Journal of the Anatomical Society of India 65 (2016) S46–S49

Contents lists available at ScienceDirect

Journal of the Anatomical Society of India

journal homepage: www.elsevier.com/locate/jasi

Original Article

Variations in the level of exit and division of sciatic nerve

Subhalakshmi Wahengbam [a,*], Kalpana Thounaojam [a], Ingocha Singh Pangambam [b], Tarunkumar Sharma Gurumayum [a]

[a] Department of Anatomy, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal, Manipur, India
[b] Section Hospital, Shahjahanpur Cantt., Uttar Pradesh, India

ARTICLE INFO

Article history:
Received 9 April 2015
Accepted 26 August 2016
Available online 3 September 2016

Keywords:
Sciatic nerve
Piriformis
Greater sciatic foramen
Tibial nerve
Common peroneal nerve

ABSTRACT

Introduction: The sciatic nerve divides normally into the tibial and common peroneal nerves at the apex of the popliteal fossa. But the division can occur at any level from the sacral plexus to the inferior part of the popliteal fossa. When it divides within the pelvis, the two branches may leave the pelvis through different routes and may be compressed by other structures, causing non-discogenic sciatica. The aim of this study was to determine the level of the exit and of the division of the sciatic nerve.
Methods: Sixty inferior extremities were examined in 30 adult male cadavers in the Department of Anatomy, JNIMS, Imphal.
Results: Sciatic nerve divided into tibial and common peroneal nerves at the apex of popliteal fossa in 58.3% of cases, below the apex in 13.3% and above the apex in 28.4%. In 5 cases (8.4%), it divided within the pelvis where common peroneal nerve passed through and tibial nerve below the piriformis in 3 cases, both the nerves passed below in 1 case and in another case, common peroneal nerve passed between and tibial nerve passed above the heads of the piriformis.
Discussion: In sciatic neuropathy, the extent of neurological deficits depends on the level of the sciatic nerve division. Division at a higher level can result in the involvement of only one out of the two branches. On the other hand, it may result in failure of popliteal block anaesthesia.

1. Introduction

The sciatic nerve, the thickest nerve in the body; almost 2 cm wide at its origin, is formed in the pelvis by the ventral rami of the spinal nerves L4-S3. It leaves the pelvis through the greater sciatic foramen below piriformis and usually divides into the tibial and common peroneal nerves near the apex of the popliteal fossa. However, the division may occur at any level above this, though rarely below it. The common peroneal component usually passes through while the tibial component passes below piriformis if they leave the sacral plexus separately. The sciatic nerve supplies the knee flexors and all the muscles below the knee so its complete palsy will result in flail foot and severe difficulty in walking. Complete sciatic nerve palsy is very rare and for some reason, possibly anatomical, the common peroneal nerve is more usually affected causing foot drop and a high stepping gait.[1] Anatomical variations of the sciatic nerve may contribute to piriformis syndrome, sciatica, coccygodynia and muscle atrophy.[2]

Sciatic nerve, via its main branches, provides sensory supply to most of the leg and foot.[1] Popliteal fossa block provides effective analgesia after foot and ankle surgery in children.[3] An ideal popliteal block is by insertion of the needle at 100 mm above the popliteal crease, i.e., proximal to division of sciatic nerve so, the high division may account for failures in the popliteal block.[4] Thus, considering the fact that there are many variations in the course and division of the sciatic nerve and that each variation has a different and a case-specific clinical presentation, this study was carried out with the aim of determining the level of the exit and the level of the division of the sciatic nerve.

2. Materials and methods

Thirty adult male cadavers without any pathology (60 inferior extremities) were studied during routine dissection classes in the Department of Anatomy, JNIMS, Imphal. Both the inferior extremities were carefully dissected to expose the sciatic nerve. The location where the sciatic nerve exits the pelvis along with its

* Corresponding author at: Department of Anatomy, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Porompat, Imphal, Manipur 795005, India.
E-mail address: subhawah_e@rediffmail.com (S. Wahengbam).

http://dx.doi.org/10.1016/j.jasi.2016.08.007
0003-2778/

relation to piriformis and the level of its division were all recorded. Photographs were taken for proper documentation.

3. Results

Four types of exit of sciatic nerve from the pelvis were observed in the present study as shown in Table 1. In the majority of the cases (55 cases; 91.6%), the sciatic nerve exited the pelvis as a single undivided nerve below piriformis: E1 type (Fig. 1a). In the remaining 5 cases (8.4%), there were high division of the sciatic nerve within the pelvis with variable relationship between the branches and piriformis. E2 type of exit where both the branches passed below piriformis was seen in just one case (Fig. 1b). There was also a single case of E3 type, where the tibial nerve passed above and common peroneal nerve passed between the two heads of piriformis. In this case, there was a connection between the tibial nerve and inferior gluteal nerve with the latter also passing above piriformis (Fig. 1c). There were three cases of E4 type where the common peroneal nerve passed through and tibial nerve passed below piriformis (Fig. 1d). From Table 1, it can be seen that the common peroneal nerve passed through piriformis in four cases but not a single case of either the sciatic nerve or tibial nerve passed through piriformis.

The specimens were divided into five groups depending upon the level of division of the sciatic nerve as shown in Table 2. Maximum number (35 cases; 58.3%) of division of sciatic nerve occurred at the apex of popliteal fossa (D4) (Fig. 2c). High division within the pelvis-(D1) was seen in 5 cases (8.4%) (Fig. 1b–d), division in the gluteal region (D2) in 3 cases (5%) (Fig. 2a) and division in the back of thigh above the apex of popliteal fossa (D3) in 9 cases (15%) (Fig. 2b). Thus, overall 17 cases (28.4%) had division above the apex of popliteal fossa whereas only 8 cases (13.3%) had division below the apex, i.e., within the popliteal fossa (D5) (Fig. 2d).

Table 1
Level of exit of sciatic nerve from the pelvis.

Type	Level of exit of the sciatic nerve	Left	Right	Total	
				No.	%
E1	Single undivided nerve below piriformis	28	27	55	91.6
E2	High division with both branches below piriformis	0	1	1	1.7
E3	High division with tibial nerve above and common peroneal nerve through piriformis	1	0	1	1.7
E4	High division with common peroneal nerve through and tibial nerve below piriformis	1	2	3	5.0
	Total	30	30	60	100

4. Discussion

There are many variations in level of exit of the sciatic nerve from the pelvis. Previous anatomical studies demonstrated 15–30% variation in the relationship between piriformis and the sciatic nerve[5] and the Beaton and Anson classification[6] given below is the widely accepted method of classification of this relationship:

Type 1: 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 heads
Type 5: Divisions between and above heads
Type 6: Undivided nerve above undivided muscle

The comparison of the previously published results and those of the present study as shown in Table 3 revealed a higher incidence of Type 1 and a lower incidence of Type 2 in the present study. There were no Type 3 or Type 4 variations in the present study. Type 5 and 6 variations were defined hypothetically by Beaton and Anson[6] and many studies including the present one found no case of Type 6 variation however Ozaki et al.[8] and Sayson et al.[9] each reported one case of Type 6 variation. The specific variant encountered in just one case in the present study which was described as the E3 exit where the common peroneal nerve passed between and tibial nerve above the heads of piriformis is a new variant that has never been reported in any literature till date, to the best of our knowledge, and it should fit to Type 5 variation, i.e., divisions between and above heads. Babinski et al.[2] and Mas et al.[10] each reported a single case of a rare variation where the common peroneal nerve passed below piriformis and the tibial nerve below superior gemellus. Since this variation was not described by Beaton and Anson, Guvencer et al.[11] proposed that this variation may be nominated as Beaton and Anson Type 7. In the present study, there was a single case of another rare variation where the two branches

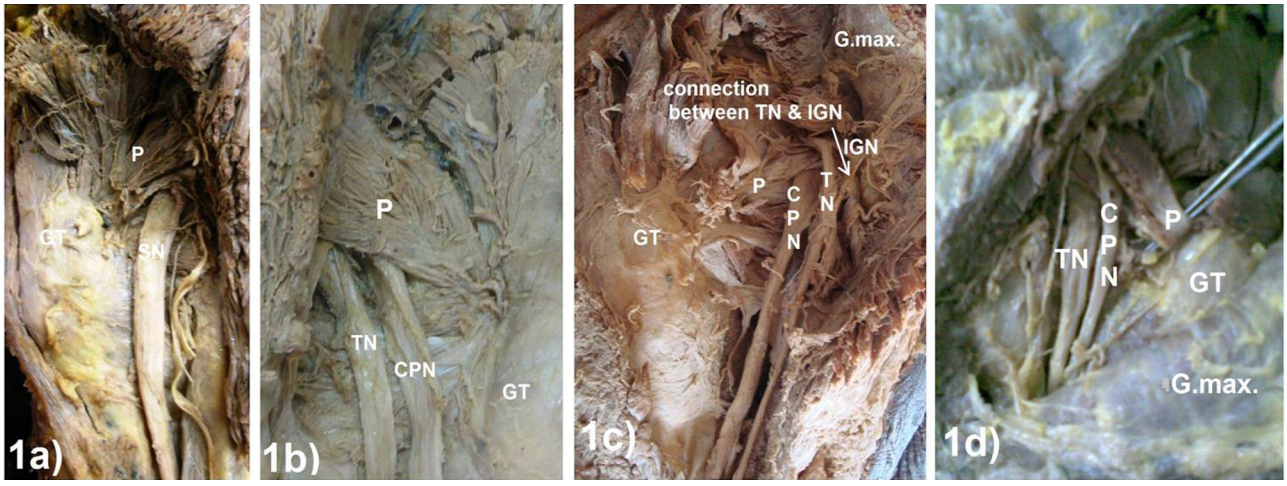

Fig. 1. Photographs showing the different levels of exit of the sciatic nerve from the pelvis. (a) E1 exit: a single undivided sciatic nerve (SN) below piriformis (P). (b) E2 exit: both tibial (TN) and common peroneal nerves (CPN) below piriformis (P). (c) E3 exit: common peroneal nerve (CPN) between and tibial nerve (TN) above the heads of piriformis (P). A connection is present between tibial nerve (TN) and inferior gluteal nerve (IGN) which also passes above piriformis and supplies gluteus maximus (G. max.). (d) E4 exit: common peroneal nerve (CPN) through and tibial nerve (TN) below piriformis (P). *Note*: GT: greater trochanter, (b–d) belong to D1 division of the sciatic nerve in the pelvis.

Table 2
Level of division of the sciatic nerve.

Group	Level of division of the sciatic nerve	Left	Right	Total	
				No.	%
D1	Pelvis	2	3	5	8.4
D2	Gluteal region	1	2	3	5.0
D3	Back of thigh above apex of popliteal fossa	5	4	9	15.0
D4	Apex of popliteal fossa	18	17	35	58.3
D5	Popliteal fossa	4	4	8	13.3
	Total	30	30	60	100

Table 3
Comparison of the level of exit of the sciatic nerve between the present study and previous studies.

Different studies	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Beaton and Anson[6]	84.2%	11.7%	3.3%	0.8%		
Beaton[7]	90%	7.1%	2.1%	0.8%		
Pokorny et al.[5]	79.1%	14.3%	4.4%	2.2%		
Guvencer et al.[11]	76%	16%	8%			
Shewale et al.[14]	73.3%	11.4%	2.2%	0%	0%	0%
Present study	91.6% (E1)	5% (E4)	0%	0%	1.7% (E3)	0%

of sciatic nerve passed separately below piriformis. This variation was also reported in just one case by Saritha et al.,[12] bilaterally in one cadaver by Patel et al.[13] but in a much higher number, i.e., 10 cases by Shewale et al.[14] and since this variation was also not described by Beaton and Anson, it may, therefore, be nominated as Beaton and Anson Type 8.

The sciatic nerve usually divides into its major components near the apex of the popliteal fossa but the division may occur at any level above this, though rarely below it.[1] The present studies agrees to the above statement as the division of sciatic nerve was found maximum (58.3%) at the apex of popliteal fossa and also in a higher percentage (28.4%) above the apex of the popliteal fossa than below this level (13.3%). Various levels of division of sciatic nerve were observed in many previous studies.[14–17] Variations in the level of division of sciatic nerve have an embryological basis. During embryological development at the base of the limb bud, the nerves contributing to the lower limb form two plexuses (lumbar and sacral). Later, as the elements from each of these plexuses grow out into the limb, they are subdivided into the dorsal and ventral components, for the dorsal and ventral musculatures. The sciatic nerve is formed when the large dorsal component of the sacral plexus (common peroneal nerve) and the ventral component (tibial nerve) move downward close together.[18] The two components are enveloped by a common fascial sheath representing epineurium of the nerve.[1] As a result, in the definitive form, it is possible that the common peroneal and tibial components of the sciatic nerve separate from each other at different levels from their origin: in the pelvis, in the gluteal region, in the back of the thigh, in the apex of the popliteal fossa or even within the popliteal fossa as observed in the present study.

4.1. Clinical significance

The anatomical variants described in this paper have important clinical significance. The division of the sciatic nerve above the popliteal fossa, which was observed in 28.4% cases, can result in failure of popliteal nerve block[4] and may also predispose to nerve injury during deep intramuscular injections in gluteal region and

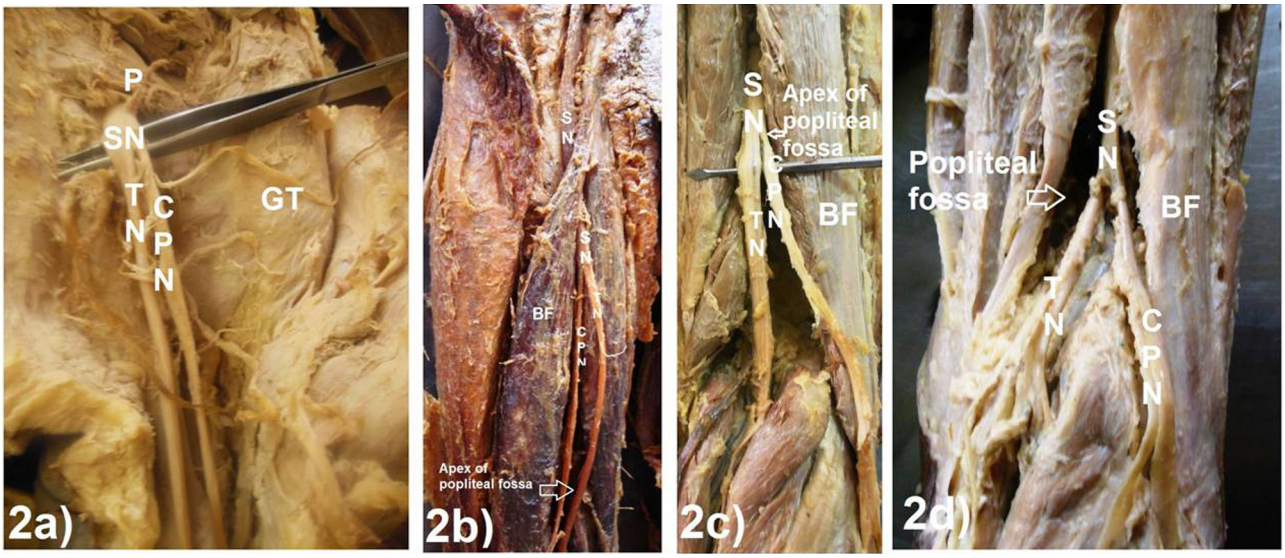

Fig. 2. Photographs showing the different levels of division of the sciatic nerve. (a) D2 division in the gluteal region. (b) D3 division in the back of the thigh above the apex of popliteal fossa. (c) D4 division at the apex of the popliteal fossa. (d) D5 division within the popliteal fossa below its apex. *Note*: P, piriformis; SN, sciatic nerve; CPN, common peroneal nerve; TN, tibial nerve; GT, greater trochanter; BF, biceps femoris.

during posterior hip operations.[13] On the other hand, high division of the sciatic nerve can result in involvement of only one branch in sciatic neuropathy and the escape of the other branch thus causing a lesser degree of neurological deficits as otherwise may occur in the low division with the involvement of the whole nerve.[16] Therefore, the course of common peroneal nerve through the piriformis muscle as was observed in E4 exit in the present study can produce entrapment of only this nerve. However in the E3 exit, along with involvement of common peroneal nerve, the tibial nerve may also be involved as the nerve may have been bended while exiting above piriformis instead of the normal exit below the muscle and for similar reason as well as because of its connection with the tibial nerve, the inferior gluteal nerve may also be involved in this case, causing an additional paralysis or even atrophy of gluteus maximus muscle which is supplied by the inferior gluteal nerve.

5. Conclusions

There are many variations in the level of exit and division of the sciatic nerve and the knowledge regarding these variations is of great importance as each variation has its specific clinical presentation. The present study reports many variations of the sciatic nerve and also provides the first report of a new anatomical variant where the tibial nerve passed above and the common peroneal nerve passed between the two heads of piriformis, associated with a connection between the tibial nerve and the inferior gluteal nerve. Radiological studies addressing the different variations should be carried out in cases with atypical sciatica and preoperative nerve imaging should also be carried out before surgeries in the gluteal region and the back of the thigh to achieve maximum level of post-operative mobility of the lower limb.

Conflicts of interest

The authors have none to declare.

References

1. Standring S. Gray's Anatomy: The anatomical basis of clinical practice.In: *Pelvic Girdle and Lower Limb*. 40th ed. Churchill Livingstone (Elsevier); 2008:1327–1465.
2. Babinski MA, Machado FA, Costa WS. A rare variation in the high division of the sciatic nerve surrounding the superior gamellus muscle. *Eur J Morphol.* 2003;41(1):41–42.
3. Tobias JD, Mencio GA. Popliteal fossa block for postoperative analgesia after foot surgery in infants and children. *J Pediatr Orthop.* 1999;19(4):511–514.
4. Vloka JD, Hadzić A, April E, et al. The division of the sciatic nerve in the popliteal fossa: anatomical implications for popliteal nerve blockade. *Anesth Analg.* 2001;92:215–217.
5. Pokorny D, Jahoda D, Veigl D, et al. Topographic variations of the relationship of the sciatic nerve and the piriformis muscle and its relevance to palsy after total hip arthroplasty. *Surg Radiol Anat.* 2006;28:88–91.
6. Beaton LE, Anson BJ. The relation of the sciatic nerve and its subdivisions to the piriformis muscle. *Anat Rec.* 1937;70:1–5.
7. Beaton LE, Anson BJ. The sciatic nerve and piriformis muscle: their interrelation a possible cause of coccygodynia. *J Bone Jt Surg Am.* 1938;20:686–688.
8. Ozaki S, Hamabe T, Muro T. Piriformis syndrome resulting from an anomalous relationship between the sciatic nerve and piriformis muscle. *Orthopedics.* 1999;22(8):771–772.
9. Sayson SC, Ducey JP, Maybrey JB, et al. Sciatic entrapment neuropathy associated with an anomalous piriformis muscle. *Pain.* 1994;59:149–152.
10. Mas N, Ozekşi P, Ozdemir B, et al. A case of bilateral high division of the sciatic nerves, together with a unilateral unusual course of the tibial nerve. *Neuroanatomy.* 2003;2:13–15.
11. Guvencer M, Iyem C, Akyer P, et al. Variations in the high division of the sciatic nerve and relationship between the sciatic nerve and the piriformis. *Turk Neurosurg.* 2009;19(2):139–144.
12. Saritha S, Praveen Kumar M, Supriya G. Anatomical variations in the bifurcation of the sciatic nerve: a cadaveric study and its clinical implications. *Anat Physiol.* 2012;2:111. http://dx.doi.org/10.4172/2161-0940.1000111.
13. Patel S, Shah M, Vora R, et al. A variation in the high division of the sciatic nerve and its relations with piriformis muscle. *Natl J Med Res.* 2011;1(2):27–30.
14. Shewale AD, Karambelkar RR, Umarji BN. Study of variations in the divisions, course and termination of the sciatic nerve. *JKIMSU.* 2013;2(1):62–68.
15. Muthu Kumar T, Srimathi. Rani A, et al. A cadaveric study of sciatic nerve and its level of bifurcation. *J Clin Diagn Res.* 2011;5(December (8)):1502–1504.
16. Sawant SP. The study of division of sciatic nerve in 100 specimens with its clinical significance. *IJSR.* 2013;2(2):306–309.
17. Prakash. Bhardwaj AK, Devi MN, Sridevi NS, Rao PK, Singh G. Sciatic nerve division: a cadaver study in the Indian population and review of the literature. *Singap Med J.* 2010;51(9):721.
18. Demiryurek D, Bayramoglu A, Erbil M, et al. Bilateral divided piriformis muscle together with the high division of the sciatic nerve. *Gazi Med J.* 2002;13:41–44.