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Anatomic correlation of common fibular nerve palsy encountered after short leg casts

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Abstract

Objectives: Short leg casts are routine applications in orthopaedic practice. The aim of the study was to investigate the course of the common fibular nerve and its branches (deep and superficial fibular nerves) around the fibular neck in order to describe a convenient method for applying the lower extremity casts with low risk of fibular nerve entrapment.

Methods: Fifty lower extremities of 26 cadavers were examined. The point where common fibular nerve itself or its branches (deep and superficial fibular nerves) crossed over the fibular neck were dissected. The points where the nerve or its branches have risk of compression between the fibula and the cast were investigated in relation to fibular length.

Results: The average fibular length was 356.9±26.4 mm. The common fibular nerve did not pass over the fibular neck in any specimen, instead, its branches crossed over it. The average distance from the tip of the fibular head to deep fibular nerve and superficial fibular nerve were 42.9±6.5 mm and 52±6.3 mm, respectively. The mean ratio of fibular length to these distances were 8.5±1.2 and 7.0±0.8, respectively.

Conclusion: As short knee casts is a frequent application in clinical practice, it is important to determine a safe upper border for the casts to protect common fibular nerve or its branches. We recommend that the upper border of short leg casts should not exceed the upper 1/7th of the fibular length of the patient in order to avoid fibular nerve palsy.

Keywords: compression; fibular nerve palsy; short leg cast

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Introduction

Lower extremity plasters (casts) are frequently used in orthopaedic practices, as immobilization of the lower extremity helps the healing process. Although this practice seems harmless, it has specific complications. These are; deep venous thrombosis (the most frequent one), the compartment syndrome of the extremity, degradation of the repositioning gained in the fracture area, rigidity of the motionless joints due to the plaster, skin problems as a result of the pressure of the plaster and compression wounds.[1]

Common fibular nerve palsy is the most common entrapment neuropathy of the lower extremity.[2–4] The common fibular nerve may either be compressed internally or externally. Internal factors include tumors, bony or synovial spurs, ganglions, hematoma, vascular abnormalities and entrapment. The external ones are improper leg cast, trauma, fracture, traction injuries, surgical procedures related with proximal fibula; i.e. anterior cruciate ligament reconstruction and treatment of tibial plateau fractures, leg orthoses and pneumatic compression, compression stockings after surgery, postural cases such as pressure caused by prolonged positioning in bedridden patients, poor patient positioning during surgery, prolonged squatting and leg crossing. Moreover fibular nerve palsy may occur due to vascular conditions, diabetes mellitus and some other idiopathic reasons.[1,4–11]

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The common fibular nerve is relatively unprotected as it traverses the lateral aspect of the neck of the fibula. This is the place where the subcutaneous tissue is thin and the common fibular nerve is superficial. Consequently, it is more vulnerable to be compressed or injured in here.[4,5,8,9,12] Particularly, thin and slender people have thin subcutaneous tissue at the fibular neck that makes them more vulnerable to such injuries.[8,9] Aigner et al.[13] confirmed that the neck of the fibula had not been a safe area, concerning osteotomies or bone biopsies. When the nerve is compressed, decrease in microvascular blood flow and axonal transport degradation can destroy the nerve structure and function within hours.[11] Acute compression causes focal demyelination. If compression is prolonged, there becomes perineural edeuma and permanent fibrosis.[11,14] Probably, long duration of the compression plays a critical role in the severe nerve entrapment findings.[5] The timing of the treatment plays an important role in the neurological recovery.[15]

The plasters applied under the level of the knee are finalysed approximately at the region where the common fibular nerve or its branches wind around the fibular neck. The fibular nerve anatomy and the fibular length is variable among individuals. A standardization concerning the length of the fibula may help determination of the places where the nerve is minimally at risk when a cast is applied. While applying a lower extremity plaster, this dreary but reversible complication may be prevented if small tips are taken into account. Thus, we decided to investigate the course of the common fibular nerve and its branches (deep and superficial fibular nerves) around the fibular neck in order to describe a convenient method for applying the lower extremity casts with low risk of fibular nerve entrapment.

Materials and Methods

Fifty lower extremities from 26 formalin fixed cadavers in (21 males and 5 females) were dissected with a mean age of 60.4 years (range: 36 to 74). The cadavers were belonging to the collection of İstanbul University Faculty of Medicine, Department of Anatomy and none of them had any pathological findings in the related region.

The part of the common fibular nerve, where it crossed over the neck of the fibula, was examined in each cadaver, as this part had the maximum risk of compression in a leg cast. The vertical distance between the point where the common fibular nerve or its branches passed over the anterior part of the neck of the fibula and the most proximal palpable point of head of the fibula was measured (a distance) (**Figure 1**). In order to standardize this vertical distance for people of any fibular length, the distance between the most proximal palpable point of

Figure 1. Measurement of the fibular length and the vertical distances between the point where the deep and superficial fibular nerves passed over the anterior part of the fibula and the most proximal palpable point of head of the fibula. **a1** and **a2**: vertical distances of the points where the deep (**a1**) and superficial fibular nerves (**a2**) passed over the anterior part of the fibula to the most proximal palpable point of head of the fibula, respectively; **b**: measurement of the fibular length; **v**: the most prominent palpable point of the lateral malleolus of the fibula; **x**: the most proximal palpable point of head of the fibula; **y**: the point where the deep fibular nerve passed over the anterior part of the fibula; **z**: the point where the superficial fibular nerve passed over the anterior part of the fibula.

head of the fibula and the most prominent palpable point of the lateral malleolus of the fibula was determined as the fibular length (b distance) (**Figure 1**). Then, the "b" distance was divided to "a" distance to figure out the relation of the fibular neck with the fibular nerve (or its branches) in respect to fibular length.

Results

In none of the cases, the common fibular nerve crossed over the neck of the fibula but its main branches (deep and superficial fibular nerves). The mean vertical distance between the point where the deep fibular nerve passed over the anterior part of the neck of the fibula and the most proximal palpable point of head of the fibula (a1) was 42.9±6.5 mm. The mean vertical distance between the point where the superficial fibular nerve passed over the anterior part of the neck of the fibula and the most proximal palpable point of head of the fibula (a2) was 52±6.3 mm. The average fibular length was 356.9±26.4 mm. The mean ratio of the length of the fibula (b) to the vertical distances of deep (a1) and superficial (a2) fibular nerves was 8.5±1.2 and 7±0.8, respectively.

Discussion

The common fibular nerve is formed by the posterior divisions of the fourth and fifth lumbar and the first and second sacral ventral rami. It descends obliquely along the lateral side of the popliteal fossa to the head of the fibula, close to the medial margin of the biceps femoris muscle. It courses between the tendon of the biceps femoris and the lateral head of the gastrocnemius muscle. It curves lateral to the neck of the fibula, deep to the peroneus longus muscle, and here it divides into its superficial and deep branches; the superficial fibular nerve and the deep fibular nerve.[12] Deutsch et al.[16] investigated the division pattern of the common fibular nerve in 70 legs of 35 embalmed cadavers and reported that in 81.4 % of their cases, the common fibular nerve divided into its deep and superficial branches at or distal to the fibular neck. In 10 % of their cases, the common fibular nerve divided to its branches at an average 7.5 mm proximal to the knee joint. In 8.6 % of them, the division occurred at an average of 33mm distal to the knee joint but proximal to the fibular neck. Likewise, in the present study, none of the cases had an undivided common fibular nerve passing over the anterior part of the neck of the fibula. In all of our cases, the deep and superficial branches of it passed over the anterior part of the fibula.

The common fibular nerve supplies the skin on lateral part of posterior aspect of the leg, via its branch, the lateral sural cutaneous nerve. Moreover, by its articular branches, it supplies the knee joint. The superficial fibular nerve provides the motor innervation of the fibularis longus and brevis muscles and it provides sensory innervation of the skin on distal third of the anterior surface of leg and dorsum of the foot. The deep fibular nerve mainly has motor function. It innervates the anterior muscles of leg and dorsum of foot, besides it supplies the skin of first interdigital cleft. In the common fibular nerve palsy, motor deficits are more frequently involved than the sensory ones.[2,12,17] In such a case, all muscles in the anterior and lateral compartments of the leg (dorsiflexors of the ankle and evertors of foot) are paralysed. Because of the loss of eversion of the foot and dorsiflexion of the ankle, foot drop is developed. Moreover, paresthesis is seen at the sensory area and there becomes a loss of sensation on the anterolateral aspect of the leg and dorsum of the foot.[18]

In order not to give harm to the common fibular nerve in proximal fibular surgical procedures, several studies have been made to explain the anatomical relationships of the common fibular nerve in this region. Dissecting 31 unembalmed cadaver legs, Rubel et al.[19] had preferred to define the relationship of the fibular nerve according to the Gerdy's tubercle. They reported that the course of the common fibular nerve defined an arc with a circumference having an average of 45 mm and this circumferential trajectory had been seen at the most prominent aspect of Gerdy's tubercle. They added that using Gerdy's tubercle as a landmark, the trajectory of the common fibular nerve could be easily defined at the level of the proximal aspect of tibia.

Aydogdu et al.[20] investigated the close anatomical relationship of the common fibular nerve and the surgical area of the high tibial osteotomy techniques in 13 human cadavers. They reported that the common fibular nerve passed within 3–6 mm of the posterior aspect of the fibular head and neck and then divided to its branches 22–28 mm distal to the fibular apex.

With the aims of minimizing injury to the common fibular nerve and its branches and establishing a clinical protocol for preoperative and postoperative evaluation of patients who would have surgery on the proximal third of the leg, Reebye[21] performed a study on 20 lower limbs of cadavers. It was reported that 76.7% of all motor nerve branches from the common fibular nerve and its terminal branches had been distributed in the proximal third of the leg; 19.5% in the middle third and 3.8% in the distal third. The same researcher added that 51.1% of the motor nerves were 60 mm distal to the fibular

head. Deutsch et al.[16] also confirmed that the risk of nerve injury is high 60 mm distal to the fibular head. In our study, the point where the common fibular nerve, deep fibular nerve or superficial fibular nerve crossed over the fibular neck, where the nerves were at risk between fibula and cast, were investigated in respect to fibular length. The common fibular nerve did not cross fibular neck in any specimen, but its branches. The average fibular length was 356.9±26.4 mm.The average distance from the tip of the fibular head to deep and superficial nerves were 42.9±6.5 mm and 52±6.3 mm, respectively. The ratio of fibular length to these distances were found to be 8.5±1.2 and 7±0.8, respectively. Our results were similar with Reebye.[21] Additionally we have determined a beneficial ratio and we suggest that the upper border of the plasters for leg should end at the upper 1/7 of the fibular length.

Common fibular nerve palsy cases due to casts are reversible. Nevertheless as the timing of the treatment is important for recovery, it is important to eliminate the other possible reasons for the common fibular nerve palsy on time. Clinical examination, electrophysiological testing and magnetic resonance imaging (MRI) is helpful for diagnosis of fibular nerve damage. MRI of the lumbar spine and sometimes knee and proximal leg, can provide eliminating the proximal lesions.[8]

Conclusion

Based on the data obtained in the present study, we recommend that the upper border of the plasters/casts for leg should end at the upper 1/7 of the fibular length. We believe that the common fibular nerve palsy due to lower extremity casts may be prevented considering this suggestion.

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Conflict of Interest

None.

Author Contributions

FD: designing the project, writing the manuscript; ÖG: designing the project, collecting data, performing analysis, writing the manuscript; İAG: collecting data; AK: writing the manuscript; MEE: designing the project, AÖ: collecting data; AU: collecting data; OC: collecting data, performing analysis.

Ethics Approval

All studies carried out in the Department of Anatomy, İstanbul University School of Medicine using bone or cadaver specimens are regulated and approved by the İstanbul University Faculty of Medicine Clinical Research Ethics Committee.

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