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ENTRY POINTS OF THE TERMINAL MOTOR BRANCHES OF COMMON FIBULAR NERVE IN FETUSES

FETÜSLERDE NERVUS FİBULARIS COMMUNIS'IN TERMİNAL MOTOR DALLARININ GİRİŞ NOKTALARI

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Öz

Amaç

Bu çalışmanın amacı, nervus fibularis communis'in ve terminal dallarının seyrini, fetal kadavralarda motor dallarının giriş noktalarını tanımlamaktır.

Gereç ve Yöntem

Bu çalışmada 100 formaldehit ile fikse edilmiş fetal kadavranın (54 erkek ve 46 kadın) 200 alt ekstremitesi çalışıldı. Nervus fibularis communis'in terminal motor dallarının giriş noktaları diseksiyon ile gözlendi. Nervus fibularis communis'in bifurkasyon noktasından epikondilus lateralis'e ve malleolus lateralis'e olan mesafeleri ölçüldü. Terminal motor dalların giriş noktaları ile bacağın anterior ve lateral kasları arasındaki mesafeler, nervus fibularis superficialis'in seyrini incelenerek, nervus fibularis superficialis'in bifurkasyon seviyesi ile malleolus lateralis arasındaki mesafe ölçümleri yapıldı.

Bulgular

Fetal dönemde tüm parametrelerin yaşla birlikte arttığı saptandı (p <0,05). Herhangi bir parametre için cinsiyetler arasında anlamlı bir fark yoktu (p> 0,05). Bacağın anterior ve lateral kasları arasında terminal motor dalların giriş noktalarının sayısındaki farklılık istatistiksel olarak anlamlı bulundu. Nervus fibularis superficialis, kadavraların % 77,5'inde sadece bacağın lateral kompartmanında, % 22,5'inde hem anterior hem lateral kompartmanlarda seyir göstermekteydi.

Sonuç

Bu çalışma, fetal dönemde nervus fibularis communis'in seyrini ve terminal motor dallarının giriş noktalarının yerini ortaya koymuştur. Umuyoruz ki, bu çalışma ileri çalışmalar için yararlı bir temel sağlayacaktır.

Anahtar kelimeler: nervus fibularis communis, fetüs, motor dallar, motor sinir giriş noktası, nervus fibularis superficialis

Abstract

Objective

The aim of this study was to describe the course of the common fibular nerve and its terminal branches with a special emphasis on the entry points of the motor branches on fetal cadavers.

Material and Methods

In this study, 200 limbs from 100 embalmed fetuses (54 males and 46 females) were studied. Location and the entry points of the motor of terminal branches of common fibular nerve were observed via dissection. The distances from bifurcation of common fibular nerve to the lateral epicondyle and lateral malleolus were measured. Distances between the entry points of the motor branches of the anterior and lateral muscles of the leg and lateral malleolus were measured. Furthermore, we examined the course of the superficial fibular nerve and measured the distance between the bifurcation level of superficial fibular nerve and the lateral malleolus.

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Results
We found that all parameters were increased with age during the fetal period ($p<0.05$). There was no significant difference between genders for any parameter ($p>0.05$). The difference in the number of the entry points of the motor branches among the anterior and lateral muscles of the leg was statistically significant. Superficial fibular nerve coursed only in the lateral compartment of the leg in 77.5% of the cases, and both in the anterior and lateral compartments in 22.5%.

Conclusion
The present study has revealed the course of common fibular nerve and location of the entry points of the motor branches of its branches during the fetal period. Hopefully, the present study will provide useful base for further studies.

Keywords: common fibular nerve, fetus, motor branches, motor nerve entry point, superficial fibular nerve

Introduction

The common fibular nerve (CFN) is one of two terminal branches of the sciatic nerve (1), it descends obliquely along the lateral side of the popliteal fossa to the fibular head. The nerve is medial to the biceps femoris and lies between its tendon and the lateral head of the gastrocnemius (2). The CFN then becomes palpable where it gets superficial and runs parallel to the tendon of biceps femoris, until the tendon attaches to the fibular head. The nerve wraps around the fibular neck; it is closely attached to the bone at this point (3). It then passes through the fibular tunnel, which is demarked deeply by the aponeurosis of the soleus muscle, and superficially by a fibrous arch of two bands, deep one formed by the aponeurosis of the fibularis longus muscle (FLM), superficial one extending from the soleus to the fibularis longus (4). Within or after the fibular tunnel, the CFN divides into the superficial fibular nerve (SFN) with motor branches to the fibularis longus and the fibularis brevis muscles (FBM); and the deep fibular nerve (DFN), which innervates the tibialis anterior (TAM), extensor digitorum longus (EDLM), and extensor hallucis longus (EHLM) muscles in the extensor or anterior compartment of the leg (5). SFN pierces the superficial fascia in the lower third of the leg. The SFN descends further to the foot, where it divides into terminal branches, namely the medial dorsal cutaneous nerve (MDCN) and the intermediate dorsal cutaneous nerve (IDCN) (6). The above course and distribution are the textbook description of the nerve. However, the SFN may have different anatomical variations, which need to be taken into account during surgery (7). Thirty per cent of the nerve injuries in the lower limb are to the CFN (8). The CFN coursing at the lateral region of the proximal fibula is a “hot spot” in traumatology and reconstructive surgery (5). Given the high frequency of injury to the CFN, it is imperative to further clarify its anatomical course and branching patterns.

The aim of this study was to investigate the anatomy and variability of the branching pattern of the CFN, and define the location of the entry points of the terminal motor branches (MEP) of CFN on fetal cadavers.

Material and Methods

We dissected the proximal fibular region, lateral and extensor compartments in 200 legs of 100 fetal cadavers (46 females and 54 males, ranging 19-40 weeks of gestation). The fetuses were embalmed in 10% formalin solution. Dissections were performed in the Department of Anatomy, Suleyman Demirel University Faculty of Medicine. Written consents from the families and approval from the Ethics Board of the Suleyman Demirel University Faculty of Medicine (11/19/2014, No:182) were obtained at the beginning of the study, prior to fetal dissections. The gestational ages of the fetuses were determined using biparietal diameter, head circumference, femur and foot length. Fetuses were divided into the following three groups according the gestational age: Group 1, 13–25 weeks (2nd trimester); Group 2, 26–37 weeks (3rd trimester) and Group 3, 38– 40 weeks (full term). After the removal of the skin, the deep fascia of the leg was incised longitudinally and the trunk of the CFN was identified. The CFN was dissected from its emergence beneath the biceps femoris muscle to its DFN and SFN branches. Location of CFN and MEP of its terminal branches were revealed via dissection. The distances from bifurcation level of CFN to lateral malleolus and lateral epicondyle were measured (Figure 1A). Number of MEP to the FLM and FBM were noted, and distances between MEP of these muscles and lateral malleolus were measured (Figure 1B). Furthermore, the course of SFN was identified and distance between bifurcation level of SFN and lateral malleolus was measured. The number of MEP to the EDLM, EHLM and TAM were specified, and distances between MEP of these muscles and lateral malleolus were measured (Figure 1C). The mean of each parameter was computed according groups using SPSS 17.0 statistical package (SPSS Inc., Chicago, IL, USA). The significance level was set at 0.05. The data with respect to groups were expressed as mean ± standard deviation. The variance (One Way ANOVA) was analyzed to compare the groups. Significance level was assessed with the Bonferroni correction. Student’s t test was used for all cases to compare the gender and the right-left sides.

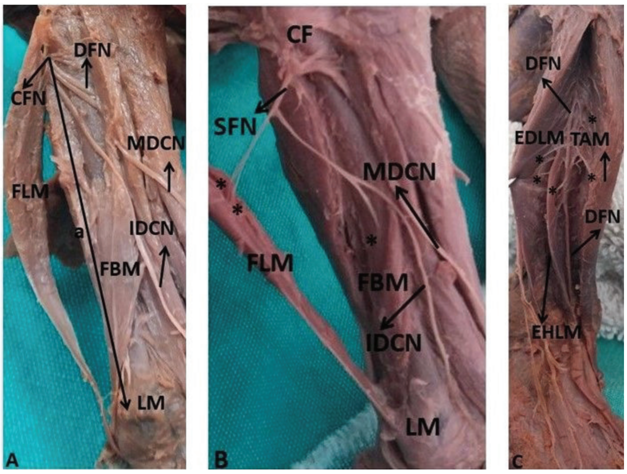

Figure 1. **(A)** The distances from bifurcation level of CFN to lateral malleolus and lateral epicondyle **(B-C)** MEP of lateral and anterior muscles of the leg (CFN: common fibular nerve, DFN: deep fibular nerve, MDCN: medial dorsal cutaneous nerve, IDCN: intermediate dorsal cutaneous nerve, FLM: fibularis longus muscle, FBM: fibularis brevis muscle, a: measured distance, CF: caput fibulae, SFN: superficial fibular nerve, TAM: tibialis anterior muscle, EDLM: extensor digitorum longus muscle, EHLM: extensor halluces longus muscle, LM: lateral malleolus, *: entry points of the motor branches to the leg muscles)

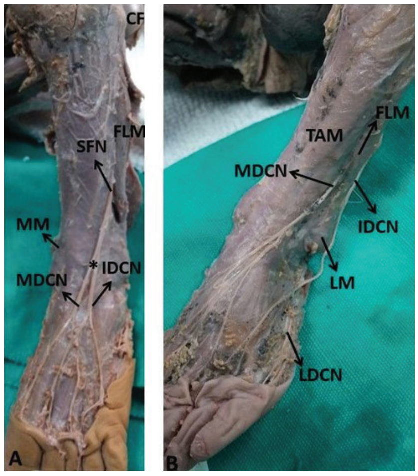

Figure 2. Course of SFN. **(A)** first group; SFN travels in the lateral compartment **(B)** second group; SFN travels both in the anterior and lateral compartment (MDCN: medial dorsal cutaneous nerve, IDCN: intermediate dorsal cutaneous nerve, LDCN: lateral dorsal cutaneous nerve FLM: fibularis longus muscle, SFN: superficial fibular nerve, TAM: tibialis anterior muscle, MM: medial malleolus, LM: lateral malleolus, *: division point of SFN)

Results

The distances from bifurcation level of CFN to lateral malleolus and lateral epicondyle were increased with age during the fetal period ($p<0.05$). No statistically significant difference was found between genders ($p>0.05$) (Table 1). Number of MEP of the FLM, FBM, TAM, EHLM and EDLM were listed in Table 2. FLM had often 2 MEPs (63%, 59.6%, 56%, for the groups, respectively), FBM had 1 MEP (96.3%, 95.7%, 88%). Among the anterior leg muscles, TAM had 2 MEPs (74.1%, 81.3%, 80%), EHLM had 1 MEP (100%, 89.4%, 76) and EDLM had 2 MEPs (66.7%, 66%,76%) (Table 2). The distance between MEP of these muscles and lateral malleolus were increased with gestational age ($p<0.05$). No statistically significant difference was identified between genders ($p>0.05$) (Table 3).

We also focused on the course of the SFN. We studied the level at which SFN separated into MDCN and IDCN, in two different ways. In the first group we measured the distance from where SFN was branched from CFN and became superficial at the lateral malleolus (distance from its origin to lateral malleolus). Furthermore, we measured the distance from the division point of the SFN on dorsum of the foot to the lateral

Table 1 The distances from bifurcation level of CFN to lateral malleolus and lateral epicondyle (mean (mm) ± SD).

Trimester	N	Lateral Malleolus		Lateral Epicondyle	
		Right	Left	Right	Left
2	26	37.62±4.91	37.80±4.73	12.67±3.60	12.34±3.37
3	49	50.18±6.95	50.34±7.20	18.62±3.77	19.16±3.87
Full Term	25	63.28±5.79	63.25±5.21	25.26±4.40	25.48±5.28

P < 0.05, differences between groups.

malleolus. These parameters increased with gestational age during ($p<0.05$) (Table 4). In this group, SFN traveled within the lateral compartment (Figure 2A). Number of this pattern was 40, 73 and 42 according to age groups, respectively. In the second group, the SFN was branched from the CFN in the deep fascia without becoming superficial, and MDCN and IDCN pierced the deep fascia fascia of the leg individually in the lower leg (Figure 2B). In this group SFN traveled both in the anterior and lateral compartments of the leg. Number of cases in this group was 12, 25 and 8 according to age groups, respectively. We measured the distance from penetration point of MDCN and IDCN to lateral malleolus. These parameters increased with age during the fetal period ($p<0.05$) (Table 4).

Discussion

The CFN and its superficial course in the lateral aspect of the proximal leg is a "hot spot" in traumatology and reconstructive surgery. Iatrogenic nerve damage during osteosynthesis of the proximal tibia or correction osteotomies at the leg are followed by consecutive loss of sensory and "foot drop" syndromes (5). In the lower limb 30% of nerve injuries are to the common fibular nerve (9). Considering the high frequency and morbidity of CFN damage, the localization and the branching pattern of the nerve must be known more clearly. Although branching model of CFN is very important for surgeons and anatomists, few studies have been performed on fetuses (1). Our study is the first detailed study of the CFN during the fetal period. We hope that the study provides useful data for the improvement of the interventions to the CFN in the newborn.

CFN is divided into superficial and deep parts. DFN innervates the anterior leg muscles and terminates in a cutaneous branch between the first and second toes. SFN innervates two peroneal muscles and provides cutaneous innervations to the lateral portion of

Table 2 Percentage of number of MEP of the FLM, FBM, TAM, EHLM and EDLM.

		FLM		FBM		TAM		EHLM		EDLM	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Trimester 2 (N=26)	**1 MEP (%)**	33.3	33.3	92.6	96.3	22.2	51.9	92.6	100	29.6	33.3
	2 MEP (%)	63	63	7.4	3.7	74.1	48.1	7.4	-	66.7	59.3
	3 MEP (%)	3.7	3.7	-	-	3.7	-	-	-	3.7	3.7
	4 MEP (%)	-	-	-	-	-	-	-	-	-	3.7
Trimester 3 (N=49)	**1 MEP (%)**	42.6	40.4	95.7	95.7	16.7	20.8	76.6	89.4	31.9	19.1
	2 MEP (%)	55.3	59.6	4.3	4.3	81.3	77.1	21.3	10.6	59.6	66
	3 MEP (%)	2.1	-	-	-	2.1	2.1	2.1	-	8.5	12.8
	4 MEP (%)	-	-	-	-	-	-	-	-	-	2.1
Full Term (N=25)	**1 MEP (%)**	52	44	88	80	12	36	72	76	24	24
	2 MEP (%)	48	56	12	20	80	64	24	20	60	76
	3 MEP (%)	-	-	-	-	8	-	4	4	16	-

P>0.05 FLM χ^2: 2.47 (right); χ^2: 3.17 (left); FBM χ^2:1.49 (right); χ^2:6.40 (left), TAM χ^2: 2.36 (right); χ^2: 8.42 (left); EHLM χ^2:4.27 (right); χ^2:8.96 (left); EDLM χ^2: 2.69 (right); χ^2: 7.22 (left) the leg below the knee. Peroneal neuropathy occurs is the most common neuropathy in the lower extremity. Typically, peroneal neuropathy involves the branches of both SFN and DFN that cause weakness of eversion, extension and dorsiflexion (10 - 12). Therefore, MEP of SFN and DFN are clinically important. When comparing the number of MEP of lateral and anterior leg muscles with other studies, our results were quite different (9, 11). Number of MEP to FLM was consistent with Lee et al.'s study; they studied on 43 legs and reported FLM has two MEP (53.8%) predominantly (11) (in our study 56%). However, number of MEP to FLM was reported as three in all cases (100%) in a study conducted by Reebye on 20 cadaver legs (9). In both studies, authors reported that FBM had two MEPs predominantly (53.8% and 90%) (9, 11); however, in our study we found FBM had 1 MEP in the great majority of the cases (88%). Moreover, Reebye stated that TAM, EHLM and EDLM had 3 MEPs (80%, 65% and 100%, respectively). However, we found that TAM had 2 MEP (80%), EHLM had 1 MEP (76%) and EDLM had 2 MEPs (76%) predominantly (Table 2). It is of clinical importance to be aware of the regional topography of the DFN within the proximal fibular compartment, especially regarding the distribution of its muscular branches, for instance while performing correction osteotomies of the leg, osteosynthesis after knee fracture, or luxation and microsurgical fibular nerve reconstruction (5). Also, we measured the distance between MEP of these muscles and lateral malleolus (Table 3); however, no similar measurements were found in the literature for a comparison. Our study is the first detailed study about the location of MEP in this regard and we think that it will be beneficial for the protection of muscle and nerve function in related interventional procedures in newborns.

Also, we described the course of SFN. In the first group SFN traveled in the lateral compartment (77.5%). In the second group, SFN traveled both in the anterior and lateral compartments (22.5%). Our findings were consistent with other studies (7, 13 - 18) (Table 5). Knowing the variability and damage risk of SFN in the lateral or anterior compartment of the leg will be of considerable benefit to the clinicians in the lower extremity surgeon. In conclusion, this study revealed the anatomy and variability of the branching pattern of the CFN and SFN, also described anatomic location of the MEP of the anterior and lateral leg muscles on fetal cadavers. We hope that our study might be useful in future studies.

Table 3 Distances between MEP of the FLM, FBM, TAM, EHLM and EDLM and lateral malleolus (mean (mm) ± SD).

Trimester	N	FLM		FBM		TAM		EHLM		EDLM	
		Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
2	26	31.69±7.31	30.83±7.46	23.94±5.76	22.94±5.63	30.71±7.03	27.76±5.69	24.56±6.06	21.03±5.58	29.83±8.23	29.21±8.34
3	49	41.95±10.97	41.66±10.57	30.86±8.04	30.24±8.77	36.84±9.35	37.15±8.75	27.34±7.56	27.42±8.05	37.61±12.85	34.84±12.94
Full Term	25	50.62±10.55	47.95±12.86	38.79±9.17	38.55±9.63	43.67±9.35	42.98±9.02	33.25±9.49	33.52±7.41	41.02±14.99	40.93±15.44

P < 0.05, differences between groups.

Table 4 Distance from where SFN was branched from CFN and became superficial at the lateral malleolus (distance from its origin to lateral malleolus); distance from penetration point of MDCN and IDCN to lateral malleolus (mean (mm) ± SD).

	First Group					Second Group				
Trimester	N	SFN		Division Point		N	MDCN		IDCN	
		Right	Left	Right	Left		Right	Left	Right	Left
2	40	23.43±7.31	21.25±5.68	9.85±4.63	10.42±4.82	12	16.76±3.73	16.20±7.95	11.23±4.18	12.69±10.30
3	73	26.63±6.75	25.81±7.77	13.13±3.90	12.41±3.08	25	25.03±6.80	24.13±7.33	15.33±5.26	16.54±5.60
Full Term	42	30.83±6.21	31.15±7.41	16.42±3.85	16.29±2.97	8	29.64±7.23	25.11±1.19	18.47±5.18	9.80±3.24

P < 0.05, differences between groups.

Table 5 Comparison of course of SFN with other studies

Author	Year	Ant.-Lat. Compartment	Lat. Compartment
Adkison et al.[1]	1991	26%	73%
Barrett et al.[5]	2006	23%	77%
Solomon et al. [16]	2001	35%	64.7%
Uçerler et Ikiz [17]	2005	-	63.3%
Apaydın et al. [4]	2008	23.7%	71%
Prakash et al. [13]	2010	28.3%	71.7%
Agthong et al.[2]	2008	28.2%	71.8%
Our study	2017	22.5%	77.5%

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