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Applied Anatomy of Common Peroneal Nerve: A Cadaveric Study

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Abstract

Background: A thorough knowledge of the anatomy of the common peroneal nerve (CPN) and its branches is essential for surgeons operating within and around the knee joint. Objectives: To describe origins, the course, branches, length and diameter of the CPN. To identify the relationship between the CPN and palpable landmark: Gerdy's tubercle (GT), the fibular head (FH), the long head of the biceps femoris (LHBF) tendon and lateral condyle of femur (LCF). Methods: We dissected thirty lower limbs of 15 fresh frozen adult cadavers (9 males; 6 females). Results: The course of the CPN was constant. The length of the CPN was 120.6 mm. The diameter of the CPN was 3.7 mm. The distance from the FH - to origin of the CPN was 99.7 mm (89.1-138.5) - to the center of the CPN as it exits beneath the LHBF in 0^0, 30^0, 60^0, 90^0 of knee flexion was respectively 62.5 mm (57.1-66.9), 56.2 mm (50.6-60.3), 47.3 mm (44.1-50.4), 44.6 mm (38.7-47.9) - to the origin of the deep peroneal nerve was 26.4 mm (19.2-37.6), - to the anterior intermuscular septum (AIS) was 15.5 mm (13.2-19.1), - to the point where the deep peroneal nerve came out from the tunnel through the AIS was 69.7 mm (56.4-83.2), The distance from the most prominent aspect of GT - to the CPN behind the FH was 45.2 mm (41.0-48.8), - to the starting point of the superficial branch of the CPN was 45.5 mm (41.0-48.6), - to the anterior recurrent branch of the nerve was 45.4 mm (41.0-48.6). The angle between the deep peroneal nerve and the fibula axis was 25.6^0 (16.2^0-36.8^0). Conclusion: A "safe" area in the proximal fibula is anterior to the FH and downward laterally, not lower than 19.2 mm and from the most lateral prominence, transverse medially not further than 13.2 mm. The inferior boundary of this area is an oblique line of the deep peroneal nerve about 16.2^0 from the fibular axis. The course of the common peroneal nerve trunk and its anterior recurrent branch defined an arc with a radius 45 mm. The most prominent aspect of Gerdy's tubercle is the center of this circumferential trajectory.

Keywords: common peroneal nerve, fibular head, long head of the biceps femoris tendon, lateral condyle of femur, Gerdy's tubercle.

1. Introduction

For surgery in the proximal third of the leg, the incidence of common peroneal nerve damage is of great concern. In the lower limb, 30% of nerve injuries are to the common peroneal nerve(6). Researches demonstrated that Gerdy's tubercle (GT), the fibular head (FH), the long head of the biceps femoris (LHBF) tendon, and the lateral condyle of femur prevail as important landmarks in determining the location of the CPN in the lateral aspect of the knee and an easily palpable landmark(2,16). A thorough knowledge of the anatomy of the CPN and its branches is essential for surgeons operating within and around the knee joint. No studies have been found focusing on common peroneal nerve in Vietnam.

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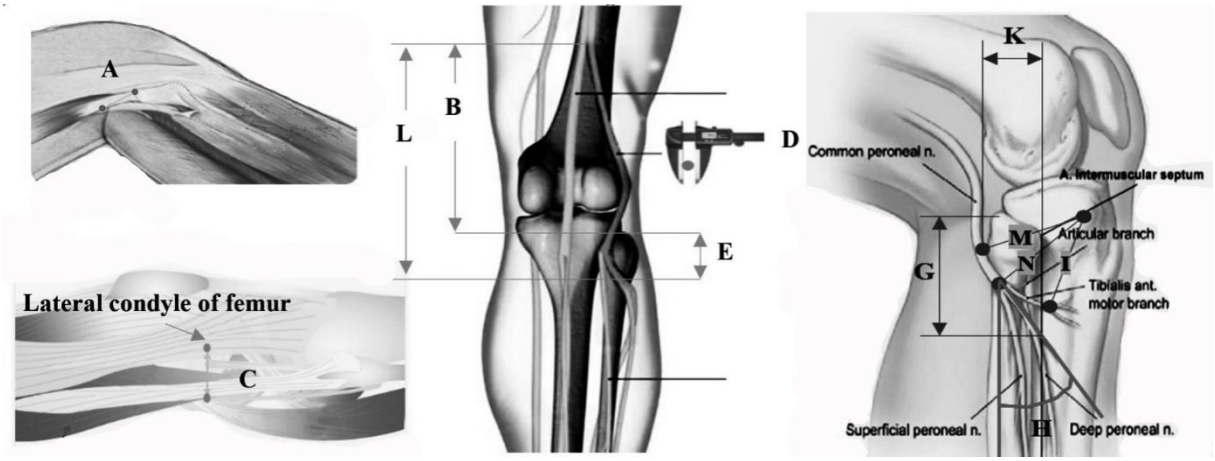
Objective To describe origins, the course of the CPN, branches, length and diameter of the CPN. To identify the relationship between the CPN and palpable landmark: Gerdy's tubercle, the fibular head, the LHBF and the lateral condyle of femur.

2. Materials and methods

We dissected thirty lower limbs of 15 adult cadavers (9 males; 6 females) at the Department of Anatomy, University of Medicine and Pharmacy at Ho Chi Minh city. Calibrations obtained in millimeters with a measuring device. The points of interest were the point of division of the sciatic nerve into the fibular and the tibial nerves, the point of division of the fibular nerve into the superficial, deep and recurrent tibial nerves, the most prominent aspect of Gerdy's tubercle, the fibular head, the LHBF, the lateral condyle of femur, the anterior intermuscular septum, and the fibular axis. All points of interest were measured and recorded in millimeters. The following measurements were made:

1. L, length of the CPN from the point of division of the sciatic nerve into the fibular and the tibial nerves to the point of division of the fibular nerve into the superficial, deep nerves.
2. D, The diameter of the CPN.
3. B, The distance from the fibular head to origin of the CPN in the popliteal fossa.
4. A, The distance from the fibular head to the center of the CPN as it exits beneath the LHBF in 0^0, 30^0, 60^0, 90^0 of knee flexion.
5. E, The distance from the fibular head to the point of origin of the deep peroneal nerve.
6. K, The distance from the most lateral prominence of the fibular head to the anterior intermuscular septum (AIS).
7. G, The distance from the fibula head and where the deep peroneal nerve exited from the tunnel through the AIS.
8. M, The distance from the most prominent aspect of GT to the CPN behind the head of the fibula.
9. N, The distance from the most prominent aspect of GT to the starting point of the superficial branch of the CPN.
10. I, The distance from the most prominent aspect of GT to the anterior recurrent branch of the nerve.
11. C, The distance from CPN to the lateral condyle of femur.
12. H, The angle between the deep peroneal nerve and the fibula axis.



Figs 1: The measurements in this study

3. Results

Features of study samples

Table 1: Features of study samples

No. Samples	Male : Female	Age	Sample
30	3 : 2	64.9	Fresh frozen cadaver

Anatomy of CPN in the knee

The common fibular nerve with a mean length of 120.6 mm and a mean diameter of 3.7 mm, extended from the sciatic notch to the neck of the fibula.

In all specimens the nerve descended obliquely along the lateral side of the popliteal fossa, medial to the biceps femoris and lying between its tendon and the lateral head of the gastrocnemius. The nerve curved lateral to the fibular head, wrapping round it. The the CPN divides into four major branches: lateral sural cutaneous nerve, three articular branches to the knee joint (two of which were found to accompany the inferior and superior lateral genicular arteries, the third articular nerve was the recurrent tibial nerve, which accompanied the recurrent tibial artery), deep fibular nerve (DFN), and superficial fibular nerve (SFN).

The relationship between CPN and anatomical landmarks

Table 2: The distance from CPN to FH

C (mm)	B (mm)	A (mm)				E (mm)	K (mm)	G (mm)	H (mm)
		0^0 of knee flexion	30^0 of knee flexion	60^0 of knee flexion	90^0 of knee flexion				
29.6	99.7	62.5	56.2	47.3	44.6	26.4	15.5	69.7	$25,6^0$

The relationship between CPN and GT

Table 3: The distance from CPN to GT

M	N	I
45.4 mm	45.5 mm	45.3 mm

4. Discussion

Features of study samples: Thirty lower limbs of 15 adult cadavers (9 males; 6 females) mean (SD) age 64.9 years, it was similar to that reported by William Ryan[13].

Anatomy of CPN in the knee:

The common fibular nerve, with a mean length of 120.6 mm and a mean diameter of 3.7 mm, this the results were similar to that reported by O. Reebye[11] et al. No correlation between length and diameter of the common fibular nerve and height ($P > 0.05$).

The course of the CPN was constant. The common peroneal nerve (CPN) is a branch of the sciatic nerve, usually arising at the junction of the upper two thirds and lower third of the posterior compartment of the thigh. The CPN descends obliquely along the lateral side of the popliteal fossa to the fibular head. It is medial to the biceps femoris and lies between its tendon and the lateral head of the gastrocnemius. It curves lateral to the fibular neck, where it is fixed to the bone by connective tissue. At this site the nerve lies in a tunnel, the medial boundary of the entrance of the tunnel was made by the bared fibular neck. The lateral boundary was made by aponeurotic extension from the tendon of LHBF onto the lateral and posterior surfaces of the peroneus longus muscle. The roof of the tunnel formed by the fleshy fibers of FL that arose from the distal aponeurotic extension of the tendon of BF onto the muscle's lateral surface, and from the fibular head and the anterior intermuscular septum. The floor of the tunnel formed by the fibular neck and the lateral surface of the fibula. This arrangement and the deep fascia on the posterior aspect of the lower part of the thigh and upper part of the leg could guard the common peroneal nerve.

After passing "fibular tunnel" the CPN runs deep to the peroneus longus muscle where it divides into the deep and superficial peroneal nerves, it was similar to that reported by several authors (Sinav[14], Okamoto [10] and Gharbawy[4]).

About branches of CPN, Tessa Watt[17] et al described four major CFN branching patterns: in Type 1, neither the DFN nor the ATRN branched before piercing the AIS; in Type 2, the ATRN branched before piercing the AIS; in Type 3, the DFN branched before piercing the AIS; in Type 4, both the DFN and ATRN branched before piercing the AIS. In our study, neither the DFN nor the ATRN branched before piercing the AIS. Allen Deutsch[3] et al reported three distinct patterns of division encountered in the common peroneal nerve with respect to the deep and superficial branches: division distal to fibular neck, division proximal to joint line and division distal to joint line and proximal to fibular neck. In the present study, the common peroneal nerve divided into its deep and superficial branches at distal to the fibular neck.

Relationship between CPN and anatomical landmarks

- The distance from CPN to the lateral condyle of femur (C)

No significant difference between our studies and the one by Hoang Truc Phuong Le[8] (P>0.05) but there was big difference in study by Balasubramaniam[1], the difference may be on ethnic.

- The distance from the fibular head to the point of division of the sciatic nerve into the fibular and the tibial nerves (B). This distance in our study was 99.8 mm, in the study by Ercan Olcay et al was 99.7 mm. No significant difference between two studies (P>0.05).

- The distance from the fibular head to the center of the CPN as it exits beneath the LHBF in 0^0, 30^0, 60^0, 90^0 knee flexion (A)

We agree with Gregory Hildebrand[5], based on the findings in these studies, we identified a relationship between the CPN and an easily palpable landmark. Of course, this identification is reliable only if the fibular head and LHBF are intact.

- The distance from the fibular head to the point of origin of the deep peroneal nerve (E)

The results of several authors: Our study: 26.4 mm, S. Chompoopong[2] et al: 28.4 mm, A. Takeda[16] et al: 26 mm, Soejima[15] at el: 20.5 mm, Ryan[13] et al: 38.9 mm. No significant difference between this study and the one made by two authors: S. Chompoopong and A. Takeda (p>0.05). However, this distance of this study is smaller than that in Ryan's study and longer that in Soejima's study.

- The distance from the most lateral prominence of the fibular head to the (AIS)

No significant difference on the matter between three studies: our study, S. Chompoopong's study (p > 0.05) and A. Takeda's study (p > 0.05).

- The distance from the fibula head and the point where the deep peroneal nerve exited from the tunnel through the AIS (K)

No significant difference between this matter in our study and that in Ryan's study (p > 0.05).

- The angle between the deep peroneal nerve and the fibula axis (H)

The angle between the deep peroneal nerve and the fibula axis in this study is similar to that reported by S. Chompoopong[2] and A. Takeda[16] but smaller than what was reported by Soejima. These differences are likely the result of ethnic and study samples.

Based on data of this study, we identified a "safe zone" in the proximal fibula. This area is anterior to the fibular head and downward laterally, not lower than 19.2 mm and from the most lateral prominence transverse medially not longer than 13.2 mm. The inferior boundary of this area is an oblique line of the deep peroneal nerve about 16.2^0 from the fibular axis. This finding concurs with S. Chompoopong and A. Takeda. According to A. Takeda[16], the nerve branches to the tibialis anterior muscle in this safe area can be sacrificed with no loss of function as there is adequate innervation by branches of the deep peroneal nerve.

The relationship between CPN and Gerdy's tubercle

From data in table 3, we can see: the course of the common peroneal nerve trunk and its anterior recurrent branch defined an arc with a radius 45 mm. The most prominent aspect of Gerdy's tubercle is the center of this circumferential trajectory. This finding concurs with Moskovich[9], Thiago Martins Teixeira[7], Ivan F. Rubel[12] and A. Takeda. The Gerdy's safe zone can be marked preoperatively by the surgeon. By using Gerdy's tubercle as our main landmark, we were able to map the trajectory of the nerve in three planes: axial, as the nerve progresses from proximal to distal; coronal, as it tracks from the posterior to the anterior part of the leg; and sagittal, as it tracks from lateral to medial and enters the anterior compartment of the leg.

5. Conclusions

A "safe" area in the proximal fibula is anterior to the fibular head and downward laterally, not lower than 19.2 mm and from the most lateral prominence transverse medially not further than 13.2 mm. The inferior boundary of this area is an oblique line of the deep peroneal nerve about 16.2 from the fibular axis. The course of the common peroneal nerve trunk and its anterior recurrent branch defined an arc with a radius 45 mm. The most prominent aspect of Gerdy's tubercle is the center of this circumferential trajectory.

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