VIA MEDICA

ORIGINAL ARTICLE

Folia Morphol.
Vol. 61, No. 4, pp. 277–282

ISSN 0015–5659
www.fm.viamedica.pl

Sciatic nerve variations in some studies on the Polish population and its statistical significance

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[Received 21 May 2002; Revised 15 October 2002; Accepted 15 October 2002]

The purpose of the study was to describe and analyse sciatic nerve variation in a relatively small, yet statistically significant, group. Consequently, a comparison of described variation to that known from former studies was performed. Additionally, we estimated the minimum group necessary for a statistical confirmation of hypothetical differences in sciatic nerve topography between the studies.

key words: sciatic nerve, individual variation, statistical analysis

INTRODUCTION

The sciatic (ischiadic) nerve is the largest one in humans. This depends not only on the number of nervous fibres gathered, but also on the large region supplied by the nerve. The importance of the nerve in the learning process of human morphology for medical students depends on several unique features of the nerve.

Firstly, the sciatic nerve is a structure which is easy to recognise, prepare, separate and observe. The width of the nerve can exceed 2 cm and its thickness reaches 0.5 cm. Its tensile strength was determined as maximum load ca. 90 kg.

Secondly, the physiological and clinical role of the nerve is easy to describe and explain, even to students who are starting their medical educational process. The sciatic nerve consists mostly of lumbosacral fibres originating from L_4–L_5 and S_1–S_3 spinal segments. They are both motor and sensory. The motor branches of the nerve supply the posterior group of thigh muscles as well as two joints of the lower limb: femoral and knee joint. Its sensory branches supply the whole tibial and foot areas with the exception of the anteromedial tibial region and the medial margin of the foot. Injuries to the sciatic nerve cause paralysis or paresis of the respective muscles and adequate sensory disturbances. In that case one cannot flex the lower limb in the knee joint. External version and plantar flexion of the extremity are also affected [3, 6].

Thirdly, the sciatic nerve presents significant variability concerning its topography and division into terminal branches (common fibular nerve and tibial nerve). This macroscopic, individual variation is easily noticeable by medical students, even during standard classes of normal anatomy. In fact it is one of the most evident examples and is very suitable as an illustration of the phenomenon of individual variation concerning human body construction.

The most recent and available studies of ischiadic nerve variation performed on the Polish population [4, 5] concern both adults and foetuses. Those studies, however, did not include any attempt at a statistical estimation of the aspect of the group size and variability observed. The searching of the largest available bibliographic databases (including MedLine) did not reveal any further studies analysing the influence of the group size on the statistical significance of sciatic nerve variation described in the group. Our own results were obtained from a study conducted in a relatively small group of 36 lower extremities (adults only). However, our material was still adequate for statistical analysis. Therefore, the most important issue concerning the

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study is whether variations in the topography and division of sciatic nerves observed in a small and a large group taken from the Polish population are coherent or if there are any statistically significant differences between them. This point of our study is one of greater importance rather than a simple description and analysis of sciatic nerve variations found in our group.

The goals of the study were:

1. Description of the sciatic nerve variations in a small, yet statistically significant, group. Features considered in the description were topographical (relation of the nerve to the piriform muscle at exit from the lasser pelvis, division of the nerve into terminal branches).
2. Comparison of the described sciatic nerve variations with those obtained in other studies on the Polish population.
3. Estimation of the minimum group necessary for statistical confirmation of differences between the studies, which could be suggested upon performed comparison.

MATERIAL AND METHODS

Sciatic nerve variations were studied in a group of 36 lower extremities obtained from the Department of Normal Anatomy, Medical University of Łódź, Poland. The extremities were collected from individuals of Polish origin (White Caucasian) 1–10 years prior to present studies and preserved in 3% water solution of ethyl aldehyde with glycerol and ethyl alcohol as additives (not standardised quantities). No statistical differences between left and right limbs (19 v. 17) and sex (17 females v. 19 males) were observed in the studied material.

The nerve was revealed during standard procedure of macroscopic preparations. During preparation of lesser pelvis region muscles (including piriform muscle) were treated with special concern. In order to reveal the division of the main trunk of the nerve into terminal branches, the descendent preparation along the sciatic nerve was done with careful identification of every branch (wider than 2 mm) originating from the main trunk. The relation to the piriform muscle was based on the main (widest) nerve trunk topography as well as topography of its terminal branches — in the case of high (pelvic) division of the sciatic nerve. The level of sciatic nerve division was described topographically, i.e. according to the region where the division took place.

For comparison of the results obtained, a former study on the Polish preparation was chosen [4, 5]. Statistical analysis was performed for whole groups, as well as for respective variations in topography and division of the nerve. However no attempt was made to analyse separately results obtained in left or right extremities, or estimation of the sex or age influence on the results in any group. The chi-square test was used as a tool for coherence determination and appropriate Yates' correction for small groups was made when necessary [1, 2]. Significant p-level was defined as $p < 0.05$.

Estimation of the minimum group necessary for statistical confirmation of differences in sciatic nerve variations was made upon the standard formulation for a priori defined number of cases needed to accept a respective hypothesis [1, 7]. Significant p-level for the formulation was $p < 0.05$. The calculations were made for all variations in topography and division of the nerve. Additional calculation was performed to compare left and right extremities as well as those taken from individuals of different sexes. The range of the estimation was based on the acceptable error of the number in case analysis (huge error consideration) [7]. In fact there are no standard values for this issue in macroscopic morphological studies. Therefore, in our study, the acceptable number of the nerves with false identification of the topographical or division variations was set on two cases for each group.

RESULTS

1. Sciatic nerve variations

   1.1. Relation of the sciatic nerve to piriform muscle (topographical variations)

According to former studies [4, 5], as well as our observations, two variants of sciatic nerve relation to piriform muscle were distinguished (Table 1).

Group I (typical) when sciatic nerve passed under the piriform muscle (despite the nerve coming as one trunk or already being divided into terminal branches). Consequently in group I three kinds of sciatic nerve topography were revealed:

IA (25 cases in our study) — Sciatic nerve passes under piriform muscle as one nervous trunk (it was the most common situation in our material) (Fig. 1).

IB (3 cases) — Sciatic nerve passes under piriform muscle as two nervous trunks, which then gather in one common sciatic nerve.

IC (1 case) — Sciatic nerve passes under piriform muscle as two nervous trunks (as in case IB), however the trunks do not gather and play the role of terminal branches of the nerve (Fig. 2).

Table 1. Variations in sciatic nerve topography and its statistical significance

Group/pattern	Present study (n = 36)	Comparable study (n = 200)	Statistical significance of difference (p < 0.05)
IA	25 (69%)	160 (80%)	Non-significant
IB	3 (8%)	9 (4.5%)	Non-significant
IC	1 (3%)	12 (6%)	Non-significant
Group I (typical) total	29 (81%)	181 (90.5%)	Non-significant
IIA	3 (8%)	5 (2.5%)	Non-significant
IIB	2 (6%)	3 (1.5%)	Non-significant
IIC	2 (6%)	1 (0.5%)	Non-significant
Others	–	8 (4%)	Non-significant
Group II (atypical) total	7 (19%)	19 (9.5%)	Non-significant

Figure 1. Variants of sciatic nerve course. Group I, type A. The whole sciatic nerve passed under the piriform muscle; A — piriform muscle, B — sciatic nerve.

Figure 2. Variants of sciatic nerve course. Group I, type C. The nerve consisted of two independent branches and passed under the piriform muscle; A — piriform muscle, B — common fibular nerve, C — tibial nerve.

Group II (atypical) when sciatic nerve, or at least a part, did not pass under the piriform muscle. In this group four kinds of sciatic nerve topography were revealed:

IIA (3 cases) — Sciatic nerve perforates piriform muscle and passes through its fibres as one nervous trunk.

Figure 3. Variants of sciatic nerve course. Group II, type B. The common fibular nerve passed and tibial one under the piriform muscle; A — piriform muscle, B — common fibular nerve, C — tibial nerve.

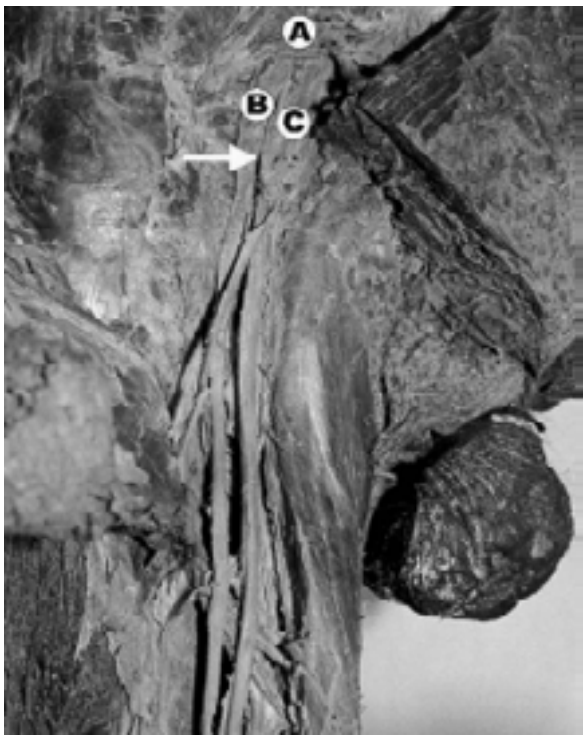

Figure 4. The height of the sciatic nerve division. High division; the sciatic nerve divided in the lesser pelvis or just after piriform muscle; A — piriform muscle, B — common fibular nerve, C — tibial nerve.

Variants IIB, IIC, IID are connected with high division of the nerve (in pelvis) into common fibular nerve and tibial nerve:

IIB (2 cases) — Common fibular nerve perforates the piriform muscle and the tibial nerve passes under the muscle (Fig. 3).

IIC (2 cases) — Common fibular nerve passes over the piriform muscle and tibial nerve under the muscle.

1.2. Division of the sciatic nerve into terminal branches

Three levels of sciatic nerve division into terminal branches were observed and distinguished:

— high (pelvic) level (5 cases in our study) — Sciatic nerve divides inside lesser pelvis or just below piriform muscle (Fig. 4);
— intermediate level (5 cases) — Sciatic nerve divides at lower 2/3 of femur (Fig. 5);
— low (popliteal) level (26 cases) — Sciatic nerve divides in popliteal fossa (Fig. 6).

2. Results of statistical analysis

Statistical analysis of our results with those reported by other investigators [4] did not reveal any significance on p-level given. Especially there were no differences between the frequency of respective relations of the nerve to piriform muscle. Relatively the biggest, yet also not significant statistically, difference concerned group IB: 3/36 v. 9/200, respectively in both studies (Table 1).

There were no statistical differences in levels of sciatic nerve division between both studies.

3. Results of estimation of the minimum group necessary for confirmation of hypothetical differences between the studies.

Two cases, which were defined as acceptable for huge errors estimation, give 6.89% of the biggest group of sciatic nerve variations in our study (Group I, i.e. kinds IA, IB and IC taken together). Such a relatively acceptable error with $p < 0.05$ requires material of minimum 48 cases to confirm statistically differences between frequency of Group I between both studies. This means that our group should be increased by one-third. The results of the study are given in Table 1.

Figure 5. The height of the sciatic nerve division. Intermediate division; the sciatic nerve divided approximately in lower 2/3 length of femur; A — sciatic nerve, B — common fibular nerve, C — tibial nerve.

Figure 6. The height of the sciatic nerve division. Low division; the sciatic nerve divided into common fibular and tibial nerves in the popliteal fossa; A — sciatic nerve.

DISCUSSION

Authors made appropriate efforts, including intensive searching of the largest available bibliographic databases (e.g. MedLine), to reveal more recent contributions on sciatic nerve variation in humans and its statistical significance connected with the number of analysed cases. However, no additional suitable studies on this subject were found and therefore the list of references includes only a few studies focused on sciatic nerve variations and some basic anatomical compendia.

The results of the present study generally confirmed other observations made on the Polish population [4, 5]. We found seven different kinds of relation between sciatic nerve and piriform muscle (IA–C and IIA–C). Authors analysing larger material described eleven patterns, including the seven presented in our group. Four other patterns were connected with pelvic division of the nerve or cases of sciatic nerve passing over the piriform muscle leaving the pelvis. If we regard all these patterns (8 cases in 200 investigated extremities) as one group and compare its frequency with our results, still the differences are non-significant. Especially there were no differences between the frequency of respective relations of the nerve to piriform muscle. Relatively the biggest, yet also not significant statistically, difference concerned group IB: 3/36 v. 9/200, respectively in both studies (Table 1). This could be an effect of the similarity of the investigated populations or the low number of cases in our study.

It is important that on 0.10 p-level this difference in group IB frequency was significant — yet differences in other groups were still not significant. This fact could suggest that the size of the studied group is the basic reason for the lack of statistically proven differences of the ischiadic nerve variations.

Another difference was connected with the level of sciatic nerve division into terminal branches. We described three levels of sciatic nerve division, while in larger material four levels were found. The differences were not statistically significant, even when separate statistical analysis [7] of very high division (absent in our material) was performed. The biggest difference concerned low (popliteal) level of the nerve

division: 26/36 v.136/200, respectively. However, this difference in frequency was not statistically significant either. Again — in this group the differences would be significant if p-level had been set at 0.10. This could support the hypothesis that the reason for the lack of statistically proven differences is the number of investigated preparations.

The present results showed, to reveal any statistically significant difference our group should be enlarged. However, even 33% enlargement of the group is, hypothetically, sufficient for this purpose. The conclusion was based on calculations concerning group IB. In the case of smaller groups (e.g. Group II or patterns IA, IB, IC taken separately) the required number of cases to be investigated was higher. This fact also supports our opinion that there could be found evidence that our results differ from the former study in the considered variation of sciatic nerve.

The most evident statistical conclusion is the comparison of 36 cases in our group and 48 cases of the hypothetical group, which is appropriate to reveal statistical differences.

We calculate that the rates 36/200 and 48/200 in that case are not statistically different as groups are taken randomly from general populations. This leads to the suggestion that, statistically speaking, our material was sufficient to reveal at least some differences between the groups. Consequently, we can interpret our results as different from former studies, but on a not sufficient p-level (0.10).

Another point of discussion is whether comparison with another former study [4] could lead to different conclusions. We could not exclude such a possibility till appropriate analysis was performed. However, the material described in the respective contributions was substantially different, consequent to the fact that most of the extremities were taken from foetuses. As a part of the discussion it is also worth mentioning that in both compared groups no differences in sciatic nerve variations connected with sex were found, although such an analysis was not the basic aim of our study. There was no difference between left and right extremities either. This is, in contrast to the above-mentioned findings, an empirical fact supporting the opinion that there was no difference in sciatic nerve variations between both studies.

The most valuable feature of sciatic nerve variations is that it is evident and noticeable even in relatively small groups of investigated extremities. In our material, which included 20 cases, we were able to observe all most frequently appearing variations of sciatic nerve topography and division levels. The individual variations of human body construction are an obvious biological fact. Nevertheless it is always worth letting medical students become familiar with this basic morphological phenomenon. According to our study we could recommend sciatic nerve as a very useful, easily reachable and handy structure for illustrating morphological variety during a course of normal anatomy for medical students.

CONCLUSIONS

1. In 30% of the cases atypical course of sciatic nerve was observed
2. Differences between our and former comparable studies are not statistically significant, however they are significant on $p = 0.10$ level
3. The investigated group could be increased to ca. 48 cases if statistical significance had to be confirmed on $p = 0.05$ level
4. Sciatic nerve is a useful example for illustrating individual variety, which could be observed even in small groups

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