Levels of Bifurcation of the Sciatic Nerve as Seen at Mulago Hospital

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Background: The sciatic nerve is comprised of the tibial, and the common peroneal nerves, and supplies the posterior thigh, the leg and foot. Its injury commonly results in a condition referred to as foot drop. The level of bifurcation of the sciatic nerve above the transverse popliteal crease is useful during sciatic nerve block, hence the need for healthcare workers to have adequate appreciation of the anatomy of the nerve. The objective of this study was to determine the level of bifurcation of the sciatic nerve above the transverse popliteal crease among Ugandans at Mulago Hospital Complex.
Methods: This was a cross-sectional descriptive study conducted at the department of anatomy dissection laboratory faculty of Medicine, Makerere University and Mulago Hospital mortuary. Eighty cadavers were dissected in the gluteal region and posterior thigh to establish the level of bifurcation of the nerve above the transverse popliteal crease, and this distance was measured.
Results: A total of 80 left lower limbs were dissected including 56 males and 24 females. Specimen height ranged between 145 and 182 cm with a mean of 162.8cm.The nerve bifurcated in the gluteal region and posterior thigh in 77.5% cases and in the pelvis in 22.5% cases. For the 77.5% nerves that bifurcated beyond the pelvis, the level of bifurcation ranged between 3.8 and 32.5 cm, most of the bifurcations occurred between 3.8-12cm above transverse popliteal crease. In four of the nerves that entered the gluteal region after bifurcation, the nerve reunited before final bifurcation occurred in the thigh.
Conclusions: The sciatic nerve bifurcation is very variable and adequate appreciation of these variations is essential. It should be noted that more than 22% of all the nerves leave the pelvis as two separate nerve which means the sciatic nerve trunk can not be traced or used for anesthetic block in the gluteal region or thigh. Only 77.5% of individuals have a sciatic nerve in the gluteal region and thigh, and even within this group of people, the vertical distance of bifurcation ranges between 3.8-32.5cm.

Introduction

The sciatic nerve is the largest nerve in the body and is a continuation of the main part of a nerve plexus which is formed by the L4, 5 and S1, 2 and 3 nerve roots known as the Lumbosacral plexus. It consists of two nerves, the tibial, derived from anterior divisions of, L4, 5, S1, 2, 3, and the common peroneal nerve derived from the posterior divisions of L4, 5, S1, 2. The nerve normally leaves the pelvis by passing through the greater sciatic foramen below the piriformis and anterior to the inferior and superior gemelli and the obturator internus muscles. It is the nerve which supplies the posterior compartment of the thigh, and the region of the lower limb below the knee joint except the skin on the anteromedial aspect of the leg. The nerve usually separates into two and sometimes three components at approximately half way or lowers down the thigh[1-3].

Clinically, it is commonly injured during intramuscular injections, and, its level of bifurcation above the popliteal fossa crease is considered by clinicians during sciatic nerve block for surgery of the calf, Achilles tendon, the ankle and foot, thus locating its major trunk before it

bifurcates, and, applying the anesthesia at that level, which is usually 5 or 7cm according to the classical teaching[4-6]. The level of bifurcation of the nerve among Ugandans had never been studied; hence there was a \need for reference values in that population. The main objective of this study was to determine the level of bifurcation of the sciatic nerve among Ugandans at Mulago Hospital Complex.

Methods

This was a cross-sectional descriptive study conducted at the department of anatomy dissection laboratory faculty of Medicine, Makerere University and Mulago hospital mortuary. The study population included 80 specimens from adults which were dissected from the gluteal region to the transverse popliteal crease. The level of bifurcation of the nerve above the transverse popliteal crease was determined. Ethical review and approval was sought from the faculty research and ethics committee. Informed consent was obtained from the next of keens of the deceased in case of the postmortem specimens.

Results

A total of 80 adult left lower limbs were dissected among which 56 (70%) were males and 24 (30%) were females. The height range of the specimens was 145 cm to 182 cm with a mean height of 162.8±1.9cm. The nerve bifurcated in the gluteal region and posterior thigh in 62 cases (77.5%) and in the pelvis in 18 cases (22.5%). Among the cases which bifurcated in the pelvis, males contributed 13 cases (72.2%) and females 5 cases (27.8%).

Among the 62 cases where the nerve bifurcated in the gluteal region and posterior thigh, the level of bifurcation above the transverse popliteal crease ranged from 3.8 to 32.5 cm with a mean vertical distance of bifurcation of 8.5cm (8.5±1.4cm) and a standard deviation of 5.8 cm. However, 57 cases (91.9%) bifurcated between 3.8-12cm. The height of the specimen was not related with the level of bifurcation of the sciatic nerve from which Pearson chi-square values of 0.810 with a P-value of 0.937 were obtained. Among the 18 cases whose nerves bifurcated in the pelvis, four fused again in the gluteal region and posterior thigh before final bifurcation.

Figure 1. Sciatic nerve components (short arrows) exit the pelvis below piriformis (long arrow) in a bifurcated state

Only 62 cadavers had the nerve bifurcated in the gluteal region and posterior thigh. The remaining 18 cases had their nerves enter the gluteal region when already bifurcated .The average height of the samples was 162.8 cm, most of the bifurcations 57(91.9%) occurred within 12cm above the popliteal fossa crease, and, as indicated, there was no relationship between height and level of bifurcation of the nerve in the gluteal region as indicated by the Pearson Product Moment Correlation Coefficient. It should also be noted that all the specimens used were for adults.

Table 1. Height of Cadavers

Height (cm)	Number of cases	Percentage (%)	Cumulative percentage (%)
145.0	1	1.3	1.3
146.0	1	1.3	2.5
148.0	2	2.5	5.0
149.0	1	1.5	6.3
150.0	3	3.8	10.0
151.0	1	1.3	11.3
152.0	1	1.3	12.5
153.0	1	1.3	13.8
154.0	2	2.5	16.3
155.0	2	2.5	18.8
157.0	3	3.8	22.5
158.0	2	2.5	25.0
158.5	1	1.3	26.3
159.0	8	10	36.3
160.0	5	6.3	42.6
161.0	7	8.8	51.3
162.0	5	6.3	57.5
163.0	1	1.3	58.8
164.0	1	1.3	60.0
165.0	3	3.8	63.8
166.0	4	5.0	68.8
167.0	1	1.3	70.0
168.0	2	2.5	72.5
169.0	1	1.3	73.8
170.0	4	5.0	78.8
171.0	2	2.5	81.3
172.0	3	3.8	85.0
174.0	3	3.8	88.8
175.0	3	3.8	92.5
176.0	2	2.5	95.0
177.0	2	2.5	97.5
179.0	1	1.3	98.8
182.0	1	1.3	100.0

Total	**80**	**100.0**	

Table 2. Height of cadavers and its relationship with the level of bifurcation of the sciatic nerve above the popliteal crease in cases where the nerve bifurcated in the gluteal region and posterior thigh.

Cadaver Height (cm)	Bifurcation Ranges (cm)			Total Number of Cases
	0-12	13-23	24-34	
145-160	27	2	1	30
161-176	26	0	2	28
177-192	4	0	0	4
Total	**57(91.9%)**	**2(3.2%)**	**3 (4.8%)**	**62(100%)**

- Pearson Chi-square value = 0.810
- P- 0.937

Table 3. Vertical level of bifurcation of the intact sciatic nerve above the transverse popliteal crease in gluteal region and posterior thigh.

Level of bifurcation in cm	Number of cases	Percentage (%)	Cumulative percentage (%)
3.8	1	1.6	1.6
4.0	2	3.2	4.8
4.5	1	1.6	6.4
5.0	8	12.9	19.3
5.5	2	3.2	22.5
6.0	8	12.9	35.4
6.5	7	11.3	46.7
7.0	11	17.7	64.4
7.5	4	6.5	70.9
8.0	3	4.8	75.7
8.5	3	4.8	80.5
9.0	5	8.1	88.6
11.5	1	1.6	90.2
14.0	1	1.6	91.8
20.0	1	1.6	93.4
23.0	1	1.6	95.0
27.0	1	1.6	96.6
32.0	1	1.6	98.2
32.5	1	1.6	100
Total	**62**	**100**	**100**

The mean height of the samples was 162.8 cm (162.8 $\pm$ 1.9 cm) with a standard deviation of 8.5.

The mean vertical perpendicular distance of bifurcation of the intact sciatic nerve above the popliteal fossa crease was 8.5cm. More than 90% of bifurcations occurred below 12 cm. However, there were some extra ordinary cases where the nerve bifurcated at; 11.5, 14, 20, 23, 27, 32, and 32.5cm respectively.

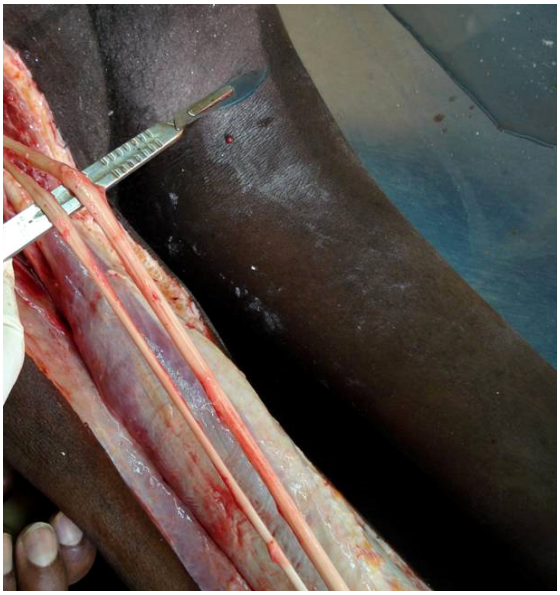

Figure 2.
A bifurcation of the sciatic nerve (indicated by arrow) 32.5 cm above the popliteal fossa crease

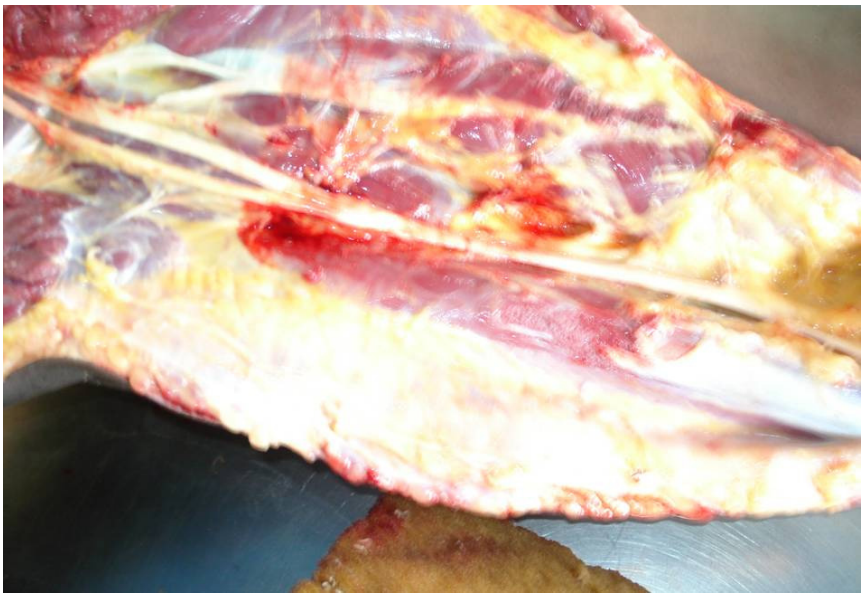

Figure 3. Common peroneal and Tibial nerves entering the gluteal region when bifurcated and then fusing again as indicated by the arrow.

Discussion

The level of bifurcation of the sciatic nerve in the popliteal fossa is a characteristic which is considered by clinicians in sciatic nerve regional block for surgery of the calf, Achilles tendon, the ankle and foot. The logic behind this is to avoid frequent failures in popliteal block by locating the major trunk of the sciatic nerve before it bifurcates and applying the anesthesia at that level. Previous studies have indicated a failure rate of popliteal blocks as high as 21% with many requiring supplementation[7].

In this study, after excluding the 18 cases where the nerves entered the gluteal region bifurcated, the remaining 62 cases had the average distance of bifurcation as 8.5 cm with a range of 3.8- 32.5cm. Most of the bifurcation 57 cases (91.9%) occurred within a distance of 12cm above the transverse popliteal crease. This is different from the classical teaching in which the level of bifurcation is taken to be at an average of 5 or 7 cm above the transverse popliteal crease which has led to the placement of the needle at 7cm[5]. Similar studies have indicated a mean level of bifurcation of 6.05 $\pm$ 2.7cm with a range of 0-11.5cm indicating that some nerves can bifurcate at a higher level than 7cm, and therefore have implicated that when performing popliteal block, insertion of the needle at 10cm above the transverse popliteal crease is more likely to result in placement of the needle proximal to the division of the nerve than placement at 5 0r 7cm according to the classical teaching[3]. In this study, it should be noted that 18 cases bifurcated before leaving the pelvis which is much higher, while among the remaining 62 cases, 57 or 91.9 % bifurcated between 3.8-12cm above the transverse crease. This should be put in consideration while locating the nerve for application of a regional block in the posterior thigh, and the needle should be placed at the 12cm mark above the transverse popliteal crease or higher.

Given the fact that the findings of this study indicate that on average the sciatic nerve among Ugandans bifurcates much higher above the popliteal crease as compared to other studies done elsewhere and because some of the nerves actually bifurcate even above the gluteal region, attempts to block the two components of the nerve at different points and employment of modern technology like ultrasound guided nerve block which have been proven to be more effective should not be overlooked[8-11].

Conclusion and Recommendations

The sciatic nerve bifurcates in the posterior thigh and gluteal region in 77.5% and in the pelvis in 22.5% of cases, and the level of bifurcation is independent of the height of the individual.

Most of the main trunks of the sciatic nerve which exit the pelvis when intact (91.9%), bifurcate between 3.8 and 12 cm above the transverse popliteal crease in the gluteal region and posterior thigh hence, when performing popliteal block in the posterior approach, the level of insertion of the needle should be atleast at the 12cm mark above the transverse popliteal fossa crease if we are to increase our chances of locating the main trunk of the sciatic nerve**.**

However, for the 22.5% nerves that leave the pelvis after separation, a sciatic nerve block is impossible, rather individual tibial and perineal blocks.
Hence the need for ultrasound guided nerve block in this area cannot be over emphasized because only about 50% of individuals studied had a sciatic nerve trunk within 5-7cm range of the transverse crease which is the recommended distance for infiltration of the local anesthetic according to classical teaching.

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