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Anatomical Study of the Sural Nerve Complex in Human Fetuses

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Authors' contributions

This work was carried out in collaboration between all authors. Author FPR co-designed the study, managed the literature search and proof read the first draft manuscript. Authors CMBS, IPO, DDB and VLCF managed the analyses of the study. Author JAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: The posterolateral region of the leg and dorsolateral as well as the and medial region of the lateral side of the foot are usually described as innervated by the sural nerve. This nerve is of great importance in neurosurgery, plastic surgery and peripheral nerves grafts, having significant diagnostic value in tissue biopsy and neurophysiological assessment of several causes of peripheral neuropathy.

Objective: The present study aimed to study the anatomy of the sural complex in human fetuses, considering its occurrence frequency, type, level of formation and distribution of the sural nerve and other components of the sural nerve complex.

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Materials and Methods: 40 lower extremities of 20 human fetuses, six males and 14 females with ages ranging from 22 to 36 weeks, were used. All fetuses were fixed in a 10% formaldehyde solution and dissected using dissecting instruments with the assistance of a 4X magnifying glass.

Results: The formation of sural nerve was found in 22 of the 40 lower limbs dissected and present in three of the five types described. The medial sural cutaneous nerve was the branch from the sural complex present in all cases.

Conclusions: Given the anatomical variations found in this study, it is possible to conclude that it is significantly difficult to establish an anatomical standard for the complex of the sural nerve. Therefore, this finding is worthy the attention of professionals who, from the clinical or surgical experimental viewpoint, deal with the components of this complex, specially the sural nerve.

Keywords: Sural nerve; fetus; anatomic variation; leg; anatomy.

ABBREVIATIONS

SCN – Sciatic nerve; CFN – Common fibular nerve; TN – Tibial nerve; MSCN – Medial sural cutaneous nerve; FCB – Fibular communicating branch; SN – sural nerve (SN); LSCN – Lateral sural cutaneous nerve; SSV – Small saphenous vein

1. INTRODUCTION

The posterolateral region of the leg and dorsolateral as well as the medial region of the lateral side of the foot are usually described as innervated by the sural nerve (SN) [1,2]. However, since the works of Ortguela et al. [3] most authors have accepted that these regions' innervation depends on a complex anatomical arrangement of nerves, in which the SN formation appears prominent [4-7].

The SN is very important in neurosurgery and plastic surgery, especially for its use in peripheral nerve grafts [8-13]. It is also of significant diagnostic value in tissue biopsy and neurophysiological assessment of several causes of peripheral neuropathy [14-16]. This may explain the persistence of interest in the anatomy of the sural nerve complex in humans.

There is great variation in the anatomy of the main branches of nerves that forms the SN and the absence of its formation has usually been reported by numerous authors [5,7,17-21]. Among branches that form the SN, the medial sural cutaneous nerve (MSCN), the lateral sural cutaneous branch (LSCN) and the fibular communicating branch (FCB) have been frequently highlighted [3-8,22-24].

In the present study on the anatomy of the sural nerve complex in human fetuses, the occurrence frequency, type and level of formation and distribution of SN in the lower limbs were considered. The involvement of MSCN, LSCN and FCB in the formation of SN was also evaluated, as well as the occurrence frequency of each of these nerves in the lower limbs.

2. MATERIALS AND METHODS

Forty lower limbs of 20 human fetuses, six males and 14 females aged between 22-36 weeks, were used. All fetuses were fixed in a 10% formaldehyde solution and were in the Anatomy Laboratory from the Tiradentes University and Federal University of Sergipe. Fetuses were obtained in accordance with the 8501 Law of November 30th, 1992, with regards to the use of unclaimed corpses for purposes of scientific study and research. The study was approved by the Ethics Committee in Research of the Federal University of Sergipe.

A vertical incision was made from an approximately medial point of the infragluteal groove to a line, drawn horizontally, between the medial and lateral malleoli of the ankle region. Each anatomical plane of the thigh and calf posterior regions was dissected from the skin to the fascias, from where they were recognized and the nerves of the calf region could be identified. Nerves from the sural nerve complex were dissected using dissecting instruments, and with aid of a 4X magnifying glass. For description purposes the calf region was divided into upper, middle and lower thirds. All collected data for description were statistically expressed as percentages.

3. RESULTS

From the 40 lower limbs dissected, the formation of SN were found in 22 limbs. In the 18 remaining limbs, nerves from the sural nerve complex, with or without anastomoses, occupied the SN place. Regarding the SN formation and the presence as well as the distribution of the remaining nerves from the sural nerve complex, five morphological types were identified. The SN was present in three of these types and absent in the other two. In the first three morphological types, the SN was formed by the union of the MSCN with:

- I - FCB, branch of the LSCN, in 14 (35%) lower limbs of 11 fetuses, seven left and seven right limbs. The distribution of SN was bilateral in three fetuses and unilateral in eight. Among the latter, they were four in each lower limb (Fig. 1)
- II - LSCN, which had its origin in the common fibular nerve (CFN). This was found in five (12.5%) lower limbs from five fetuses. All nerves were unilaterally distributed with three in the right and two on the left limb (Fig. 2)
- III - FCB and LSCN, both originating from the CFN. The LSCN, in relation to the FCB, had a lateral path and ended at different calf levels. This type was found in three (7.5%) lower limbs from three fetuses and SN occurred unilaterally, two cases in the left limb and one in the lower limb (Fig. 3).

Morphological types in which there was no SN formation:

- IV - MSCN and LSCN, with or without anastomoses, have been located along the calf in 14 (35%) lower limbs of 10 fetuses, being seven right and seven left. The distribution of nerves was bilateral in four fetuses and unilateral in six, three in the right and three on the left limb (Fig. 4).
- V - MSCN was the main nerve along the calf. It occurred in four (10%) lower limbs of three fetuses, two left and two right, being two distributed unilaterally and one bilaterally. In only one lower limb another nerve, besides the MSCN, was found, which was formed by the union of branches originating from the tibial nerve (TN) and CFN, respectively (Fig. 5).



Fig. 1. SN formation by the union of the MSCN with the FBC



Fig. 2. SN formation by the union of the MSCN with the LSCN

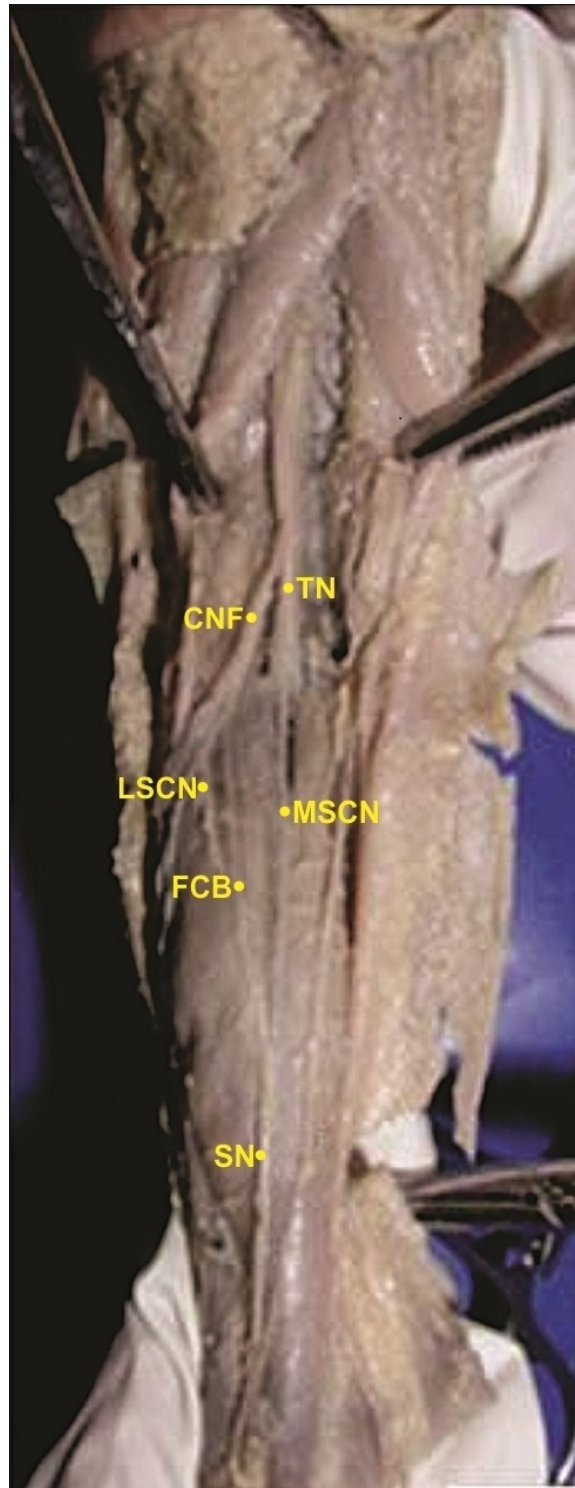


Fig. 3. SN formation by the union of the NSCM with the FBC and the LSCN



Fig. 4. MSCN and the LSCN occupying along the leg the place of the SN

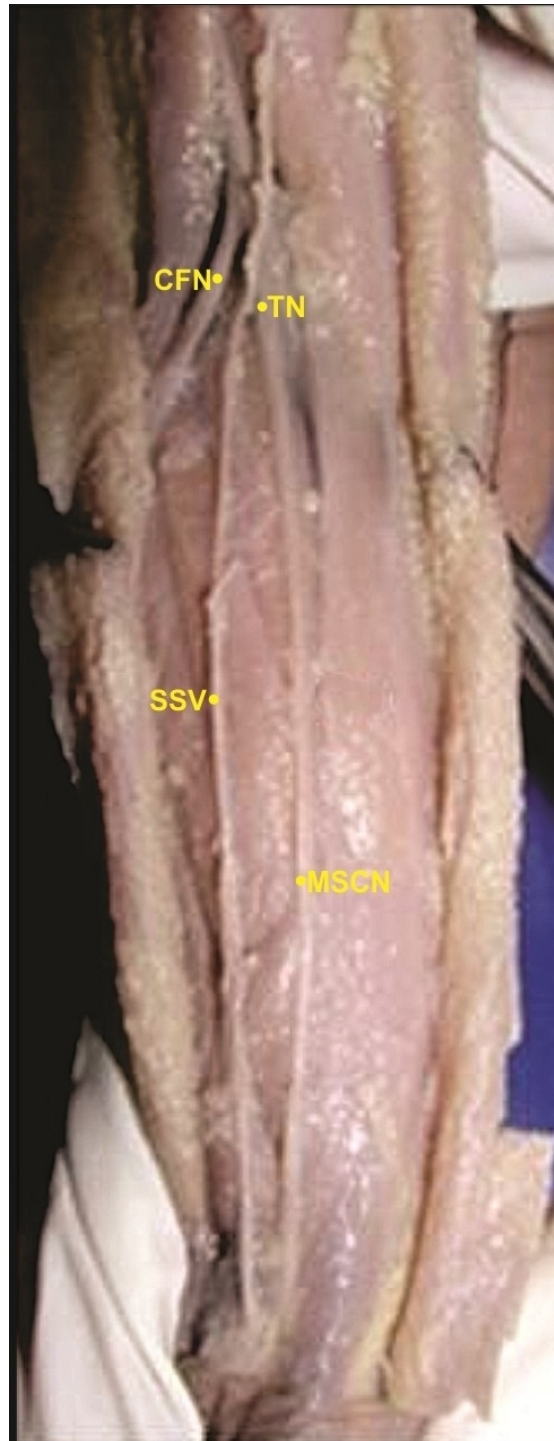


Fig. 5. MSCN occupying alone the place of SN having on side the SSV

The presence and distribution of SN and other components of the sural nerve complex in 40 lower limbs were described in Table 1. As for the lower limb where there was the SN formation, the formation of the nerve was predominant at the middle level (54.5%). In the upper third of the left lower limb, no morphological type of formation of the SN described was found. The morphological type III was not found in any of the lower limbs (Table 2).

Table 1. Distribution of the sural complex components from the lower limb

Components	Right	%/total	Left	%/total	Total
MSCN	20	50.0	20	50.0	40
LSCN	18	45.0	18	45.0	36
FCB	08	20.0	09	22.5	17

Table 2. Level of SN formation by location in the lower limb

Morphological types	Upper third		Middle third		Lower third		Total
	Right	Left	Right	Left	Right	Left	
I	1	0	2	6	4	1	14
II	1	0	0	2	2	0	05
III	0	0	1	1	0	1	03
TOTAL	2	0	3	9	6	2	22
%/TOTAL	9.5		54.5		36.0		100

4. DISCUSSION

There is a significant variation in the frequency of the SN formation in the literature, ranging from 40.5% to 100% [6,24-26]. In our study, the SN was present in 22 (55%) of the 40 dissected lower limbs, in which the SN was found to be equally distributed to each limb.

Some authors classify the anatomical variations of the SN formation and components of the sural nerve complex in morphologic types. Ortiguera et al. [3], Dolan et al. [8] and Mahakkanukrauh, Chomsung [17] described two types; Mestdagh et al. [6] and Pyun, Kwon [27] described three types; Benjamin et al. [4], Uluutku et al. [5] and Aktan et al. [23] described four types; and Ugrenovic et al. [7]; Park et al. [28] described five types. Similarly to these latter authors, we described five morphological types in this study.

Most authors have recorded as more frequent SN formation by the union of MSCN with the FCB and classified it as morphological type I. These authors have shown variations in the frequency of this type ranging from 21 to 80.6% [3,4,6-8,24,28-30]. Park et al. (28) classified the union of the MSCN with the FCB in types I, II, III and IV. The difference between the first three types was in terms the thickness of these nerves. While in the type IV the FCB would have its origin from MSCN.

Like most of these authors, we found the morphological type I in 14 (35%) lower limbs, from 11 of the 20 fetuses studied and these were equally distributed in both limbs. Regarding the SN location, eight were unilateral and three bilateral. Uluutku et al. [5] and Ugrenovic et al. [7] found the morphological type I which was mainly in the right lower limb and bilaterally distributed.

There is much controversy among authors as to the SN formation from the union of the MSCN with the LSCN. Mahakkanukrauh, Chomsung [17] and Drizenko et al. [29] considered these cases as the main morphological type. Pyun, Know [27] classified this SN formation as morphological type I. As Ugrenovic et al. [7] we classified these cases as morphological type II. The frequency reported by these authors was 9% for the morphological type II, but we found 12% in the course of our work. Benjamin et al. [4] classified as type II as the cases where the SN formation emerged directly from the MSCN. Ugrenovic et al. [7] found type II to be distributed unilaterally and bilaterally: with three on the right leg and two on the left. In our findings every nerve formed by the union of the MSCN with the LSCN was unilateral, three were distributed in the right limb and two in the left limb.

In 7.5% of the cases we found the SN formation from the union of the MSCN and the FCB that, along with the LSCN, were a CFN branch and were classified as morphological type III. Uluutku et al. [5] found a similar type in 72.5% of their cases, and in 5% of the cases the participation of the posterior femoral cutaneous nerve was included in the SN origin. Mahakkanukrauh, Chomsung, [17] reported only one case (0.7%).

In the morphological type IV described in our study, and which was found in 35% of the studied lower limbs, the MSCN and the LSCN separately occupied the SN place. Aktan Ikiz et al. [23] and Pyun, Kwon, [27] described similar findings in 7.7% and 6.7% of cases, respectively. However, none of these authors reported data on their distribution in the lower limbs.

Ortiguela et al. [3], Benjamin et al. [4], Uluutku et al. [5], Mestdagh et al. [6], Mahakkanukrauh, Chomsung [17], Ugrenovic et al. [7], Drizenko et al. [29], Aktan Ikiz et al. [23] and Pyun, Kwon, [27] reported a significant range, 5% to 52%, where the MSCN took the SN place. For Ortiguela et al. [3], Uluutku et al. [5] and Mahakkanukrauh Chomsung [17], only the MSCN was found in the SN place. In our findings the MSCN held the SN position in 10% of the 40 lower limbs evaluated and it was classified as morphological type V.

In none of our cases was the LSCN was found in the SN position as described by Mestdagh et al. [6], Ugrenovic et al. [7], Drizenko et al. [29] and Sekiya et al. [30] or the in the PCB as described by Benjamin et al. [4]. A rare anatomical variation was described by Ugrenovic et al. [7], where the MSCN and the FCB occupied the SN position.

The MSCN was present in all lower limbs and it had equal distribution in each member. This finding coincides with that described by Ortiguela et al., [3], Uluutku et al. [5], Mestdagh et al., [6], Ugrenovic et al. [7] and Aktan Ikiz et al. [23], who found frequencies between 93.3% and 100%. The LSCN was found in about 90% cases and was equally distributed between the lower limbs. Coert, Dellon, [22] and Lawrence, Botte, [31] found ranges between 81% and 100%. For the presence of FCB, these authors described a frequency variation from 63.5% to 80% [3,5-7]. We found the FCB in 42.5% of the lower limbs with symmetrical distribution.

Most authors agreed that in 34.6% to 81.5% of cases the SN formation occurs at the mid part of the leg [5,27,28]. We found this formation in 54.5% of the lower limbs, followed by the lower level, with 36%. Aktan Ikiz et al., [23], Coert, Dellon, [22] and Eid, Hegazy, [13] reported higher prevalence of upper and lower levels, respectively.

5. CONCLUSION

Given the anatomical variations found in this study, it is possible to conclude that it is significantly difficult to establish an anatomical standard for the complexity of the sural nerve. Therefore, this finding is worthy of the attention of professionals who, from the clinical or surgical experimental viewpoint, deal with the components of this complex, especially the sural nerve.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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