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Anatomical variation of sciatic nerve division in the popliteal fossa and its implication in popliteal nerve blockade

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The sciatic nerve (SN) originates from the L4–S3 roots in the form of two nerve trunks: the tibial nerve (TN) and the common peroneal nerve (CPN). The TN and CPN are encompassed by a single epineural sheath and eventually separate (divide) in the popliteal fossa. This division of the SN occurs at a variable level above the knee and may account for frequent failures reported with the popliteal block.

We studied the level of division of the SN in the popliteal fossa and its relationship to the common epineural sheath of the SN. The level of division of the SN sheath into TN and CPN above the knee was measured in 30 cadaver specimens. The SN was invariably formed of independent trunks (TN and CPN) encompassed in one common epineural sheath. The SN divided at a distance range of 50 to 180 mm above the popliteal fossa crease.

The present findings suggest that the TN and CPN leave the common SN sheath at variable distances from the popliteal crease. This finding and the relationship of the TN and CPN sheaths may have significant implications for popliteal nerve block. (Folia Morphol 2009; 68, 4: 256–259)

Key words: sciatic nerve, division, popliteal fossa, blockade

INTRODUCTION

The sciatic nerve (SN) is the largest nerve in humans. This is due not only to the number of gathered nervous fibres, but also to the size of the region supplied by the nerve. The width of the nerve can exceed 2 cm and its thickness reaches 0.5 cm. Its tensile strength was determined as maximum load ca. 90 kg [14]. Normally the sciatic nerve reaches the gluteal region from the pelvic fossa by passing below the piriformis muscle. The nerve divides into the tibial (TN) and common peroneal nerve (CPN) at the lower part of the posterior compartment of the thigh [26].

The sciatic nerve consists mostly of lumbosacral fibres originating from the L4–L5 and S1–S3 spinal segments. They are both motor and sensory. Two separate nerve trunks (TN and CPN) enveloped by a common fascial sheath (epineural sheath) can be distinguished from the onset [27]. These two trunks leave the pelvis (together with the posterior cutaneous nerve of the thigh) through the sacro-sciatic foramen between the tuberosity of the ischium and the greater trochanter of the femur. The TN and CPN eventually diverge, with the TN descending medially through the popliteal fossa into the back of the leg and the CPN diverging laterally from the midline

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to pass behind the head of the fibula and lateral to its neck [19]. The motor branches of the nerve supply the posterior group of thigh muscles as well as two joints of the lower limb: the femoral and knee joints. Its sensory branches supply the whole tibial and foot areas with the exception of the anteromedial tibial region and the medial margin of the foot [3]. The sciatic nerve presents significant variability concerning its topography and division into terminal branches (common fibular nerve and tibial nerve) [8].

Sciatic nerve block is a well-recognized technique for providing anaesthesia and post-operative analgesia for foot and ankle surgeries [9]. Historically, sciatic nerve blocks are among the least performed blocks by the anaesthesiologist. However, diabetic patients require regional block, particularly popliteal block, for foot surgeries to prevent systemic decompensation. Popliteal block, which refers to a block of the sciatic nerve in the popliteal fossa, is an excellent anaesthetic choice for foot and ankle surgeries especially in diabetic patients who have compromised physiological status. It allows the use of a calf tourniquet and is devoid of the systemic and local complications seen with general, spinal, and epidural anaesthesia [7, 10]. The classical approach to sciatic nerve block in the popliteal fossa (popliteal block) often requires multiple attempts to localize the sciatic nerve. Recently, it has been suggested that an intertendinous approach to popliteal block may result in a more consistent localization of the sciatic nerve [1].

Previous studies reported several variations in sciatic nerve division as high division surrounding superior gemellus or piriformis muscles and trifurcation of the sciatic nerve, which is extremely rare [2, 11, 16, 17]. Therefore, the aim of this study was to examine the anatomical variations of the SN in the popliteal fossa to determine the optimal distance from the popliteal crease for the needle to be placed in the popliteal block.

MATERIAL AND METHODS

The lower extremities of 30 adult cadavers (15 females, 15 males) were obtained from the Department of Anatomy, College of Medicine, King Abdulaziz University, Jeddah, for dissection of the popliteal fossae. The cadavers had been deceased for between 6 and 18 months and were free of gross pathology. They were embalmed for anatomical purposes in a solution of phenol (13%) as the principal fixative and glycerine (28%) for retention of water content. The popliteal fossa crease was identified, and the skin and subcutaneous tissue overlying the popliteal fossa were removed to the level of the superficial fascia of the hamstring muscles. Further dissection of the more caudal aspect of the fossa was performed to identify the more superficial CPN. The epineural sheath of the CPN was dissected proximally to the main trunk of the CPN until the point at which its sheath merged with that of the TN into the single epineural sheath of the SN. This point was defined as the division of the SN. For each dissected leg, distances from the division of the SN to the popliteal fossa crease were measured with callipers (degree of accuracy 61 mm) and recorded. Distances from the division of the SN to the popliteal fossa crease were compared between the left and right legs by paired *t*-test. In order to determine whether the distances differed by sex, mean distances for each cadaver were calculated; these mean distances were then compared by Student's *t*-tests. P values < 0.05 were considered statistically significant.

All analyses were performed with the Statistical Package (SPSS Version 10.0 for Windows™; SPSS Inc, Chicago, IL).

RESULTS

A total of 30 right and 30 left legs from 15 female and 15 male adult cadavers were examined with the exception of the left leg of one male cadaver and the right leg of one female cadaver which could not be examined because of prior disruptions in the area to be measured. The connective tissue sheaths surrounding the TN, the CPN, and the division of the SN were easily identified in all dissected specimens (Fig. 1). In the male cadavers, the distances from the division of the SN to the popliteal fossa crease did not differ between the left and right legs of the 15 cadavers which were measured (Rt., 84.5 mm and Lt., 83.3 mm). In the female cadavers, the distances from the division of the SN to the popliteal fossa crease did not differ between the left and right legs of the 15 cadavers which were measured (Rt., 78.5 mm and Lt., 79.2 mm). There was no significant difference in the measured distance by sex (83.9 ± 22.7 and 78.85 ± ± 41.3 mm for male and female legs, respectively). The measured distances varied widely, ranging from 50 to 180 mm (Table 1).

DISCUSSION

Regional anaesthesia, which has become increasingly popular for lower-limb procedures, improves the quality of postoperative pain relief [13]. Among regional anaesthesia techniques for the lower limb, sciatic nerve block is a well-established procedure

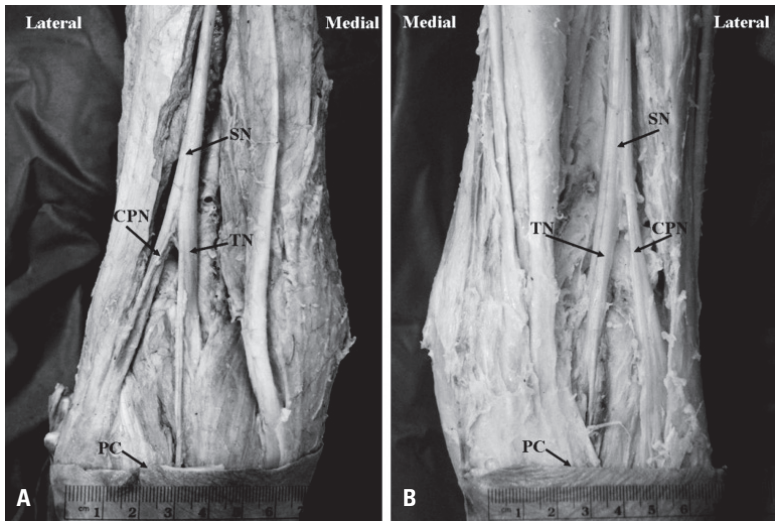

Figure 1. Division of the sciatic nerve in the left female (**A**) and right male (**B**) popliteal fossae. Popliteal fossa is shown dissected. The sciatic nerve (SN) divides into the tibial (TN) and common peroneal nerves (CPN) above the popliteal fossa crease (PC). The TN and CPN depart the common epineural sheath of the SN and descend into the popliteal fossa, enveloped by their respective sheaths.

Table 1. Mean distance of sciatic nerve bifurcation in the popliteal fossa among male and female cadavers

Side (right or left)	Male [mm] mean ± SE	Female [mm] mean ± SE
Right lower limb (15)	84.5 ± 4.31	78.5 ± 7.87
Left lower limb (15)	83.3 ± 3.98	79.2 ± 7.21
Mean ± SE	83.9 ± 4.14	78.85 ± 7.54

Student t-test: no significant differences

that is widely used either alone or in association with other nerve blocks [4].

The sciatic nerve is the thickest nerve in the human body. The sciatic nerve converges from the sacral plexus, enters the thigh posteriorly to the femur, and runs toward the popliteal fossa. Accordingly, it can be blocked at different levels along its pathway. The classic posterior approach of Labat modified by Winnie is the most frequently used approach. Several different proximal approaches to the sciatic nerve have been described in the literature however; the classical posterior approach of Labat is undoubtedly the most often used [5, 6].

The sciatic nerve is composed of independent medial and lateral divisions that are physically but not functionally joined by a common connective tissue sheath [24]. The tibial and common peroneal nerves are bundled together, wrapped by a separate epineurium, and contained in a common epineural adventitia with multiple layers of connective tissue. They do not exchange nerve fibres [23]. This is important to bear in mind when sciatic nerve block is performed in the popliteal fossa. Because of the described anatomy, exposure of one of these branches to the local anaesthetic may be limited when the injection is made distally to the division of the two branches [25]. In addition, separation of the tibial and common peroneal nerves at highly variable distances above the popliteal fossa crease is often seen [12, 20, 23].

Anatomical variations in the level at which the SN divides into the TN and CPN have been suspected as a possible cause for incomplete block of the SN in the popliteal fossa [19, 22]. In the present study, the division of the SN occurs at variable distances from the popliteal crease, ranging from 50 to 180 mm. These distances did not differ significantly by sex. According to the anatomical model, if a needle is inserted 50 mm or 70 mm above the popliteal fossa crease, the chance that the tip of the needle will be proximal to the division of the SN is only 46% and 57%, respectively [18]. In contrast, insertion of the needle 100 mm above the popliteal fossa crease virtually ensures placement of the needle in the vicinity of or proximal to the division of the SN [20].

To improve the success rate of popliteal blocks, some investigators have suggested a double-injection technique in which both branches are separately identified and anaesthetized [21]. Others have suggested injecting a larger volume of local anaesthetic to increase the spread within the epineural sheath to reach both the TN and CPN [21].

In conclusion, the SN divides into the TN and CPN at variable distances above the popliteal fossa crease. If our findings are applicable to clinical practice, when the needle is inserted at commonly suggested insertion sites in performing the popliteal block (50–100 mm), local anaesthetic may be deposited in the vicinity of the TN or the CPN, but not both. However, insertion of the needle 160 mm above the popliteal crease virtually ensures placement of the needle in the vicinity of, or proximal to, the division of the SN. Although these findings may not be of importance in the double-injection technique [15], in which the TN and CPN are identified and anaesthetized by separate injections of local anaesthetic, they may have implications for the more commonly used single-injection technique.

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