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Original Research Article

# STUDY OF ANATOMICAL VARIATIONS OF STRUCTURES IN RELATION TO PIRIFORMIS MUSCLE

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## ABSTRACT

**Background:** Piriformis muscle is the key muscle of gluteal region. It constitutes an important surgical landmark in the identification of structures that emerge above and below it.

**Materials and Methods:** Twenty embalmed cadavers were studied during routine dissection for first year MBBS students in the department of Anatomy at Dr.B.R.Ambedkar Medical College, Bangalore.

**Observations and Results:** Out of twenty cadavers, in two cadavers we observed piriformis muscle being pierced by the nerves.

**Conclusion:** The variations in the exit routes of the structures in relation to piriformis muscle is important for surgeons, as this is the area of frequent surgical manipulation during hip replacement surgery, nerve injury during deep intramuscular injections in gluteal region.

**KEY WORDS:** Piriformis Muscle, Hip Replacement Surgery, Intramuscular Injections, Gluteal Region.

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## INTRODUCTION

The piriformis is the uppermost of the small muscles of the gluteal region, and the key to the arrangement of the nerves and vessels in the gluteal region. It largely fills the greater sciatic foramen, through which the branches of the sacral plexus and the branches of the internal iliac vessels to the gluteal and pudendal regions leave the pelvis and therefore the vessels and nerves that enter the gluteal region are closely related to this muscle. The superior gluteal nerve and vessels appear at its upper border, while the inferior gluteal nerve and vessels, the sciatic nerve, the posterior femoral cutaneous nerve and the nerves to the small perforators except the piriformis typically appear at its lower border. In more than 10% of cases, the piriformis is perforated by one or both parts of sciatic nerve [1].

Piriformis arises from the anterior surface of the sacrum by three digitations between the pelvic sacral foramina, gluteal surface of the ilium near the posterior inferior iliac spine. It is inserted to the medial side of the upper border of the greater trochanter of the femur. It is supplied by twigs from S1 and S2 nerves. Piriformis is the lateral

rotator of thigh in extended position [2].

Sciatic nerve is the terminal branch of sacral plexus and is the thickest nerve measuring about 2cm in width It is formed by two components-tibial and common peroneal nerve. The tibial component is derived from the ventral branches of ventral rami of L4,L5,S1,S2,S3 and the common peroneal component from the dorsal branches of ventral rami of L4,L5,S1,S2. Both components assemble & emerge through the greater sciatic foramen below the piriformis. Sometimes the division of sciatic nerve takes place in the pelvic cavity. The two components do not join and pass independently; in such condition the common peroneal nerve pierces the piriformis and the tibial nerve passes below the piriformis [2].

The inferior gluteal nerve arises from the dorsal branches of ventral rami of L5,S1,S2. It leaves the pelvis via greater sciatic foramen below piriformis, and divides in to branches that enter the deep surface of gluteus maximus [2].

The posterior femoral cutaneous nerve arises from both anterior and posterior divisions of the sacral plexus, from the first three sacral nerves. It passes in to the gluteal region beneath the piriformis muscle, posteromedial to the sciatic nerve and then passes superficially down the back of the thigh to the knee. It supplies the skin of the lower part of gluteal region and posterior thigh. It also gives perineal branches (the cluneal or clunical nerves) that innervate the skin of the perineum and scrotum or labia together with branches from the Pudendal nerve [1].

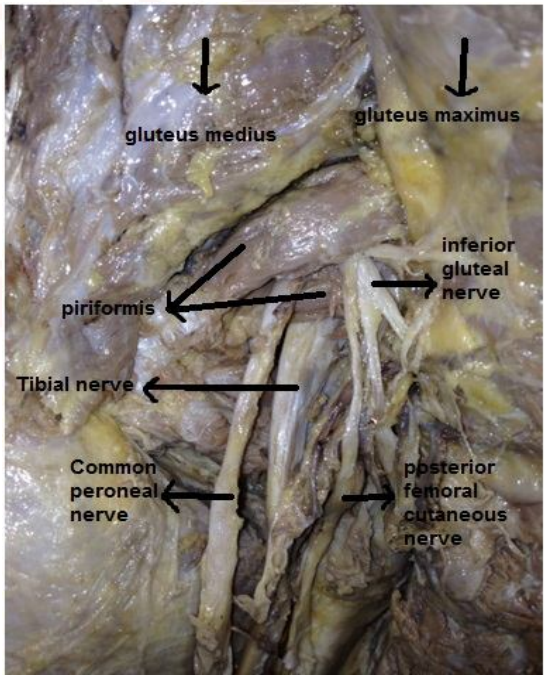
## MATERIALS AND METHODS

The present study was conducted on twenty embalmed cadavers (forty gluteal regions) in the Department of Anatomy at Dr.B.R.Ambedkar Medical College, Bangalore. Bilateral dissection of gluteal regions was performed according to Cunningham's manual of practical anatomy. Bilateral skin incisions were made along the iliac crest from anterior superior iliac spine to posterior superior iliac spine, extending the incision to the natal cleft between the buttocks medially and an oblique incision was put extending from lower part of natal cleft to mid-thigh region. Skin flaps and superficial fascia were reflected laterally, deep fascia was removed from gluteus maximus muscle and its attachments was defined and the muscle was cut across at its lower edge 3cm medial to its femoral insertion, incision extended upwards to the upper border of gluteus maximus superior to the greater trochanter, muscle flaps were reflected, piriformis muscle was indentified and relation of structures to piriformis muscle were studied [3].

## OBSERVATIONS AND RESULTS

Unilateral variations were observed in the relation of nerves to piriformis muscle in two cadavers out of twenty cadavers. In rest of the cadavers, the relation of structures emerging above and below the piriformis were normal and followed the normal course.

**Fig. 1:** Shows common peroneal nerve, inferior gluteal nerve and posterior femoral cutaneous nerve, piercing priformis and tibial nerve emerging from lower border of piriormis muscle.




**Case 1:** The variation was found on left side of gluteal region and there was higher division of sciatic nerve in to common peroneal nerve and tibial nerve, tibial nerve emerging from the lower border of piriformis and common peroneal nerve emerging by piercing the piriformis muscle. Both roots united at the lower border of greater trochanter of femur and continued downwards for about 8cm and at the superior angle of popliteal fossa, sciatic nerve divided in to common peroneal nerve laterally and tibial

nerve medially and lower down both the terminal branches of sciatic nerve followed the normal course. Also the inferior gluteal nerve and posterior femoral cutaneous nerves were observed piercing piriformis muscle along with common peroneal nerve which is very rare.

**Case 2:** In this case, there was higher division of sciatic nerve and only the common peroneal nerve was piercing piriformis mucle and tibial nerve emerging from lower border of piriformis on right side of gluteal region. Rest of the structures were normal in their course in relation to piriformis muscle.

No such variations were found in the gluteal region in respective opposite gluteal regions.

## DISCUSSION

Variations in the division of sciatic nerve in relation to piriformis muscle have been well described by many authors.

Beaton & Anson classified relationships of the piriformis and sciatic nerve in 120 specimens in 1937, and in 240 specimens in 1938 and their classification known as the Beaton & Anson classification is as follows [4,5]

Type 1: Undivided sciatic nerve passes below undivided piriformis muscle

Type 2: Divisions of sciatic nerve passes between and below divided piriformis muscle

Type 3: Divisions of sciatic nerve passes above and below undivided piriformis muscle

Type 4: Undivided sciatic nerve passes between heads of divided piriformis muscle

Type 5: Divisions of sciatic nerve passes between and above heads of divided piriformis muscle

Type 6: Undivided sciatic nerve passes above undivided piriformis muscle.

The present cases (both 1 and 2) showed type-2 variation as in both the cases common peroneal nerve was observed piercing piriformis muscle and tibial nerve emerging below piriformis muscle accounting for 5% (2 of 40 dissected gluteal region). However, in case-1, even the inferior gluteal nerve and posterior femoral cutaneous nerve were also piercing piriformis along with common peroneal nerve. Bergman reported common peroneal division passing through the piriformis in 12% of 420 dissected gluteal regions and in another study 17 cases (12.3%) of 138 gluteal regions [6]. Singh A K studied 100 gluteal regions and in 4% cadavers demonstrated that common peroneal nerve passed through the piriformis and the tibial nerve through the infra piriformis portion of greater sciatic foramen (bilaterally in one of the cadavers and unilaterally in 2 cadavers) [7]. (Table 1)

**Table 1:** Shows the percentage of common peroneal nerve piercing piriformis in different studies.

| Sl. No | Author | Year | Percentage of common peroneal nerve piercing piriformis |
|---|---|---|---|
| 1 | Beaton L E & BJ Anson [4] | 1937 | 11% ( 120 cadavers) |
| 2 | Beaton L E & BJ Anson [5] | 1938 | 7% (240 cadavers) |
| 3 | Chiba S [8] | 1992 | 34% (175 of 514 dissected gluteal regions) |
| 4 | Gabrielli et al [9] | 1997 | 11.2% (9 of 80 dissected gluteal region) |
| 5 | Ugrenovic et al [10] | 2005 | 2.5% (5 of 100 dissected gluteal region) |
| 6 | Mustafa Guvencer et al[11] | 2009 | 14%(7 of 50 dissected gluteal region ) |
| 7 | Singh A K [7] | 2011 | 4% (4 of 100 dissected gluteal region ) |
| 8 | Ogeng'o JA et al [12] | 2011 | 7.9% (13 of 164 dissected gluteal region) |
| 9 | Konstantinos Natis et al[13] | 2014 | 4.1 % (12 of 275 dissected gluteal region ) |
| 10 | Lewis S et al [14] | 2016 | 8.8%( 9 of 102 dissected gluteal region) |
| 11 | Present study | 2017 | 5% (2 of 40 dissected gluteal regions) |

The studies that correlates the division of sciatic nerve with the course of inferior gluteal nerve and its relationship with piriformis muscle is very scarce. However few authors have studied this relationship and have classified, one among them is Chiba [8] who classified I-XIII types based on the 1) number of nerves perforating the piriformis muscle 2) whether all or part of the nerve perforated the muscle 3) the order of perforation and position in the muscle and 4) communications between the nerves. Chiba classified occurrences of the inferior gluteal nerve passing through the piriformis muscle together with the common peroneal nerve as type V. Case- 1 could be classified as type V as in this case also it was found that the trunk of inferior gluteal nerve was piercing piriformis along with common peroneal nerve and accounts for 2.5% in our study.

Gabrielli et al [9] found that out of 80 dissected gluteal regions, in 6 cases the trunk of the inferior gluteal nerve passed through the muscle along with common peroneal nerve and in 3 cases, only a portion of the nerve perforated the muscle.

Tillmann B [15] reported the inferior gluteal nerve leaving the pelvis through the piriformis

bilaterally in 3 cases and unilaterally in 7 cases each out of 112 cases and in all cases common peroneal nerve also exited the pelvis through the piriformis.

However, Jun Yan et al [16] reported inferior gluteal nerve exiting the pelvis from the upper border of the piriformis in 4 of 94 gluteal regions (4.26%).

Zeliha kurtoglu [17] reported in one case where in common peroneal nerve and a very small part of the Posterior femoral cutaneous nerve passed through the piriformis muscle. In case-1 also we found posterior femoral cutaneous nerve piercing piriformis.

**Embryology:**

During embryonic stage of development lumbar and sacral plexuses are formed at the base of lower limb bud. As these plexuses grow out in to the limb the sciatic nerve is formed when the large dorsal component of sacral plexus (common peroneal nerve) and the ventral component (tibial nerve) of sacral plexus move downward close together. Based on developmental formation, it is possible that common peroneal and tibial nerves separate from each other at different levels from their origins [10].

The growth as well as the path finding of nerve fibres towards the target is dependent upon concentration gradient of a group of cell surface receptors in the environment. Several signalling molecules and transcription factors have been identified which induce the differentiation of the dorsal and ventral motor horn cells. Two theories have emerged concerning the directional growth of nerve fibres -The Neurotropism or Chemotropism hypothesis of Ramon y Cajal and the principle of Contact –Guidance of Weiss [18].

The salient features of chemotropism is that axonal growth cones act as sensors to concentration gradients of molecules in the environment and grow up the gradient towards the source,i.e. the target. Contact -Guidance mechanisms operate in parallel with Neurotropism. Adhesion to the structures with which the growth cone contacts also play a role. A group of cell surface receptors viz.neural cell adhesion molecule (N-CAM) and L1 and the cadherins act as transcription factors which recognize and bind to components of the extracelluar matrix. Thus both cell-cell and cell-matrix interactions may be involved in axonal path finding. Over or under expression of one or multiple transcription factors as mentioned above have been found to be responsible for the variations in the formation, relation and distribution of the motor nerve fibres [18].

**Clinical significance:** A clinical condition resulting from compression of the sciatic nerve or its components by the piriformis muscle is known as piriformis syndrome. In approximately 12% of people in whom the common peroneal division of the sciatic nerve passes through the piriformis, this muscle may compress the nerve [19]. Piriformis syndrome results in pain radiating down the leg, weakness of the hip abductor and ankle dorsiflexion along with numbness on the dorsum of the foot [14]. According to Papadopoulos et al., the incidence of piriformis syndrome is six times more frequent in females than in males [20]. It was first described by Yeoman [21] in 1928 while studying the cause of low back pain and Robinson [22] in 1947 coined the term “piriformis syndrome”.

The diagnosis of piriformis syndrome is made by clinical features, electromyography and nerve conduction velocity, computed tomography and magnetic resonance imaging [23-25].

The causes for inferior gluteal nerve injury are piriformis entrapment, intramuscular injections, augmentation gluteoplasty (is a procedure to increase the size and improve the contour of the gluteal region), posterior and posterolateral hip surgeries. Patient with inferior gluteal nerve entrapment usually presents with pain, weakness and numbness of the gluteal region [26].

## CONCLUSION

The knowledge of variations in the relationship of nerves with piriformis, which is a key muscle of gluteal region is of importance to surgeons performing hip surgeries with posterior approach, to anaesthetist for giving nerve blocks. The variations in the exit route of nerves in relation to piriformis muscle should be kept in mind while giving deep intramuscular injections in the gluteal region as injury to inferior gluteal nerve results in paralysis of gluteus maximus muscle and injury to posterior femoral

cutaneous nerve results in pain, paresthesias and sensory disturbances in the posterior part of thigh.

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**Conflicts of Interests: None**

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