CASE REPORT

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Variant distribution of the calf cutaneous nerves - case report and clinical impact

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SUMMARY

We report a cadaveric case of unusual innervation pattern of the right calf and ankle. During dissection of an 82 years-old, formalin-fixed, male cadaver, the posterior femoral cutaneous nerve was found providing sensory supply to the lateral knee region, while it terminated at the level of the ankle. Moreover, the medial sural cutaneous nerve did not anastomose with a peroneal communicating branch and it continued as the lateral dorsal cutaneous nerve of the foot. In cases that the peroneal communicating branch is absent, the medial sural cutaneous nerve is called sural nerve. Additionally, the lateral sural cutaneous nerve travelled over the calf crossing the sural nerve at its middle and thus, providing sensory supply to the upper lateral calf and the lower medial aspect of the calf and ankle. This peculiar sensory supply may cause diagnostic hazard in cases of nerve injury with neurological symptomatology, whereas due to the presented variability, nerves are prone to iatrogenic injury during procedures in the area.

Key words: Posterior femoral cutaneous nerve – Termination – Ankle – Sural nerve – Peroneal communicating branch

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INTRODUCTION

The sensory supply of the posterior aspect of the lower extremities is well-studied. Posterior femoral cutaneous nerve (PFCN) and sural nerve (SN) provide the main innervation of the posterior side of the thigh and calf. Medial and lateral sural cutaneous nerves originate from the tibial and common peroneal nerves, providing sensory supply to the skin of the calf. The SN is usually formed by the union of the medial sural cutaneous nerve and a peroneal communicating branch which typically arises from the lateral sural cutaneous nerve. However, if the peroneal communicating branch is absent, the medial sural cutaneous nerve serves as SN. Indeed, variations in the formation of SN were noted in 12.5-59.8% of the cases studied in the literature. (Kosinski, 1926; Williams, 1954; Huelke, 1957; Ortigüela et al., 1987; Eid and Hegazy, 2011; Seema, 2013). The medial and lateral sural cutaneous nerves, the peroneal communicating branch and the SN are often referred to as “the sural nerve complex”, presenting great variability in the literature (Ortigüela et al., 1987; Seema, 2013). Primary or secondary injury to either of these sensory nerves may lead to neurologic deficits or pain over the supplied areas. Although classic anatomy suggests that if symptomatology is present, the responsible nerve branch is the one that supplies the affected dermatome; in cases of variant innervation

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pattern, the diagnosis may not be straightforward.

We present a cadaveric case with variant course and branching pattern of the PFCN and SN, that is of great clinical interest for the physician and surgeon intervening in the region of lower calf and ankle.

CASE REPORT

During routine dissection of an 82 years-old, formalin-fixed, male cadaver, a variant innervation pattern of the posterior aspect of the right lower extremity was observed. In specific, the PFCN originated typically from the sacral plexus and it continued its course over the thigh and calf. The PFCN gave off a lateral sensory branch 10 cm above the popliteal fossa which provided sensory supply to the lateral knee region (Fig. 1a, b). The nerve terminated at the level of the ankle, innervating the medial aspect (Fig. 1c). The length of the PFCN after it arose from the great sciatic foramen, was found approximately 74 cm.

The medial sural cutaneous nerve originated from the tibial nerve at the level of the popliteal fossa and did not anastomose with a peroneal communicating branch; thus, the SN derived exclusively from the medial sural cutaneous nerve. The lateral sural cutaneous nerve arose from the common peroneal nerve at the popliteal fossa and branched off a sensory branch to the lateral aspect of the calf. Then, it travelled over the calf superficially to the SN and crossed it over at the middle of the leg (Fig. 1b). The lateral sural cutaneous nerve followed a parallel course to the PFCN and terminated medially, at the level of the ankle, while the SN was thicker and continued over the dorsum of the foot as lateral cutaneous nerve (Fig. 1c).

DISCUSSION

Anatomy

In classic textbooks of anatomy, PFCN is described to originate from the ventral rami of S1, S2, S3 or S4 spinal nerves. It constitutes a purely sensory nerve: it exits the great sciatic foramen below the piriformis muscle, medial to the sciatic nerve, and travels beneath the gluteus maximus muscle along with the inferior gluteal artery. In the subgluteal area it gives off inferior cluneal and perineal branches. The PFCN travels beneath the fascia lata, courses over the biceps femoris muscle and arises from the deep fascia at the popliteal region giving off its final sensory branches (Standring, 2005). Thus, PFCN provides sensory supply to the inferior gluteal, the perineal and posterior thigh

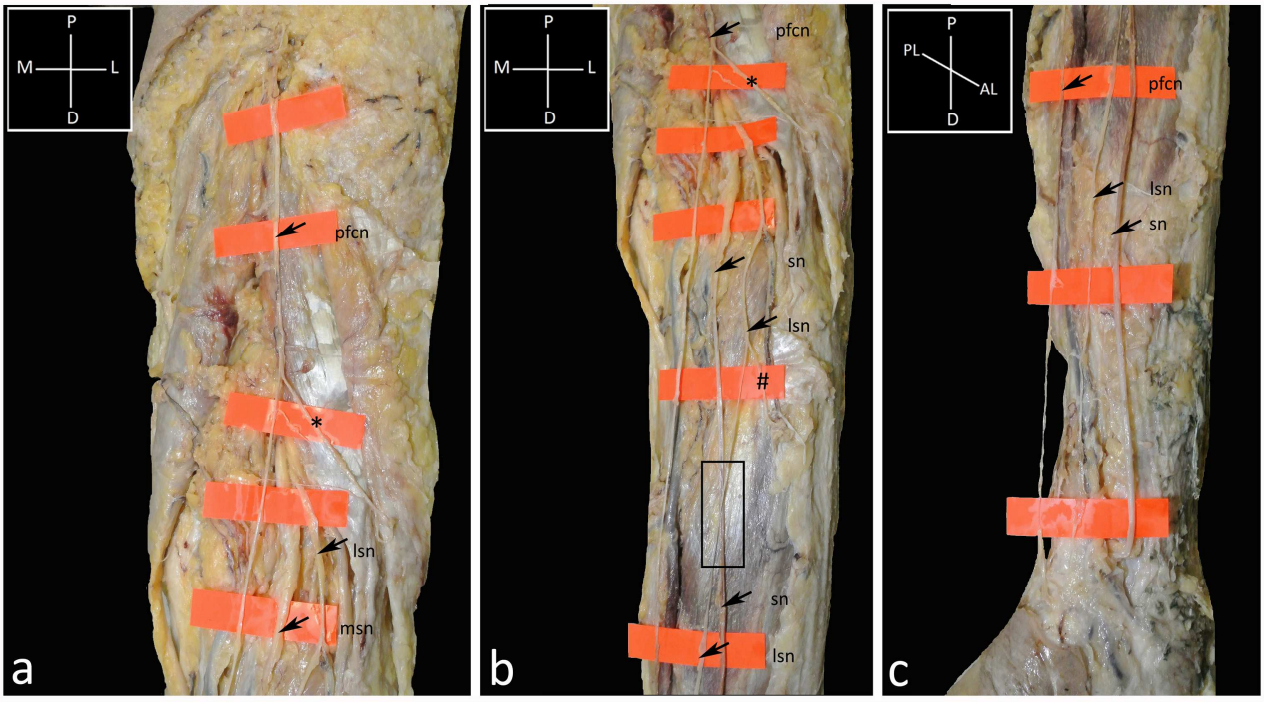

Fig. 1. (a) Distribution of the posterior femoral cutaneous nerve (pfcn) over the right thigh and of the lateral sensory nerve branch that it provided above the level of the knee (*).The medial sural cutaneous nerve (msn) originated from the tibial nerve, while the lateral sural cutaneous nerve (lsn) arose from the common peroneal at the popliteal fossa and gave off a lateral sensory branch (#) innervating the lateral upper calf. (P: proximal, D: distal, M: medial, L: lateral). **(b)** The peroneal communicating branch of the sural nerve was absent. Thus, the medial sural cutaneous nerve served as sural nerve (sn). At the middle of the calf, the lateral sural cutaneous nerve crossed over the sural nerve (square shape). (P: proximal, D: distal, M: medial, L: lateral). **(c)** The posterior femoral cutaneous nerve (pfcn) terminated at the level of the ankle, along with the lateral sural cutaneous nerve (lsn), while the sural nerve (sn) passed posterior to the lateral malleolus and continued as lateral dorsal cutaneous nerve of the dorsum of the foot. (P: proximal, D: distal, PL: posterolateral, AL: anterolateral).

areas. In the presented case, PFCN was responsible for the innervation of the lateral knee area, while the nerve did not terminate until it reached the ankle (Fig. 1). Kosinski (1926) reported that PFCN may even terminate at the level of the heel and in 7.3% of the studied cases, it descended to the lower quarter of the leg.

The SN is typically formed by the anastomosis of the medial sural cutaneous nerve and the peroneal communicating branch, while in the absence of union, SN is derived from the medial sural cutaneous nerve alone (Ortigüela et al., 1987; Seema, 2013). SN travels over the gastrocnemius muscle and supplies the posterolateral aspect of the lower third of the leg. Then, it continues its course distally to the lateral malleolus providing sensory innervation to the lateral side of the foot and little toe (Standring, 2005). SN is considered to be a purely sensory nerve, although some studies show existence of motor components (Amoiridis et al., 1997). Many variations have been reported as far as the origin and course of SN are concerned. In our case, the SN was formed without the participation of a peroneal communicating branch and it continued as lateral dorsal cutaneous nerve of the foot, while the lateral sural cutaneous nerve supplied the medial lower calf (Fig. 1c). As described in literature, in only 40.2-87.5% of the cases the SN is formed by the medial sural cutaneous nerve and the peroneal communicating branch (Kosinski, 1926; Williams, 1954; Huelke, 1957; Ortigüela et al., 1987; Eid and Hegazy, 2011; Seema, 2013). Respectively, in 19.2%-53.8% of cases, the medial sural cutaneous nerve forms the SN and continues as lateral dorsal cutaneous nerve over the dorsum of the foot (Kosinski, 1926; Huelke, 1957).

As Kosinski (1926) describes, the lateral sural cutaneous nerve was mainly encountered to cross superficially the medial sural cutaneous nerve, as presented in our case, in order to provide innervation to the lower medial aspect of the calf, along with the PCFN. Innervation of the lower half of medial aspect of the calf by the lateral sural cutaneous nerve is found in 90% of the cases (Kosinski, 1926). Interestingly, the lateral sural cutaneous nerve is also supposed to give off a sensory branch to the lateral malleolus area. However, in our case, the lateral malleolus area was purely innervated by the medial sural cutaneous nerve. Based on the above data, our case is a variation of Type A of Kosinski's innervation pattern, which was found in 53% of the studied cases. The main characteristics of Type A is the lack of anastomoses between the nerve branches, the innervation of the inner calf by the lateral sural cutaneous nerve and the formation of the lateral dorsal cutaneous nerve of the foot only by the medial sural cutaneous nerve. The difference observed in our case is that PFCN did not terminate until the level of the ankle, covering along with the lateral sural cutaneous nerve the sensory supply of the medial aspect of the leg.

Clinical implications

Injury of the PFCN may occur after trauma to the gluteal region, compression due to prolonged positioning or bicycling, mass-like lesions, such as hematoma or tumor formation, entrapment neuropathy and intragluteal injection, while PFCN trauma is responsible for some of the symptoms present at the so called "piriformis syndrome" (Arnoldussen and Korten, 1980; Obach et al., 1983; McCrory and Bell, 1999; Mobbs et al., 2002; Gomceli et al., 2005; Tong and Haig, 2000; Kim et al., 2009). PFCN injury may lead to hypoaesthesia or hyperaesthesia, dysesthesia, paraesthesia, burning sensation or pain over the supplied areas, thus the gluteal region (clunialgia), posterior aspect of thigh and upper calf. In our case of variant innervation pattern, if PFCN neuropathy is present, the symptoms will radiate to the patient's inner calf and ankle, causing diagnostic conflict, as the nerves typically supplying this area is the SN and saphenous nerve.

The etiology of SN neuropathy is multiple. Traumatic injury to the nerve may be observed after surgery to the area, trauma to the gastrocnemius muscle or fracture of the distal fibula, talus, calcaneus and base of 5th metatarsal bone (Gross et al., 1980). The SN entrapment neuropathy isn't also rare and is usually caused by fascial thickening and space-occupying masses, such as lipomas or Baker's cyst in the popliteal fossa (Pringle et al., 1974). SN injury could affect only one of its two components (Paraskevas et al., 2014). Typically, injury to the SN leads to sensory alterations over the posterolateral aspect of the leg and lateral dorsum of the foot. In our case, injury to either SN branch will lead to different symptomatology. SN injury will affect the lateral dorsal cutaneous nerve of the foot and the clinical examination will reveal alterations over the lateral aspect of the foot. Trauma to the lateral side of the calf and entrapment of the lateral sural cutaneous nerve may lead to sensory deficits and alterations over the medial aspect of the calf; however the symptoms may be milder than expected, as the area is co-supplied by the PFCN and the diagnosis may be obscure.

Knowledge of the topographic anatomy of the nerves in the posterior aspect of the leg is essential in establishing a correct diagnosis in cases of nerve injury. Physicians and surgeons should always keep in mind the anatomy of PFCN and SN, as the literature reveals a greater than expected variability. If there is a diagnostic conflict, sensory nerve conduction studies may be used to assess the electrophysiological measurements of the PFCN and SN, while in cases of variant symptomatology and obscure neurological examination, imaging studies may also appear helpful (Dumitru and Marquis, 1988; Brooks et al., 2011; Damarey et al., 2013; Kim et al., 2014). Nerves of the ankle

area may be in risk of injury during several procedures, such as bone fracture repair, arthroscopy and Achilles' tendon repair (Citak et al., 2007; Woo et al., 2010); in the presented case, iatrogenic injury could be caused to PFCN due to topographic proximity. We should also note that in case of SN harvesting for nerve transplantation, the surgeon should keep in mind the potentially low termination of PFCN. Imaging studies, especially sonography, can be of great assistance in order to identify the topography of the nerves of the ankle preoperatively (Ricci et al., 2010; Kim et al., 2014), whereas magnetic resonance neurography should be mentioned as a diagnostic and mapping tool (Thawait et al., 2014).

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