

Neuromuscular variations in the gluteal region – Embryological basis and clinical significance

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Abstract

Piriformis, is a key muscle in the gluteal region. Under its lower border sciatic nerve and inferior gluteal nerves exit. During routine educational dissection of the lower limb, bilateral gluteal regions in fifteen cadavers (30 gluteal regions) focusing on the variations of inferior gluteal nerve and sciatic nerve with respect to piriformis muscle were observed in the department of anatomy, All India Institute of Medical Sciences, New Delhi, India. In one of the left sided specimens, inferior gluteal nerve had an abnormal course, piercing superior belly of piriformis muscle instead of emerging through the lower border of it along with variation of the sciatic nerve. The common peroneal component of the sciatic nerve was coming out between the two anomalous tendinous slips of the piriformis muscle, whereas the tibial component, emerged along lower border of the piriformis muscle bilaterally in the same cadaver. In the remaining cadavers, there were no variations of the inferior gluteal nerve with respect to the piriformis muscle. But in another cadaver, there was a similar variation of the sciatic nerve bilaterally. Inferior gluteal and sciatic nerves, when compressed by muscle belly or tendinous slips of the piriformis muscle, may cause lurching gait and sciatica respectively. Knowledge of the different variations of these peripheral nerves with respect to the piriformis muscle is important to clinicians and surgeons for the accurate diagnosis and intervention. *Clin Ter* 2021; 172 (2):91-93. doi: 10.7417/CT.2021.2290

Key words: piriformis, sciatic nerve, inferior gluteal nerve, cadaver

Introduction

Inferior gluteal nerve, one of the cardinal nerves arises from the dorsal branches of fifth lumbar, first and second ventral rami of sacral nerves (1). After its origin, it leaves pelvis through greater sciatic foramen below the piriformis muscle (PM) into gluteal region to supply gluteus maximus (GM) muscle (2) The sciatic nerve (SN) arises from the lumbar and sacral spinal segments (L4 to S3). It has two components, tibial and common peroneal components,

arises from the ventral divisions of L4-S3 and dorsal divisions of L4-S2 from sacral plexus respectively. They supply sensory and motor innervation to the lower limb. The PM originates from the ventral surface of sacrum around the sacral foramina that exit through greater sciatic foramen to insert over the greater trochanter of the femur. It is the key muscle of the gluteal region, so that superior gluteal vessels and nerves emerge along the upper border, whereas inferior gluteal nerve and vessels, sciatic nerve, posterior cutaneous nerve of thigh, nerve to quadratus femoris, pudendal nerve, internal pudendal vessels, nerve to obturator internus pass along the lower border of piriformis. It is classified into three types based on the distance between the musculotendinous junction and its insertion: Type A (long upper and short lower muscle belly); Type B (short upper and long lower muscle belly); Type C (fusion of both muscle bellies at same level) (3). The PM is an important anatomical landmark ultrasonographically in the gluteal region such as a superior gluteal nerve block or sacral plexus block and also for any surgical approach such as total hip arthroplasty (4). Absence of the piriformis muscle affects the orientation in gluteal region and therefore the identification of the targeted structures. Individual variations of each inferior gluteal and sciatic nerves are common but coexistence of variation of both the nerves along with the anomaly of PM is rare. As the gluteal region is one of the common sites for the surgical interventions, these variations draws the attention of clinicians while performing the operations through posterior approach for hip surgeries, nerve blocks during anaesthesia etc (5). Knowledge of the different variations of these peripheral nerves with respect to the PM is important for the apposite diagnosis and intervention.

Material and methods

During routine educational dissection at department of anatomy, All India Institute of Medical Sciences, New Delhi, India, bilateral gluteal regions of fifteen cadavers (Males=11 and Females=4) were taken to investigate the inferior glu-

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teal and sciatic nerves relations with the piriformis muscle. Initially skin incision was made, followed by removal by superficial fascia and deep fascia to expose the GM muscle. After cutting across GM muscle, flaps were exposed to see the underlying structures i.e. piriformis muscle, inferior gluteal nerve and sciatic nerve without damaging them.

Results

After meticulous dissection of all the cadavers, only in one male cadaver, left sided gluteal region showed inferior gluteal nerve pierced the superior belly of the PM (Fig 1). It was also associated with the variation of the peroneal component of the SN, that it exited between the two anomalous tendon slips of the PM (Type B) but the tibial component of SN came out from the lower border of PM (Fig 1). On the other side of the same cadaver, same variation of SN along with two anomalous tendinous slips of PM had also observed but there was no variation of the IGN. In the remaining cadavers, there were no variations of the IGN observed. In another specimen, there was the same variation of SN without IGN and PM variation bilaterally (Fig 2). In all the remaining cadavers, both inferior gluteal nerve, peroneal and tibial components of SN passed under the lower border of PM which had a single belly and a single tendon (Fig 3).

Discussion

Piriformis, a muscle of gluteal region, posterior to the hip joint originates from ventral surface of sacrum, exits pelvis through greater sciatic foramen to insert on the greater trochanter of the femur. It is a key muscle of the

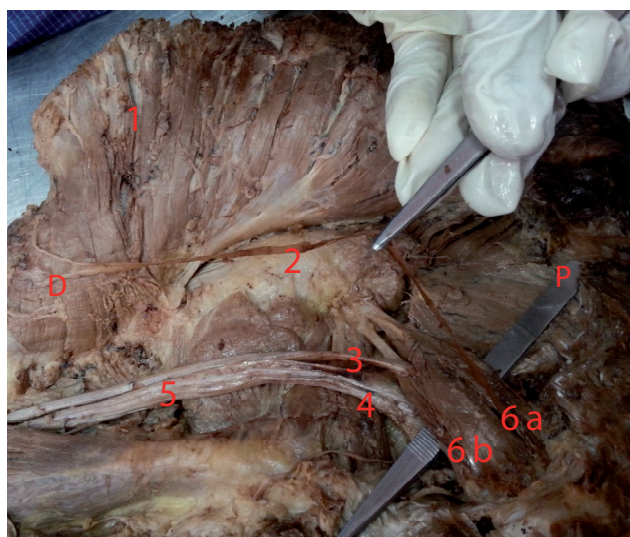


Fig. 1. Photograph showing left gluteal region. Inferior gluteal nerve (2) emerging from superior belly of piriformis muscle (6a). Common peroneal component (3) of sciatic nerve (5) passing between two anomalous tendinous slips of PM. Tibial component (4) of sciatic nerve (5) exits below the inferior border of PM. Piriformis muscle (PM), 6a & 6b-superior and inferior bellies of PM, Gluteus maximus muscle (1), P- Proximal, D- Distal.

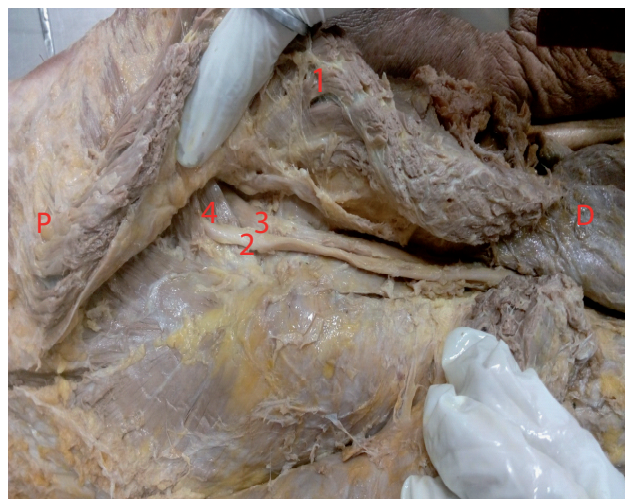


Fig. 2. Photograph showing left gluteal region. Common peroneal component (2) of sciatic nerve pierced the PM (4). Tibial component of sciatic nerve passed along the inferior border of PM (4). Gluteus maximus muscle (1), P- Proximal, D- Distal.

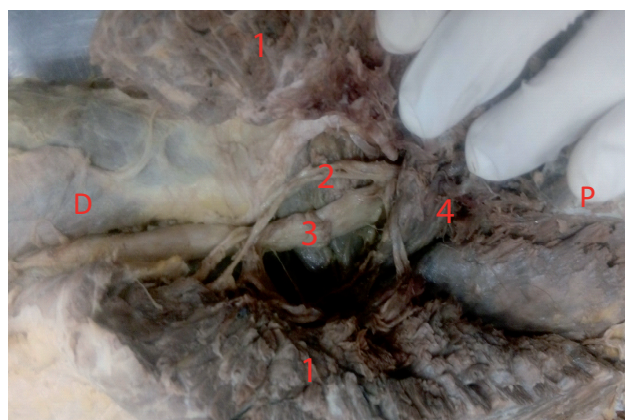


Fig. 3. Photograph showing right gluteal region. Both inferior gluteal nerve (2) and sciatic nerve (3) passed along the lower border of piriformis muscle (4). Gluteus maximus muscle (1), P- Proximal, D- Distal.

gluteal region and a lateral rotator of the hip joint which is supplied by the nerve to the piriformis from the sacral plexus. It is classified based on the distance between the musculotendinous junction and its insertion (3). In the present study, in one of the cadavers, it was observed that PM was of type B variety along with inferior gluteal nerve piercing the superior belly of the PM. The same finding were also documented earlier (6), but coexistence of the anomalous tendinous slips of the PM along with IGN were not documented. If this IGN is compressed due to hyper-contraction of PM, GM muscle gets compromised resulting in weakness of extension at hip joint and lurching gait (7). In the same specimen, the sciatic nerve (L4-S3) variations in relation to PM, was also observed i.e., common peroneal component pierced the PM between its two anomalous tendinous slips and tibial component exited along the inferior border of PM bilaterally. This is a common variation of the sciatic nerve

as reported earlier (8).

The similar variation of the sciatic nerve was observed in another specimen out of thirty without IGN variation in the present study. As the common peroneal component of the SN emerging the single belly of the PM, it may also be compressed by the hyper-contraction of PM which can lead to a foot drop (9). Even though variations in the SN and IGN variations were commonly documented individually, (10, 5, 11), variations of the coexistence of both the nerves with respect to PM is not documented earlier.

Conglomeration of the gluteus maximus and piriformis muscles, both of which are supplied by the IGN, can also lead to piriformis syndrome (10). In one of the cadavers of the present study, the IGN was coming out through the superior belly of the PM, and IGN supplied only the gluteus maximus muscle unilaterally. There may also be differential muscle belly spasm of the PM due to variance in microtrauma and hence differential nerve compression can occur i.e., nerve leaving from the superior border of superior belly, inferior border of inferior belly or through the PM. Whenever there is hypercontraction of PM due to anatomical variations or due to scar tissue of the PM or injury during leg and hip maneuvers, there may be a chance for the compression of the nerves like IGN and SN in the present study (12).

Embryological basis of the two tendinous slips could be since during dermatomyotome development of PM, two separate myotome structures developed as two separate condensations of mesenchyme from two different sites. This might be also the same reason for the IGN and common peroneal component of sciatic nerve which came out through the PM in the present case (13). These variations in IGN, SN, PM may be due to either molecular incoordination in myogenesis or in axonal guidance in the development of peripheral nervous system. During myogenesis, there are six stages of development and each stage is associated with numerous genetic factors like Pax-3 (paired box transcription factor), c-Met (protooncogene), HGF (Hepatocyte growth factor) (14), Lbx1 (Drosophila Lady bird late gene) etc (15). Variations in the expression of these factors will result in muscular defects. But there may be abnormality in the development of nerves also. After the formation of growth cone the direction of a nerve is determined by many factors like netrins, slits, semaphorins, ephrins etc (16). Differential expression of these molecules also can lead to abnormal pathway of the nerve. Thus, whether the change in molecular regulation is in myogenesis or in the development of nerve may lead to variations of both nerves and muscles as seen in our present study.

Conclusions

The knowledge of the anatomical variations of the IGN and SN together with respect to PM are vital for clinicians during administration of intramuscular injections, augmentation gluteoplasty, gluteal pain and different presenting symptoms and signs and also for the orthopedic surgeons during hip surgeries though posterior approach. If the IGN compressed between the two bellies of PM called inferior gluteal entrapment syndrome in which the impairment of

normal gait is present and it is compensated by hamstring muscles. The compression of the nerves may lead to lurching gait and sciatica. These variations in IGN, SN, PM may be due to either molecular incoordination in myogenesis or in axonal guidance in the development of peripheral nervous system.

Conflict of Interest

All authors declare no conflict of interest.

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