaver(no.13), bilateral variations with common peroneal passing above and tibial nerve passing below the piriformis were observed. Both tibial and common peroneal joins to form sciatic nerve at upper part of thigh and again bifurcate at the superior angle of popliteal fossa (Fig.3).

In another female cadaver (no. 34) bilateral variations of sciatic nerve with two bellies of piriformis muscle were found. On left side, origin of sup belly of piriformis was fleshy with insertion in the form of tendon and inferior belly origin was musculotendinous with insertion in the fleshy muscle form. Here common peroneal nerve emerges between the two bellies of piriformis and then passes through the inferior belly of piriformis between the fleshy and tendinous part and tibial nerve passes below the inferior belly (Fig. 4).

On right side, both bellies of piriformis with fleshy origin and tendinous insertions were seen. Here the common peroneal nerve passes between the two bellies, but instead of tibial nerve, five roots of the tibial nerve emerge below the piriformis and join to form tibial nerve in the gluteal region (Fig.5). On both sides formation of sciatic nerve in the gluteal region and bifurcation at the apex of popliteal fossa were found.

In four male cadavers, unilateral variation (in two on right and in two on the left side) were observed. Out of that in three, sciatic nerve formation was in the gluteal region and in one it was in the upper part of thigh region but in all, bifurcation was at the level of apex of popliteal fossa. In one cadaver on right side two bellies of piriformis muscle and superior belly merges with gluteus medius muscle (Fig. 6), In another cadaver, three bellies of piriformis were observed where common peroneal nerve passes above the lowermost belly and tibial nerve passes below that belly (Fig.7)

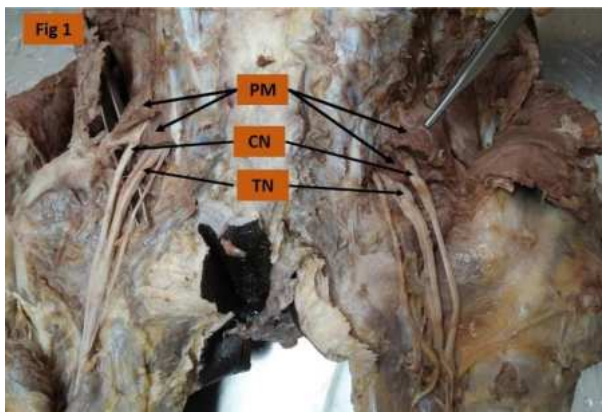


Fig.1: Male cadaver showing bilateral variation. Splitted piriformis muscle. Separate common peroneal and tibial nerve throughout their course. TN-Tibial nerve, CN-common peroneal nerve, PM- Piriformis muscle.

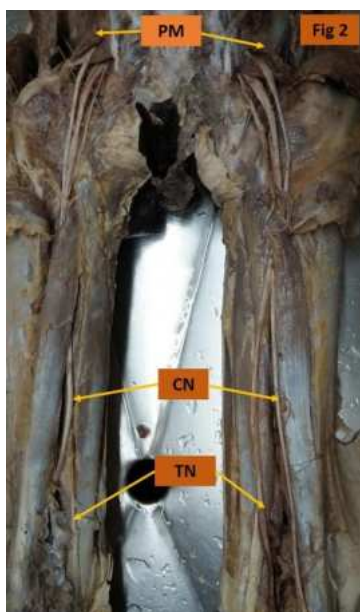


Fig.2: Male cadaver showing bilateral variation. , PM- Piriformis muscle(Splitted). Separate common peroneal(CN) and tibial nerve(TN) through out their course.

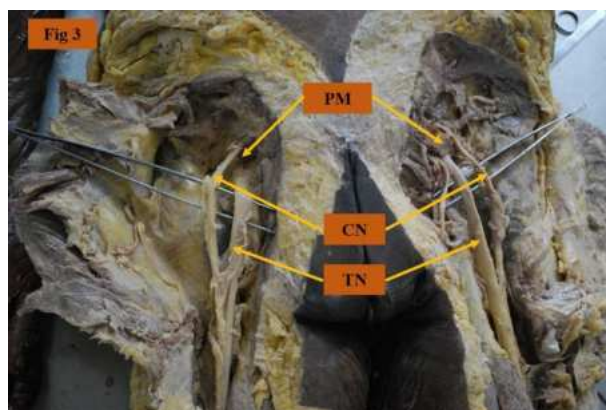


Fig.3: Female cadaver showing bilateral variation. Common peroneal passing above piriformis and tibial nerve below the piriformis. TN-Tibial nerve, CN-common peroneal nerve, PM- Piriformis muscle. SN- Sciatic nerve.

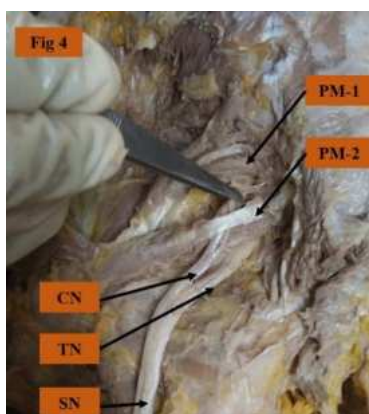


Fig.4: Female cadaver, left gluteal region showing two bellies of piriformis. Superior belly origin fleshy and insertion in the form of tendon and inferior belly origin musculotendinous and insertion in the form of muscle. Common peroneal nerve emerging above inferior belly and passes between the tendinous and fleshy part of inferior belly. Tibial nerve passes below inferior belly. TN-Tibial nerve, CN-common peroneal nerve, PM-1- Piriformis superior belly, PM-2- Piriformis inferior belly, SN- Sciatic nerve.

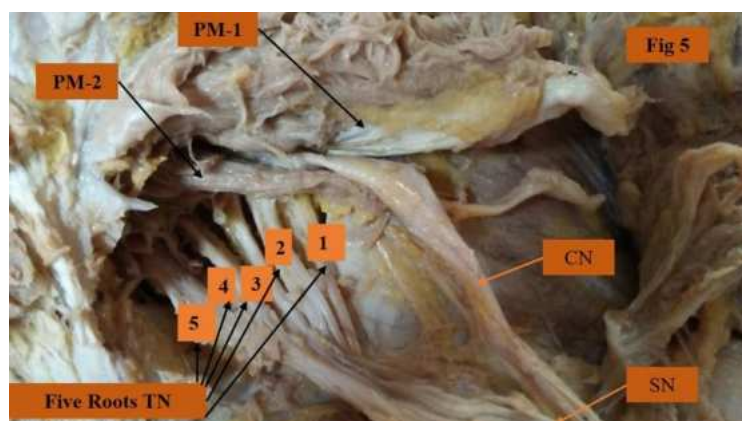


Fig.5: Female cadaver, Right gluteal region showing two bellies of piriformis cut at insertion. Origin fleshy and insertion in the form of tendon. Common peroneal nerve emerging above inferior belly and instead of tibial, five roots of tibial nerve emerging below the inferior belly of Piriformis. TN-Tibial nerve, CN-common peroneal nerve, PM-1- superior belly of Piriformis muscle, PM-2- inferior belly of piriformis, SN- Sciatic nerve.

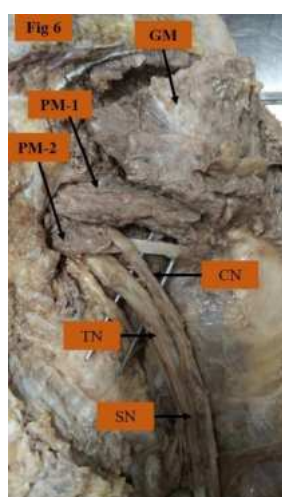


Fig.6: Male cadaver, Right gluteal region showing two bellies of piriformis. Superior belly fleshy and merges with gluteus medius, Inferior belly origin fleshy and insertion in the form of tendon. Common peroneal and tibial nerve passing above and below the inferior belly respectively TN-Tibial nerve, CN-common peroneal nerve, PM-1- superior belly of Piriformis muscle, PM-2- inferior belly of piriformis. GM- Gluteus Medius, SN- Sciatic nerve.

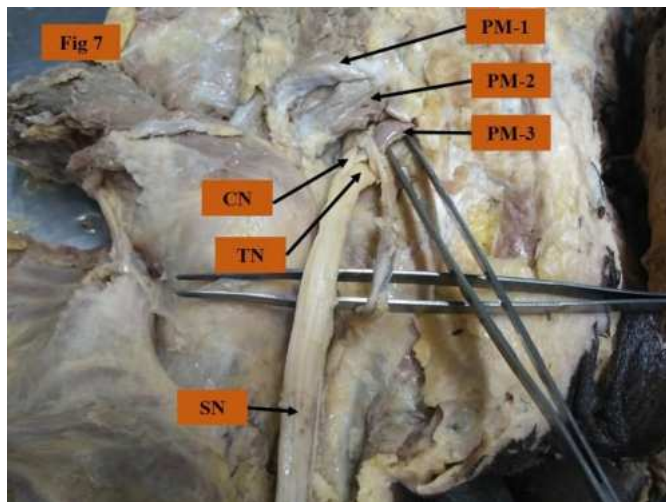


Fig.7: Male cadaver, Left gluteal region showing three bellies of piriformis.. Common peroneal and tibial nerve passing above and below the inferior belly respectively TN-Tibial nerve, CN-common peroneal nerve, SN- Sciatic nerve, PM-1- superior belly of Piriformis muscle, PM-2- Middle belly of piriformis, PM3- Inferior belly of piriformis.

Sciatic nerve divides into common peroneal and tibial nerve at the superior angle of popliteal fossa. The different anomalous variations of both piriformis muscle and sciatic nerve and also the variable relationship between them, may lead to compression of sciatic nerve due to entrapment which further may lead to piriformis syndrome [5]

Table no 2: Percentage of various relationship between sciatic nerve and piriformis muscle according to Beaton and Anson classification

Name of the researcher	Type 1 Normal pattern Undivided nerve below undivided muscle.	Type 2 Divisions of nerve between and below undivided muscle.	Type 3 Divisions above and below undivided muscle.	Type 4 Undivided nerve between the heads.	Type 5 Divisions between and above the muscle.	Type 6 Undivided nerve above undivided muscle.	Other than Beaton and Anson classification
Beaton & Anson [2] (1937)	84.20%	11.70%	3.30%	0.80%			
Beaton & Anson [6] (1938)	90%	7.10%	2.10%	0.80%			
Uluutku & Kurtoglu [7] (1999)	74%	16%	10%				
Pokorny et al. [8] (2006)	79.10%	14.3%	4.40%	2.20%			
Güvençer M et al. [9] (2009)	52%	16%	8%				
Patel S et al. [11] (2011)	91.80%	11.1%	2.23%				
Saritha S et al. [11](2012)	92.00%	2%	2%				
Adibani M. [5] (2014)	92%	2%	2%				4%
Present study	90.40%	4.80%	1.92%				2.88%

Table no 3: Total percentage of normal and anomalous relation of sciatic nerve and piriformis muscle.

Researchers	Total number of limbs	Normal pattern (%)	Variations	
			Unilateral(%)	Bilateral(%)
Singh AK. [12] (2011)	100	96% (96)	2%	2%
Sanitha S. [11] (2012)	50	94%	6%	-
Adibatti M [5] (2014)	50	92%	4 %	4%
Sangram S. [13] (2015)	50	82%	10%	8%
Anbumani T.L. [14] (2013)	50	90%	6%	4%
Sukre and Badaam. [15] (2016)	60	83.33%	16.67	-
Jha and Baral. [16] (2020)	40	92.5%	7.5%	-
Present study	104	90.40%	3.84%	5.76%

Patel S et al. in 2011 studied the variation in high division of sciatic nerve and its relation to piriformis muscle in 43 cadavers (86 lower extremities) and observed higher division of sciatic nerve in 7 (8.14%) lower limbs. In two extremities, sciatic nerve divides in the pelvic cavity and tibial and common peroneal comes out separately below piriformis muscles and in 5, sciatic nerve divides in pelvic cavity but common peroneal exit by piercing piriformis and tibial passes below the piriformis muscle [10].

Subnis As in 2012 studied the variations in bifurcation of sciatic nerves in 70 embalmed cadavers and observed bifurcation at lower level in 90.7% and higher division in 9.28% lower limbs. In one case they found rare variation in which common peroneal nerve exit the pelvis by piercing the obturator internus and tibial exit below gemellus inferior muscle [17]. Present study observed division of sciatic nerve at higher level in 9.60%.

Sangram S et al. (2015) studied the bifurcation of sciatic nerve in 50 lower limbs and observed percentage of higher division of sciatic nerve in pelvic cavity and in gluteal region were 14% and 4% respectively. They mentioned that variation of sciatic nerve bifurcation has clinical importance in hip surgeries, intramuscular injections in gluteal regions. As variant relations of sciatic nerve and piriformis muscle are responsible for soft tissue problems in hip region mostly in the athletes, its study may contribute in sports rehabilitation and medicine [13].

Huq E and Bailie P in 2017 observed the variation of sciatic nerve not mentioned in Beaton and Anson classification. They observed higher division of sciatic nerve in the pelvic cavity and common peroneal nerve emerges below the piriformis muscle as normal pattern but tibial nerve emerges below the superior gemellus [18]. Similar variation was also observed in previous studies like Babinski et al., Ogeng'o et al, Paval and Nayak, Mas et al [4,19-21].

Patil J. et al. during dissection observed the ventral and dorsal divisions of lumbo- sacral plexus forming common peroneal and tibial nerve, passing ventral and dorsal to piriformis muscle respectively in the gluteal region. Both nerves join to form sciatic nerve in the distal part of gluteal region. They mentioned that such low formation of sciatic nerve may lead to non-discogenic sciatica or piriformis syndrome [22].

In present study we observed formation of tibial nerve in the gluteal region (Fig.5) by joining five roots below inferior belly of piriformis and common peroneal emerging above the inferior belly and sciatic nerve formation was in the gluteal region.

Piriformis syndrome is the entrapment neuropathy as a result of compression of sciatic nerve due to abnormal conditions of the piriformis muscle such as inflammation, spasm, hypertrophy, contracture or anatomic variations. One of the anatomic variations is presence of accessory piriformis muscle [23, 24].

Kim et al in 2019 with the help of magnetic resonance imaging reported the case of piriformis syndrome which was developed as a result of incidence of accessory belly of piriformis muscle originating from proximal third part of main piriformis muscle. Here accessory belly separately get inserted on the greater trochanter inferior to insertion of main piriformis muscle [25].

Piriformis syndrome may be caused by secondary adhesion of the nerve to surrounding tissue or piriformis muscle. The persons suffering from piriformis syndrome present buttock pain which may radiate along posterior aspect of thigh region, rarely having muscle weakness or numbness [26,27].

Present study observed variations in piriformis muscle. We observed bilateral splitted piriformis and common peroneal nerve passing through it (fig.1), in one cadaver two bellies of with superior belly muscular and merging with gluteus medius muscle(fig.6), in one female cadaver two bellies of piriformis bilaterally (Fig 4&5) and on left side(Fig. 4) common peroneal emerges above the inferior belly and then passes between the tendinous and muscular part of inferior belly. In such condition there may be chances of entrapment of the nerve. In one cadaver we observed the three bellies of the piriformis muscle (Fig.7).

Ravindranath Y et al reported the presence of accessory head of piriformis in 3 adult male cadavers. In two cases this accessory belly arises from Sacro tuberos ligament and in one both from Sacro tuberos ligament and the fascia overlying it. According to them, in case of undiagnosed pain in gluteal region, possibility of accessory slip of piriformis may be considered as one of the causes. In such cases MRI and CT may be helpful for confirmation of the diagnosis [28].

Conclusion:

In present study, we observed variation in division of sciatic nerve and its variant relation to piriformis muscle in 10 (9.60%) limbs. Variations of sciatic nerve are frequent, so its knowledge is essential for physicians and surgeons in understanding the pathophysiology of buttock pain. In cases of higher division of sciatic nerve, there are more chances of nerve damage during intramuscular injections in gluteal region. The knowledge of higher division of sciatic nerve and its variant relation to piriformis muscle also helps in early diagnosis and treatment of sciatic nerve entrapment.

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