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Case Report

Anatomy Section

Dual Innervation to the Gluteus Maximus: A Case Report with Clinical Implications

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ABSTRACT

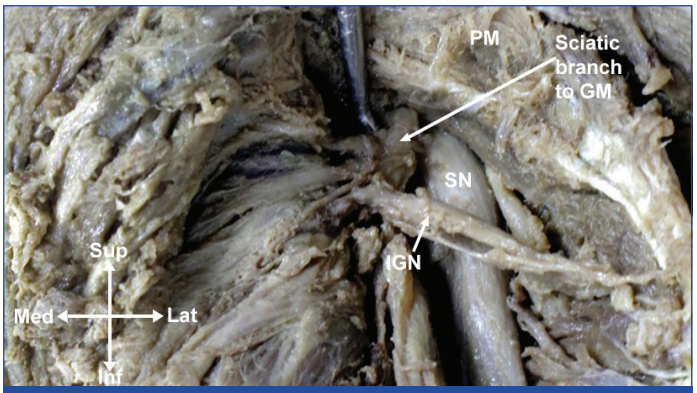
Anatomical variations of the gluteus maximus have significant clinical implications. The gluteus muscle is commonly innervated by the Inferior Gluteal Nerve (IGN). However, this innervation could be affected by its embryological development. An anomalous innervation of the gluteus maximus by the Sciatic Nerve (SN) was identified during a bilateral dissection of the gluteal region. Dissection was performed on an elderly female cadaver, preserved with 10% formalin, and performed following the guidelines given in Grant's Dissector 16th edition. The left and right gluteus maximus were innervated by their corresponding IGN. However, both demonstrated an additional innervation by the SN. This branch by the SN was located proximal to the IGN and emerged near the inferior border of the piriformis muscle. Patients with dual gluteus maximus innervation can present with clinical signs and symptoms which might be easily misdiagnosed. Therefore, physicians need to be aware of this abnormal innervation to accurately diagnose and avoid potential iatrogenic nerve injuries during interventions.

Keywords: Botulinum toxin, Inferior gluteal nerve, Muscle relaxants, Piriform syndrome, Sciatic nerve

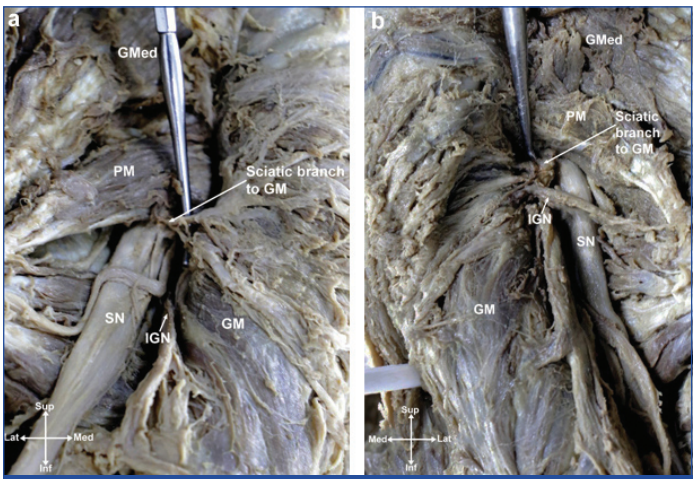
CASE REPORT

An anatomical variation was found in an elderly adult female cadaver during a gross cadaveric dissection session for first-year medical students held at the Department of Anatomy and Cell Biology, Universidad Central del Caribe, School of Medicine (UCC-SoM). The past medical history, family history, and cause of death were not available. The dissected cadaver displayed an anomalous bilateral innervation of the gluteus maximus muscle (GM). The left and right GM were innervated by their corresponding IGN with an unusual innervation by a branch of the SN. Both SN branches were located proximal to their corresponding IGN and emerged near the inferior border of the piriformis muscle bilaterally [Table/Fig-1a,b]. The SN branches subsequently divided into multiple rami that spread through the fascia of each GM. Further evaluation revealed an atypical location of the IGN on the right gluteal region, where the latter travelled perpendicular and superficial to the SN [Table/Fig-2].

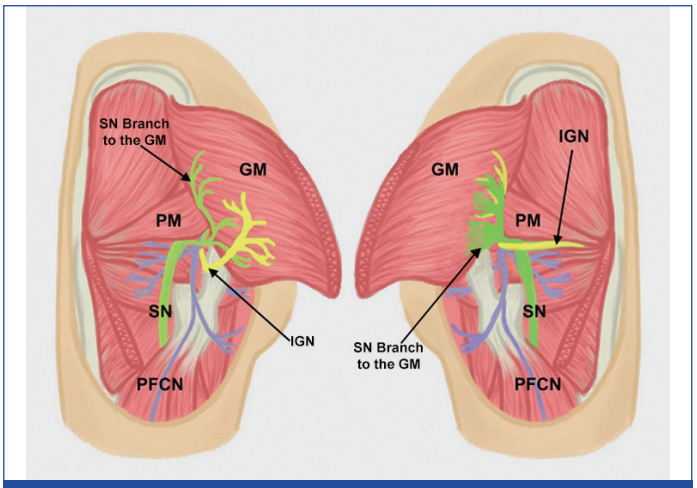
The left and right gluteus medius muscles were reflected to visualise the deep lateral rotators and associated neurovascular structures. No anatomical variations were identified regarding the gluteus minimus muscles, piriformis muscles and the corresponding tendons within the left and right gluteal areas [Table/Fig-3]. The superior and inferior gemellus muscles were observed bilaterally with a predominant tendinous portion of the obturator internus muscle dividing both structures, as expected. The left and right quadratus femoris muscles were also identified bilaterally, and better visualised on the left side.



[Table/Fig-2]: Gluteal dissection of the right region showing an atypical position of the IGN, where the latter travelled perpendicular and superficial to the SN innervating the GM.
PM: Piriformis muscle; SN: Sciatic nerve; IGN: Inferior gluteal nerve



[Table/Fig-1]: Gluteal dissection of a) the left; and b) right; region showing a branch of the SN innervating the GM. GM- Gluteus Maximus Muscle; GMed- Gluteus Medius Muscle; PM- Piriformis Muscle; SN- Sciatic Nerve; IGN- Inferior Gluteal Nerve.



[Table/Fig-3]: Diagram showing the anatomical variation found in the gluteal region with their corresponding branch of the SN innervating the GM.
GM: Gluteus maximus; PM: Piriformis muscle; SN: Sciatic nerve; IGN: Inferior gluteal nerve; PFCN: Posterior femoral cutaneous nerve

DISCUSSION

Anatomical variations of the GM are rare with a high clinical significance [1-4]. The GM is the largest and most superficial muscle in the gluteal region, commonly recognised as the strongest extensor of the hip joint [5]. The latter also functions as an accessory muscle in the lateral rotation of the hip joint and in the stability of the pelvis [5]. Regarding its innervation, the muscle is usually innervated by the IGN, a branch of the sacral plexus arising from the ventral rami of the L5 to S2 [5]. However, the latter might vary depending on its embryological development, resulting in a variation in the muscle's innervation. The theory of relative innervation contemplates that this variation might be secondary to its embryology, correlating the developing muscle fibres and the proximity of the nerves [6].

Embryological basis: During limb development, the GM is formed from myoblasts and the fusion of several muscle components as well as its nerve genesis and attachment. It has been described that the innervation of limbs is an early embryological development, where the lower limbs are supplied from the last 4th lumbar and the first three sacral metameres (lumbosacral plexus) [7]. Thus, anatomical variations concerning innervations to the lower limbs are most likely due to an abnormal process during limb development at mid-4th week of gestation [7].

Several studies have described variations within the gluteal region, but limited literature described a bilateral and dual innervation of the GM by it's corresponding IGN as well as a branch of the SN [1-4]. Even though there is limited research on the explanation of dual innervation in the gluteal region, Tichý M and Grim M provided insight through their research observations that the human GM develops as a result of a fusion of two foetal muscles [8]. The portion of the GM originating from the coccyx, pars coccygea, is a separate foetal structure from the portion originating proximally termed as pars sacroilleaca [8]. Subsequently, in the prenatal period, these two portions fuse together creating a cohesive muscle structure whose muscle fibres and bundles mask the prenatal borderline of the original fusion [8]. According to these findings, the dual innervation of the IGN and a branch of the SN could be secondary to the fact that the GM embryological formation is a fusion of two foetal muscles.

Patients with an abnormal innervation to the lower limb muscles such as GM, could present with ambiguous clinical symptoms. In literature, there have been several studies reporting multiple forms of abnormal innervations of the GM by the SN [1-4]. Implications of this variations are of clinical and surgical importance.

Clinical significance: Patients with the dual innervation to the GM by the IGN and SN can present signs and symptoms which might be easily misdiagnosed. Pain in the gluteal region, in patients with this variation, could be associated with other conditions related to the SN, such as piriformis syndrome. Piriformis syndrome is an uncommon, neuromuscular disorder caused by inflammation of the piriformis muscle with subsequent compression of the SN [9]. This nerve regularly exits the pelvis through the inferior border of the piriformis muscle [5]. Patients with this condition commonly report inferior medial quadrant buttock pain, sciatica, hip pain, intolerance to sitting and dyspareunia in females [9]. Likewise, the pain may radiate into the back of the thigh, but it may also occur in the lower leg at dermatomes L5 or S1. Piriformis syndrome is a clinical diagnosis. However, patients may require electromyography, nerve conduction studies and/or nerve stimulation to confirm the entrapment of the SN [9].

Clinical implications: In this report, the abnormal SN branches emerged below the piriformis muscle and proceeded laterally to innervate the GM. Patients with this anatomical variation might present with non specific symptoms. Inflammation of the piriformis muscle in patients with this dual anatomical innervation could present with clinical complaints opposed to the typical symptomatology of piriformis syndrome. The patient may also complain of non specific pain in all quadrants of the gluteal region. In addition, the inflammation of the GM could also compress the abnormal SN branch causing pain in all quadrants of the gluteal region. An accentuated pain could be expected given the abnormal branch of the SN to the GM. Independent of the underlying anatomy, treatment of piriformis syndrome consists mainly of the use of muscle relaxants, Non Steroidal Anti-Inflammatory Drugs (NSAIDs), and physical therapy [9]. Some patients may benefit from steroid injections, botulinum toxin therapy or surgical intervention, if previous conservative therapy had failed [9].

As previously suggested, patients with an abnormal branch of the SN to the GM could be at a higher risk for iatrogenic nerve injury secondary to gluteal injection or surgical procedures. The diffuse lateral position of the SN places this structure in a high-risk position to be penetrated by a needle while administering a deep muscle injection. Most of the SN injuries, secondary to a deep muscle injection, are associated with injection placed outside the upper quadrant of the gluteal region [10].

Concerning surgical procedures, direct injuries to the SN may be caused by pressure, heat, crush or cut to the nerve itself. The indirect nerve damage may be due to positioning, compression, or traction during interventions [10]. Any of these events could occur during surgeries involving the gluteal region, such as acetabular fracture repairs, total hip arthroplasty, insertions of implants during gluteoplasty, among others [11]. Given that patients with the variation presented in our case may exhibit a non specific complaint due to their abnormal anatomy, iatrogenic nerve injuries may occur unexpectedly during surgical interventions. Likewise, if any nerve injury occurs, recognition is critical given that it may result in muscle or limb paralysis if left untreated.

CONCLUSION(S)

The atypical innervation of the SN to the GM found during this study allowed us to recognise the multiple complications that could represent this dual innervation. Ranging from simple clinical manifestations to iatrogenic nerve injuries, this variation is relevant to medical professionals. Knowledge about this anatomical variation is critical to prevent complications in surgical interventions, intramuscular injections, and nerve block during anaesthesia. Treatment options and surgical approaches should be also targeted to offer effective interventions in patients with this variation.

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