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Research Article

ANATOMICAL VARIATIONS IN PELVIC PART OF SCIATIC NERVE, A CADAVERIC STUDY AND ITS CLINICAL IMPLICATIONS

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Abstract

Background: Sciatic nerve is the largest and widest nerve in the human body. It is also called as the ischiatic nerve or ischial nerve. It is the main continuation sacral plexus. It supplies posterior compartment thigh, leg and foot. Understanding the anatomical variations of the sciatic nerve is essential for clinicians and surgeons due to its implications for sciatic neuropathy, piriformis syndrome, and other surgical procedures. This study aims to investigate the variations of the sciatic nerve's bifurcation level concerning the piriformis muscle using a human cadaveric model.

Materials and Methods: This Descriptive type of Observational study was conducted during the routine cadaveric dissection of I MBBS Students in the Department of Anatomy, Govt Thanjavur Medical College, Thanjavur. 50 Gluteal regions were examined in 25 adult embalmed human cadavers.

Result: Out of 50 lower limbs dissected High division of sciatic Nerve was found in 6%, Trifurcation in 2%. Sciatic Nerve in relation to piriformis variations Type 2 (2%), Type 7 (4%) was also noted.

Conclusion: Variations such as high division, its relation with piriformis can lead to nerve injury during deep intramuscular injections, failure of sciatic nerve block anaesthesia and piriformis syndrome.

Key words: Sciatic nerve, ischial nerve, anatomical variations of the sciatic nerve, piriformis syndrome.

INTRODUCTION

The sciatic nerve, derived from the Greek word "Ischiadichus," is also known as the ischiadic nerve. It is the largest nerve in the human body and originates as a terminal branch of the sacral plexus, with a diameter of 2 cm at its origin.[1,2] The sciatic nerve is 2cm wide and the thickest nerve in the body. It is formed in the pelvis by joining of ventral rami of L4-S3 Spinal Nerves. It leaves the pelvis through the Greater sciatic foramen below the piriformis muscle and descends between the

Greater trochanter and Ischial Tuberosity, along the back of thigh dividing into Tibial and Common peroneal Nerves at the superior angle of popliteal fossa.The level of division of sciatic Nerve into Tibial and Common peroneal is very variable. The commonest site is at the junction of middle and lower thirds of thigh, near the apex of popliteal fossa, but the division may occur at any level above this point and rarely may occur below it. [3].

High division of the sciatic nerve is either unilateral or bilateral, and both the components of sciatic nerve has variable relation with piriformis muscle. It leads to compression of the nerve resulting in piriformis syndrome. The compression of the nerve produce paralysis or paresis of respective muscles and sensory disturbances. The commonest cause of sciatic nerve injury is posterior dislocation and fracture of hip joint.[4]The variation in the division of Sciatic Nerve Manifest as piriformis syndrome, sciatica, inadvertent nerve injury during deep intramuscular injections, failure of sciatic nerve block during popliteal block anaesthesia,[5] External compression of sciatic nerve in buttock in immobile patients injure the sciatic nerve.[6] The variations in the sciatic nerve and its relation with piriformis muscle have surgical importance for the posterior Para trochanteric portal during arthroscopic surgery.[7]

The sciatic nerve is particularly vulnerable to injury during posterior hip dislocation, prolonged external compression over the buttock, and in immobile patients lying on hard surfaces. It can also be severely damaged by misplaced therapeutic intramuscular injections into the gluteal region, with iatrogenic causes being the most common source of sciatic nerve injury.[8]

This study was conducted to know the formation, relation of pelvic part of sciatic nerve and any high division of sciatic nerve, course of sciatic nerve in relation to piriformis. The detailed knowledge about formation, relation of sciatic nerve and any high division of sciatic nerve within lesser pelvis will be useful for physician, Anesthetists, Neurosurgeons, orthopaedician to avoid surgical errors.

MATERIALS AND METHODS

This Descriptive type of Observational study was conducted during the routine cadaveric dissection of I MBBS Students in the Department of Anatomy, Govt Thanjavur Medical College, Thanjavur, India. 50 Gluteal regions were examined in 25 adult embalmed human cadavers for the period of three years from 2018 to 2020. All the cadavers available for study period were included. Fifteen of the cadavers were male and ten were female cadavers.

Inclusion Criteria

Adult donated cadavers in the age group of 30 to 80 years of both sexes for routine dissection to the first year MBBS students at Department of Anatomy, Thanjavur Medical College, Thanjavur.

Exclusion Criteria

The lower limbs of trauma, deformity and contractures were excluded from the study.

DISSECTION PROCEDURE:

The course and division of the Sciatic Nerve were noted to see any possible variations. The Gluteal region, back of thigh and popliteal fossa were exposed by dissection. The Gluteus maximus muscle was cut from its insertion and reflected towards its origin. The Biceps femoris muscle was retracted and the nerve was then exposed in the popliteal fossa. The exit of the nerve from the pelvis, its relation to piriformis and the level of division were recorded. The entire course of the nerve was described and looked for any possible variations.

PARAMETERS TO BE NOTED:

1. Formation of sciatic nerve.
2. Incidence of high division of sciatic nerve within lesser pelvis.
3. The course of sciatic nerve in relation to piriformis.
4. The course of the superior gluteal artery in relation to roots of sciatic nerve
5. The course of inferior gluteal artery in relation to roots of sciatic nerve.

RESULTS

The formation of sciatic nerve was observed in sagittal section of 50 sides of 25 formalin preserved whole pelvis specimens. Out of the 50 specimens dissected, 42 were male specimens, 8 were female specimens.

1. FORMATIONOFSCIATIC NERVE

In the present study in all 50 specimens ventralrami of spinal nerves L4, L5, S1, S2, S3 contribute to the formation of the sciatic nerve and in all specimens the connecting link (furcal nerve) between lumbar and sacral plexus was formed by L4 only and in every specimen formation normal type of plexus was seen. Low fusion of Lumbosacral trunk with first sacral nerve was seen in two specimens.

Table 2.Formation of sciatic nerve (n=50)

Origin	***Frequency***	***Percentage***
Normal(L4-5,S1-3)	50	100

Variations in roots of sciatic nerve:

In two specimens second sacral nerve branched. In one specimen third sacral nerve branched.

Fig1.Specimen showing low fusion of LST with S1



(LST – Lumbosacral trunk; L4 – Fourth Lumbar nerve; L5 – Fifth lumbar nerve;S1– FirstSacralnerve;S2–Second sacralnerve;S3–Third sacral nerve

Table 2.Variations in roots of sciatic nerve (n=50)

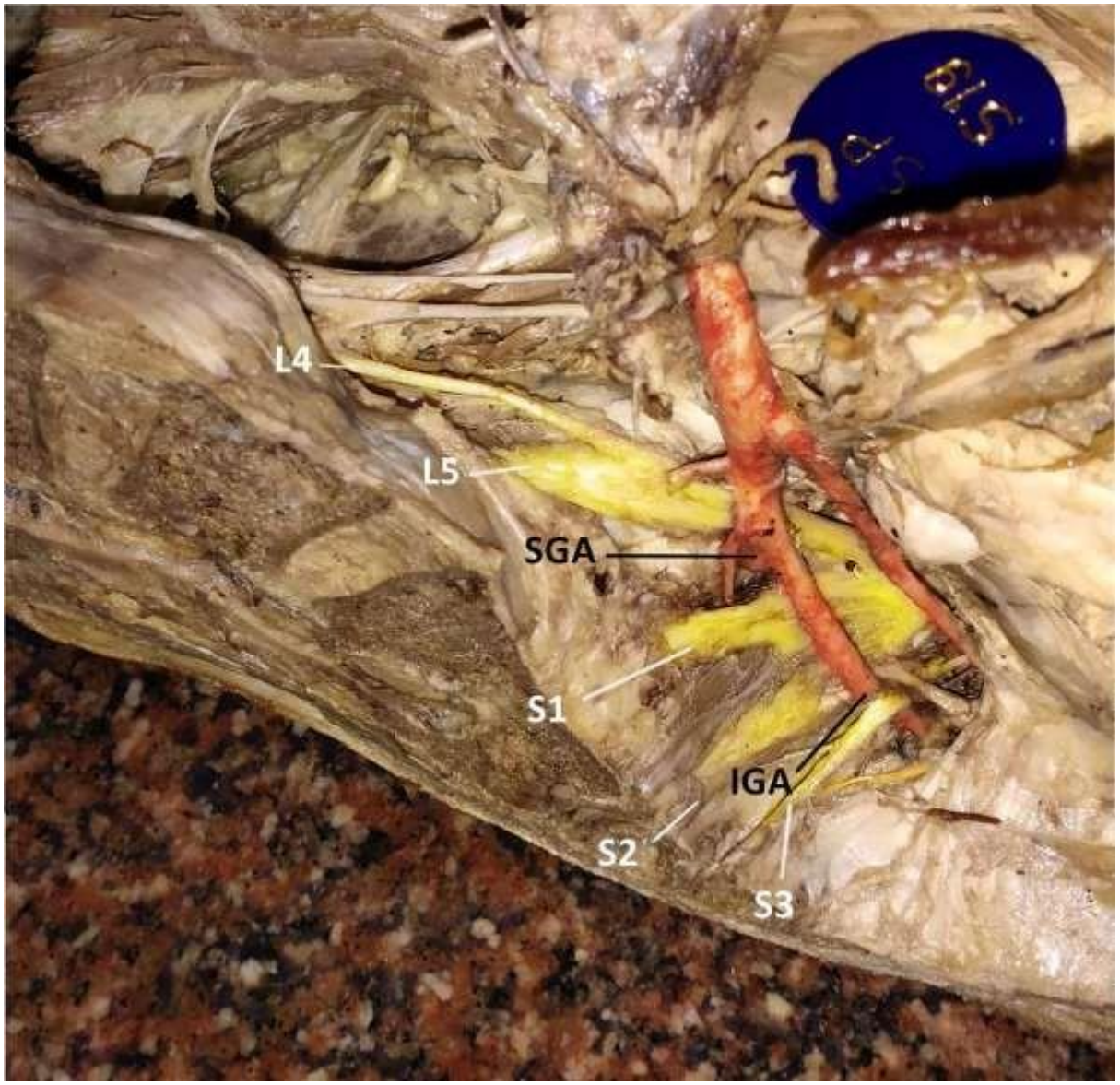
Type	***Frequency***	***Percentage***
Normal	47	94
S2branching S3 branching	2	4
Total	1	2
	50	100

Fig2.Specimen showing branching of S2



(L4–FourthLumbarnerve;L5–Fifthlumbar nerve;S1–FirstSacral nerve; S2 – Second sacral nerve; S3 – Third sacral nerve)

Fig3.Specimen showing SGA passing between L5 and S1; IGA passing between S2 and S3; S3 branching pattern



(L4 – Fourth Lumbar nerve; L5 – Fifth lumbar nerve; S1 – First Sacral nerve;S2– Secondsacralnerve;S3 –Thirdsacral nerve; SGA–Superior gluteal artery; IGA – Inferior gluteal artery)

2. INCIDENCE OF HIGH DIVISION OF SCIATIC NERVE WITH IN LESSER PELVIS

In the present study forty seven out of fifty specimens appeared as single nerve within the lesser pelvis. In three out of fifty specimens the sciatic nerve is divided in to its two terminal branches the tibial and the common peroneal nerve within the lesser pelvis.

Normal	47	94
High division	3	6
Total	50	100

3. THE COURSE OF THE SCIATIC NERVE IN RELATION TO THE PIRIFORMIS

In the present study, forty seven out of fifty specimens showed the normal course of sciatic nerve (type 1) in relation to the piriformis**.**

In two specimens the sciatic nerve divided into its two terminal branches the tibial and the common peroneal nerve within the lesser pelvis. Both branches left the pelvis separately through the lower part of greater sciatic foramen below the piriformis and entered the gluteal region (type 7).

In one specimen the sciatic nerve divided into its terminal branches while passing through the lower part of greater sciatic foramen. The common peroneal nerve pierced the piriformis and entered the gluteal region whereas the tibial nerve passed below the piriformis and entered the gluteal region. Just below the piriformis both divisions reunited (type 2). Refer figure 4 and 5.

Table.5–Variations in the course of sciatic nerve in relation to piriformis in the observed specimens (n=50)

Sciatic nerve	*Frequency*	*Percentage*
Type1	47	94
Type2	1	2
Type7	2	4
Total	50	100

Fig.4: Specimen showing high division of sciatic nerve within lesser pelvis; Course showing Type 7 pattern

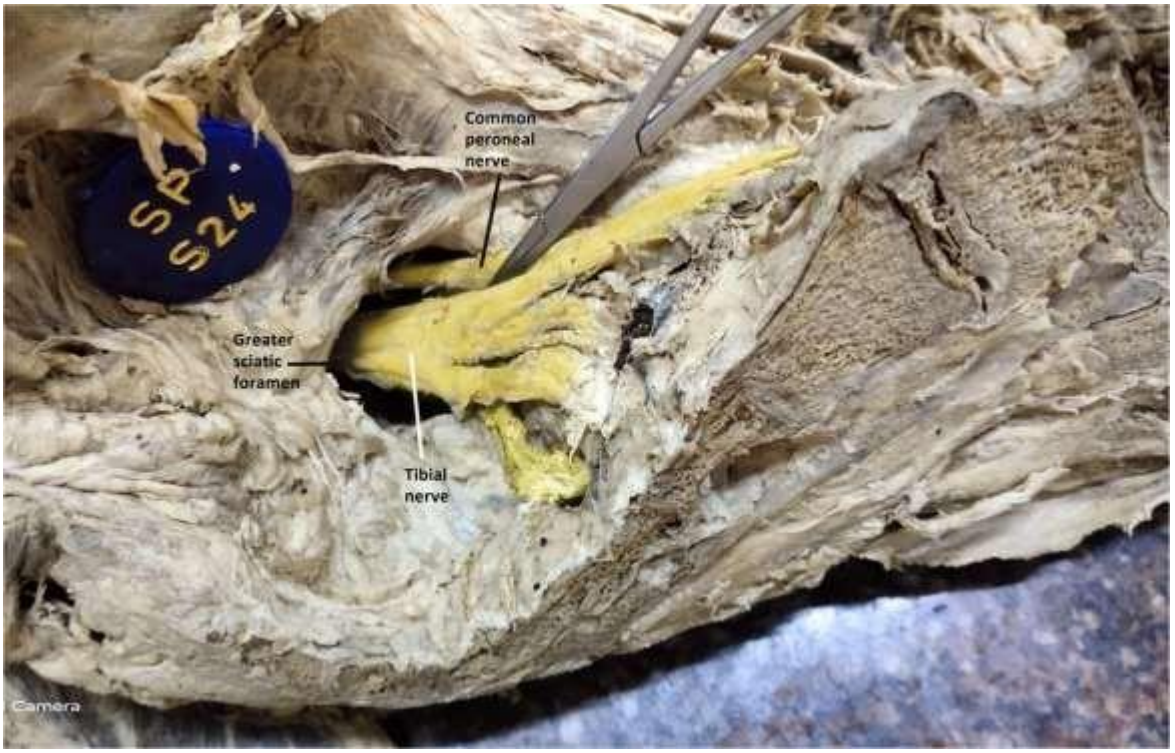


Fig5.Specimen showing course of sciatic nerve region with Type 2 pattern



4. THE COURSE OF SUPERIOR GLUTEAL ARTERY IN RELATION TO ROOTS OF SCIATIC NERVE

In present study in forty-three out of fifty specimens the superior gluteal artery passed between the 5th lumbar nerve and the first sacral nerve.

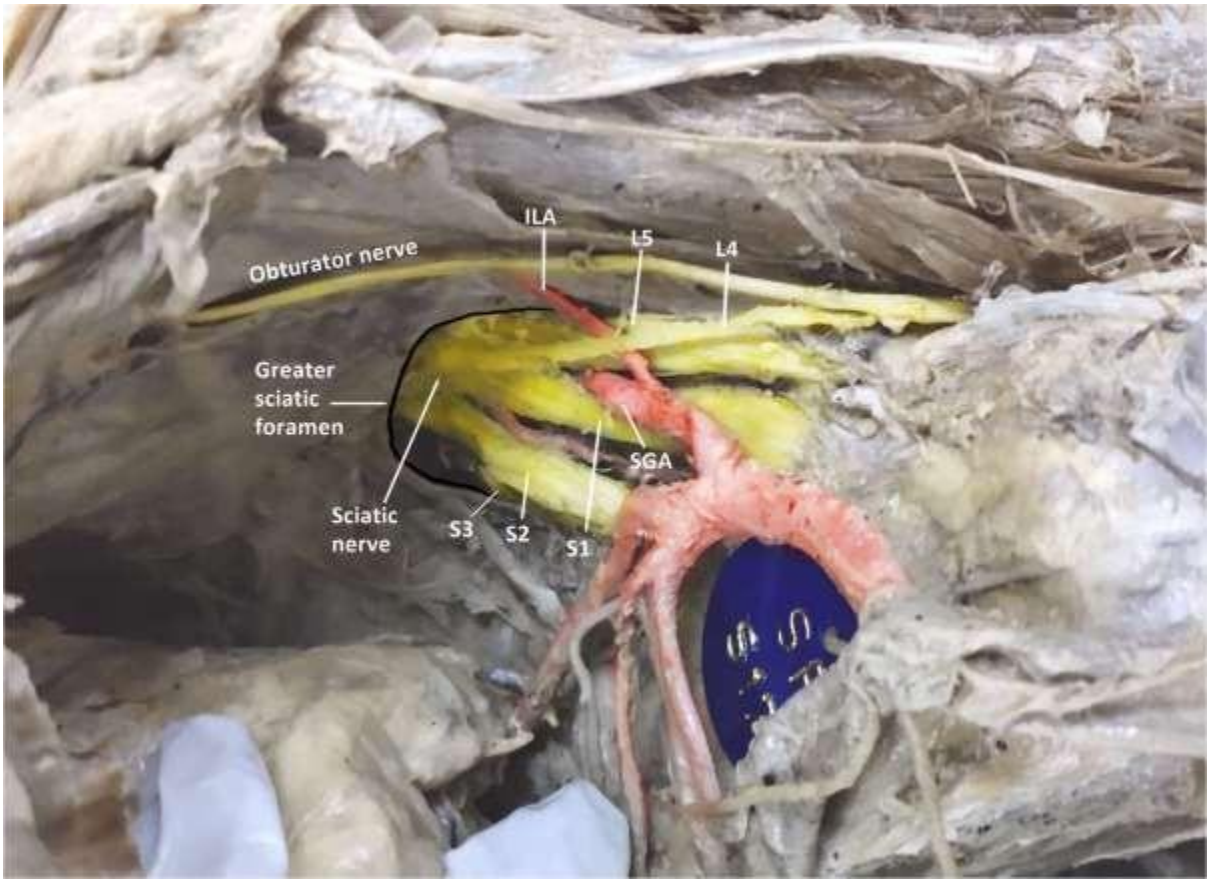
In seven specimens the superior gluteal artery passed between the obturator nerve and the lumbosacral trunk. Figure 6

Fig6.Specimen showing course of Superior gluteal artery between Obturator nerve and Lumbosacral trunk



(LST–Lumbosacral trunk;ON–Obturator nerve;SGA– Superiorgluteal artery)

Fig7.Specimen showing course of superior gluteal artery between L5 and S1



(ILA– Ilio lumbar arteryL4 –Fourth Lumbar nerve;L5– Fifth lumbar nerve; S1 – First Sacral nerve; S2 – Second sacral nerve; SGA – Superior gluteal artery)

Table.6–Variations in relation of Superior gluteal artery to Sciatic nerve in observed specimen (n=50)

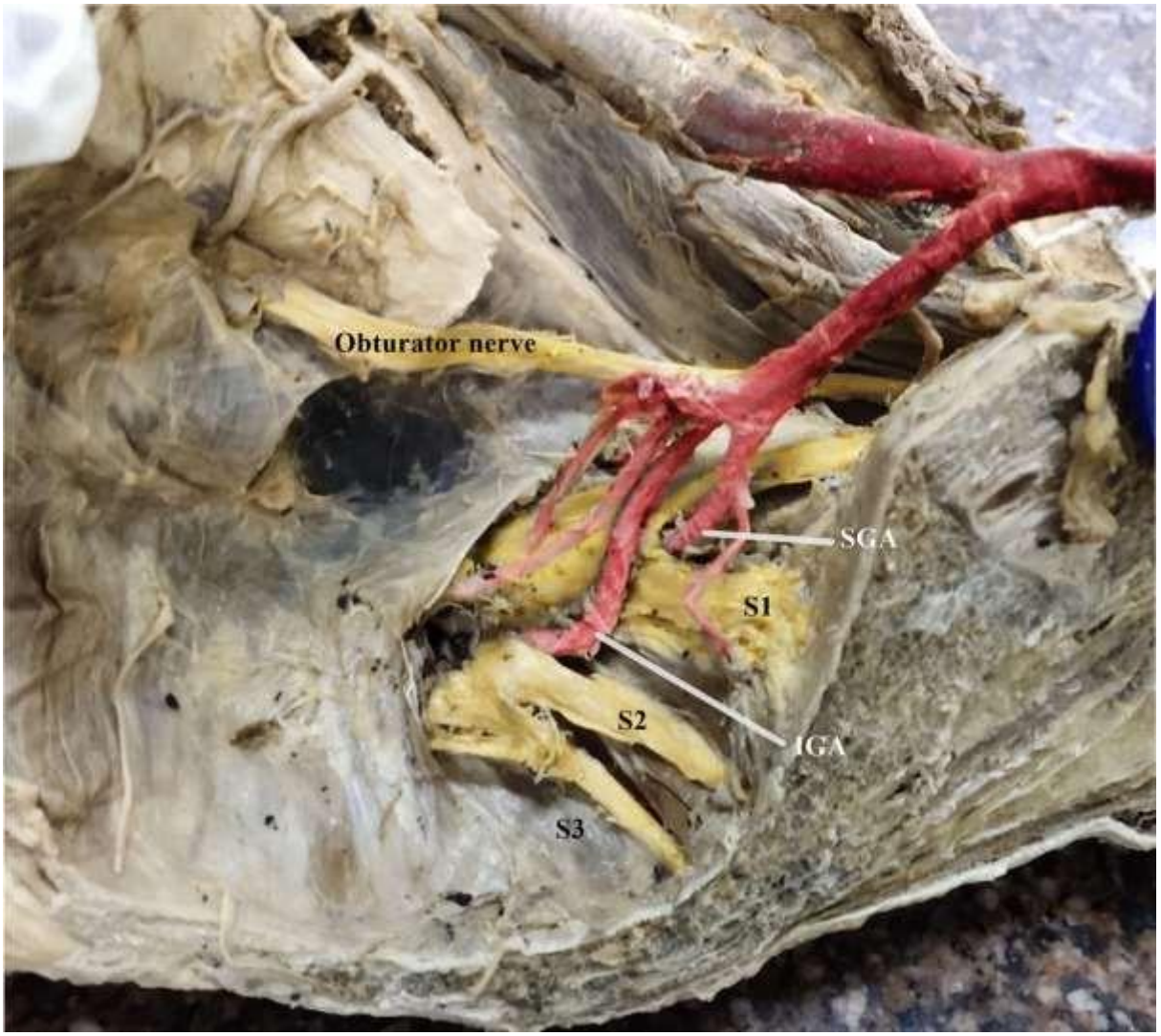
SGA	***Frequency***	***Percentage***
Between L5 and S1	43	86
Between ON and LST	07	14
Total	50	100

5. THE COURSE OF THE INFERIOR GLUTEAL ARTERY IN RELATION TO ROOTS OF SCIATIC NERVE

In the present study in thirty two out of fifty specimens the inferior gluteal artery passed between the first sacral and the second sacral ventral spinal nerves.

In eighteen specimens the inferior gluteal artery passed between the second sacral and the third sacral ventral spinal nerves. Refer figure no 8.

Fig 8.Specimen showing course of IGA between S1 and S2;Normal formation of sciatic nerve



(S1–First Sacral nerve;S2–Second sacral nerve;S3– Third sacral nerve; SGA – Superior gluteal artery; Inferior gluteal artery)

Table7.Variations in relation of Inferior gluteal artery to sciatic nerve (n=50)

Inferior gluteal artery	*Frequency*	*Percentage*
Between S1 and S2	32	64
Between S2 and S3	18	36
Total	50	100

DISCUSSION

1. FORMATIONOFSCIATICNERVE

According to Bergman's comprehensive encyclopedia of Human Anatomic variations [14]the sciatic nerve is formed by ventral rami of spinal nerves L4-L5, S1-S3. The greater part of S2 and S3 converge on the inferomedial aspect of the lumbo sacral trunk in the greater sciatic foramen to form the sciatic nerve.

In the present study in all 50 specimens ventral rami of spinal nerves L4,L5, S1, S2, S3 contribute to the formation of the sciatic nerve and the connecting link (furcal nerve) between lumbar and sacral plexus was formed by L4 only and in every specimen formation normal plexus was observed. , no prefixed and post fixed plexus was seen. Low level fusion of lumbo sacral trunk and first sacral nerve seen in two specimens.

In the **present study** variations on the level of neural roots of sciatic nerve observed three times only. In two specimens S2 branched, in one specimen S3 branched.

Viktor Matejcik et al (2009) conducted a study in 100 specimens and observed changes in sacral plexus on the level nerve roots 41 times. Double ascension of L5 roots in eight cases and plexiform in four cases were noted. Double S1 root 16 times, S2 8 times, S3 once and S1 along with S2 4 times. S1, S2, S3 roots were branched in 15 cases. Truncus lumbo sacral is was thickened in 19 cases. Low level connection between LST and S1 was observed in 10 cases. High division was seen in two specimens. Prefixed type seen in 19 cases; post fixed type seen in five cases. L4 root took part in formation of lumbo sacral trunk in every case. Changes in the sacral plexus on the level of neural root observed 41 times.[9]

2. INCIDENCE OF HIGH DIVISION OF THE SCIATIC NERVE WITH IN LESSER PELVIS

In the present study the sciatic nerve divided before leaving the pelvis in 6% and in 94% after leaving the pelvis.

Ogen'oJAetal(2011)studied in 164 specimens in Kenyan population. The level of sciatic nerve division before exiting pelvis observed in 20.1% and in 79.9% after

exiting pelvis.[10]

Mallikaryun et al (2014) conducted a study in 50 specimens. In 8% specimens the sciatic nerve divided before exiting pelvis and in 92% after exiting pelvis.[11]

Dhivyaetal(2016) conducted a study in Indian population in 64 specimens In 6.25% the sciatic nerve divided before leaving the pelvis and in 93.5% after leaving the pelvis.[12]

Naveena Swargam et al (2017) study was conducted in 30 specimens. In 6.6% the sciatic nerve divided before leaving the pelvis and in 93.33% specimens after leaving the pelvis.[13]

Shailesh M Patel etal (2011) studied in 86 specimens and observed that in 5.6% the sciatic nerve divided before exiting the pelvis and in 94.2% after exiting the pelvis.[14]

5.THE COURSE OF SCIATIC NERVE IN RELATION TO PIRIFORMIS

The present study was conducted in 50 specimens and observed 94% were type 1, 2% were type 2, and 4% were type 7. Moore & Dalley et al (1999)examined 650 specimens and observed 87.3% were type 1, 12.2% were type 2,0.5% were type 3.[15]. Ugrenovic et al (2005) examined 100 fetuses and observed 96% were type 1, 2.5%were type 2, 1.5% were type 3.[16]. Machado et al(2003) examined 100 fetuses and observed 82% were type 1,16% were type 2,2% weretype 3.[17]. Misra et al (1954) examined 300 specimens and observed 87.4 were type 1,6% were type 2, 2.1 % were type 3.[18] . Fukumotto et al (1935) examined 306 specimens and observed 65.5% were type 1, 34.6 % were type 2.[19]. Pan et al (1941) examined 140 specimens and observed 65.7% were type 1,32.9% were type 2, 1.4 % were type 3.[20]

3. THE COURSE OF SUPERIOR GLUTEAL ARTERY IN RELATION TO ROOTS OF SCIATIC NERVE

Hiadka Anetai 2017 Variations of superior gluteal artery were classified into four patterns on the basis of adachi's classification. Type A between L4 and L5, type B between L5 and S1, type C between S1 and S2, type D between obturator nerve and lumbo sacral trunk. [21]

He observed four types of superior gluteal pathway in relation to variation in the segmental origin of furcal nerve. In type Afurcal nerve formed L3 + L4, L4, a large branch from L4 join the lumbosacral trunk. In type B the furcal nerve formed by L4, a small branch from L4 join the lumbosacral trunk, L4 + L5. In type C, the furcal nerve formed by L4 + L5. In type D the furcal nerve formed by L4.In relation to the furcal nerve they classified the course of superior gluteal artery into three patterns.

New classification

Type A: The SGA passes under the ramus from which the furcal nerve originates

Type B: The SGA passes one segment below the ramus of origin of furcal nerve.

Type C: The SGA passes between the obturator nerve and the lumbosacral

trunk.

In the **present study** type B and type D were seen, type A and type C were not seen In 43 specimens the superior gluteal artery passed between L5 and S1 (Type B). In 7 specimens the superior gluteal artery passed between the obturator nerve and the lumbosacral trunk. (Type D). In every case formation normale type of plexus was only seen and the furcal nerve was formed by L4 only .So we couldn't study the course of the superior gluteal artery in relation to variation in the origin of the furcal nerve.

4. THE COURSE OF THE INFERIOR GLUTEAL ARTERY IN RELATION TO THE ROOTS OF SCIATIC NERVE

According to Gray's anatomy 41stedition the inferior gluteal artery passes between either the first and second or second and third sacral ventral rami.[22] In the **present study** in 32 out of 50 specimens the inferior gluteal artery passed between the first and the second sacral ventral rami. In 18 specimens the inferior gluteal artery passed between the second and the third sacral ventral rami. We couldn't come across any previous study on the course of inferior gluteal artery in relation to the roots of sciatic nerve. So we couldn't discuss with previous study.

CONCLUSION

High division of sciatic nerve was found in 6% of specimens and trifurcation of sciatic nerve in 2% of lower limbs. Sciatic nerve in relation to piriformis muscle variations Type 2 (2%), Type 7 (4%) were noted. Cadavers make the best means to see the anatomical variations of different structures of the body. Variations in the formation of sciatic nerve lead to diagnostic confusion, as well as atypical clinical and electromyography findings. Incidence of high division, variations in the course of the sciatic nerve in relation to the piriformis leads to sciatica, piriformis syndrome and incomplete sciatic nerve block during surgery. Variations such as high division and trifurcation of nerve can lead to nerve injury during deep intramuscular injections, failure of sciatic nerve block anaesthesia during various surgical procedures or inadvertent damage to sciatic nerve during varicose vein stripping. Variations in the course of sciatic nerve may complicate surgery and in the interpretation of sciatic neuropathy. The sciatic nerve injuries may be prevented or decreased to minimum by detailed knowledge about normal anatomy and variations of the sciatic nerve. So it is mandatory for the surgeons, anesthetists, radiologists and neurologists to have a detailed knowledge about the formation, course and relations of sciatic nerve.

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