The Division of the Sciatic Nerve in the Popliteal Fossa: Anatomical Implications for 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 28 cadaver leg specimens. The SN was invariably formed of independent trunks (TN and CPN) encompassed in one common epineural sheath. The SN divided at a mean distance of 60.5 ± 27.0 mm (range 0 to 115 mm) above the popliteal fossa crease. We conclude 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 block.

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Blocks of the sciatic nerve (SN) in the popliteal fossa are associated with a variable success rate (1–3). With this technique, also known as a "popliteal block," the needle is inserted 50–70 mm above the popliteal fossa crease and advanced toward the SN (2,4). The tip of the needle ideally should be positioned next to the main trunk of the SN before its separation into the tibial nerve (TN) and common peroneal nerve (CPN). Injection of local anesthetic in the vicinity of only one of these components may result in an incomplete block. We examined the anatomical variations of the SN in the popliteal fossa and determined the optimal distance from the popliteal crease for the needle to be placed in the popliteal block.

The SN derives its fibers from the L4-S3 spinal segments and is almost 2 cm wide at its origin near the sacral plexus. Two separate nerve trunks (TN and CPN) enveloped by a common fascial sheath (epineural sheath) can be distinguished from the onset (5,6). 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 to pass behind the head of the fibula and lateral to its neck (7). The SN provides motor branches to the hamstrings and all muscles below the knee. The SN also provides the sensory innervation to the posterior thigh and entire leg and foot below the knee (except the medial aspect, which is innervated by the saphenous nerve, a branch of the femoral nerve).

Methods

The lower extremities of 15 adult cadavers were obtained for dissection of the popliteal fossae. The cadavers had been deceased from 6 to 18 mo and were free of gross pathology. They were embalmed for anatomical purposes in a solution of phenol (13%) as the principal fixative and glycerin (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 caudad 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

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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 calipers (degree of accuracy ±1 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 for the Social Sciences (SPSS Version 5.02 for Windows™; SPSS Inc, Chicago, IL).

Results

We examined 14 right and 14 left legs from seven female and eight male adult cadavers. The left leg of one male cadaver and the right leg of one female cadaver 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 (Figure 1). Distances from the division of the SN to the popliteal fossa crease did not differ between the left and right legs of the 13 cadavers whose legs could both be measured (57.5 ± 25.7 mm and 66.2 ± 23.9 mm, respectively). There was no difference in the measured distance by sex (55.1 ± 25.5 and 64.2 ± 27.5 mm for male and female legs, respectively). The fascial sheath enveloping the SN divided into two distinct sheaths surrounding the CPN and TN as they separated in the distal popliteal fossa. The mean distance above the popliteal fossa crease at which the SN divided was 60.5 ± 27.0 mm. The measured distances varied widely, ranging from 0 to 115 mm (Figure 2). The coefficient of variation was 44.6%. In 57% of the specimens, the SN divided within 70 mm of the popliteal crease; in 75% of the legs, the SN divided within 81 mm; and in all legs studied, the SN divided within 115 mm.

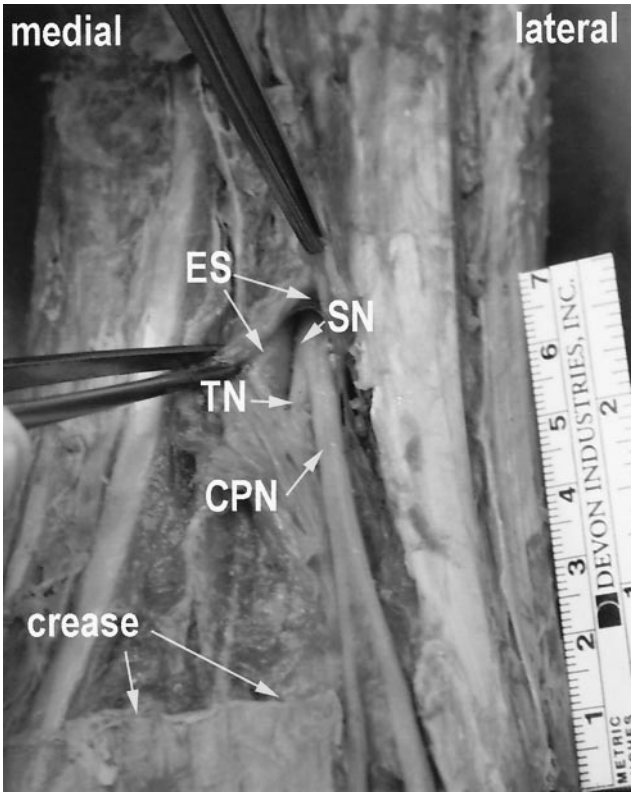

Figure 1. Division of the sciatic nerve in the popliteal fossa. Popliteal fossa is shown dissected. The sciatic nerve (SN) divides into tibial (TN) and common peroneal nerves (CPN) above the popliteal fossa crease (crease). The TN and CPN depart the common epineural sheath (ES) of the SN and descend into the popliteal fossa enveloped by their respective sheaths.

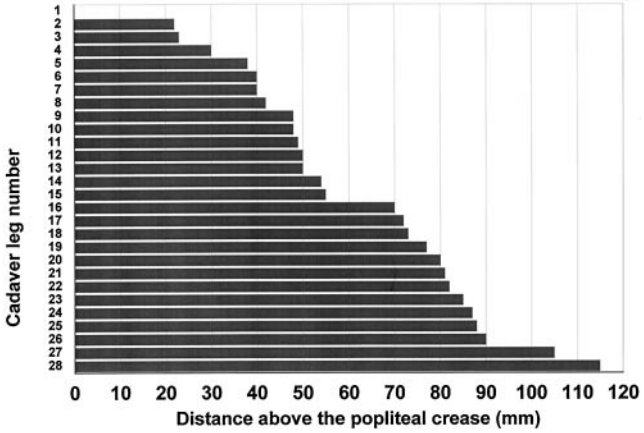

Figure 2. Division of the sciatic nerve above the popliteal fossa crease. Horizontal bars indicate distances above the popliteal fossa crease at which the sciatic nerves divided in individual leg specimens.

Discussion

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 (5,8,9). Our data indicate that the division of the SN does occur at highly variable distances from the popliteal crease. These distances did not differ by sex or by laterality. Indeed, according to our anatomical model, if a needle is inserted at 50 mm (1) 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. In contrast, insertion of the needle at 100 mm above the popliteal fossa crease, as suggested by Singelyn et al. (4), virtually ensures placement of the needle in the vicinity of or proximal to the division of the SN.

To improve the success rate of popliteal blocks, some investigators have suggested a double-injection technique, in which both branches are separately identified and anesthetized (10). Others have suggested injecting a larger volume of local anesthetic to increase the spread within the epineural sheath to reach both the TN and CPN (5). It is important to keep in mind that the SN is composed of independent medial and lateral divisions that are physically but not functionally joined by a common connective tissue sheath. These nerve trunks (TN and CPN) are bundled together with multiple layers of connective tissue, but they do not exchange nerve fibers (5). This is important in popliteal nerve blockade, because TN and CPN remain enveloped in their respective sheaths as they diverge from the epineural sheath of the SN. This, in turn, may limit exposure of one of these branches to the local anesthetic when the injection is made distal to the division of the SN.

It is possible that distortion in the anatomy caused by the embalming process and dissection may limit the applicability of these data to clinical practice. However, we exercised great care in selecting undistorted specimens and performing dissections of the popliteal fossae.

In conclusion, the SN divides into the TN and CPN at highly 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 (50–70 mm), local anesthetic may be deposited in the vicinity of the TN or the CPN, but not both. However, insertion of the needle at 100 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 (10), in which the TN and CPN are identified and anesthetized by separate injections of local anesthetic, they may have implications for the more commonly used single-injection technique.

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