

# Aberrant Extra-pelvic Formation of Inferior Gluteal Nerve: Clinical Implications

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## ABSTRACT

**Introduction:** anatomical variation of inferior gluteal nerve (IGN) has not received much attention from clinicians. Mechanical injuries of IGN such as entrapment, compression by adjacent structures in the gluteal region are not infrequent. The present case reports unusual bilateral IGN anatomical variation formed by variable contributions of dorsal division of ventral rami (L5, S1 & S2) entering below the piriformis. On the right side, the upper root of IGN traversed the space alone and supplied the medial part of the gluteus maximus (GM). The middle and lower roots accompanied the inferior gluteal artery (IGA), encircled it and formed the lower root of IGN dorsal to the artery; which then supplied the lower part of GM. On the left side, the upper and the middle roots encircled the IGA and then united to form the upper root of the IGN. The middle root arose in common with the posterior cutaneous nerve of the thigh. The lower root traversed the space alone superficial to the sciatic nerve and supplied the left GM. The roots of IGN embracing the IGA (the lower two roots on the right side and the upper two roots on the left side) from before backwards place it in a vulnerable position for compression in the event of any vascular lesion like arterial aneurysm. IGN neuropathy can present as abnormal gait or kinesiological disturbance. Awareness of such variation will aid in clinical diagnosis.

**Keywords:** Inferior gluteal nerve; Inferior gluteal artery; Gluteal region; Gluteus maximus; Hip extension.

## Introduction

The inferior gluteal nerve (IGN) arises from the L5-S2 nerve roots of the lumbosacral plexus and supplies gluteus maximus (GM) muscle. IGN and inferior gluteal arteries (IGA) reach the gluteal region from the pelvis through the greater sciatic foramen below the piriformis along with other neurovascular structures notably the sciatic nerve. The IGN is primarily a motor nerve, but a few reports state it to be carrying sensory fibres innervating the skin of the gluteal region<sup>1</sup>. Anatomical variations have been largely ignored. This can be because IGN nerve pathology is not life threatening and pain is often not a clinical symptom, however it could lead to gait abnormality. Clinically IGN injury may present as atrophy, flaccidity and decreased tone of GM with consequent weakness in hip extension. No sensory loss is usually observed except when there is concomitant injury of the posterior cutaneous nerve of the thigh. Dull aching pain may be a presenting complaint in some with compressive lesions such as tumours and aneurysms. Physical examination is generally unyielding but imaging studies do provide useful information to aid in diagnosis. Till date only few reports of anatomical variation of IGN have been reported. Clinical importance of IGN has been realized more with use of advanced imaging studies to diagnose tumour, aneurysms in the gluteal region<sup>2,3</sup>. Anatomy of IGN is relevant for gluteal skin flap surgeries<sup>4</sup>. The

typical point of exit of the IGN under cover of GM is immediately posterior-medial to the hip joint. This relationship with the hip joint places this nerve at risk of iatrogenic injury in posterior surgical approach to the hip joint<sup>5</sup>. Accordingly it is pertinent to appreciate the basic anatomy of IGN and IGA and their anatomic relations in the gluteal region. Furthermore, presence of anatomical variations of IGN places the nerve at risk of compressive injuries during hip surgeries. Therefore the physicians and surgeons approaching the gluteal region should be familiar with the unusual pattern of formation of IGN and its variations.

## Methods

During routine cadaveric dissection for undergraduate teaching during academic session 2021-2022, an unusual variation of the IGN was observed bilaterally in a 68-years-old male cadaver. The cadaver was embalmed with a solution containing a mixture of ethanol, glycerol, formalin, and phenol and regularly kept in weak formalin solution. The gluteal region especially structures under cover of the GM were dissected carefully employing the conventional dissection methods. The standard institutional guidelines for using human cadaver for teaching and research were followed strictly. Relevant consent from the kin of the deceased was obtained at the time of body donation.

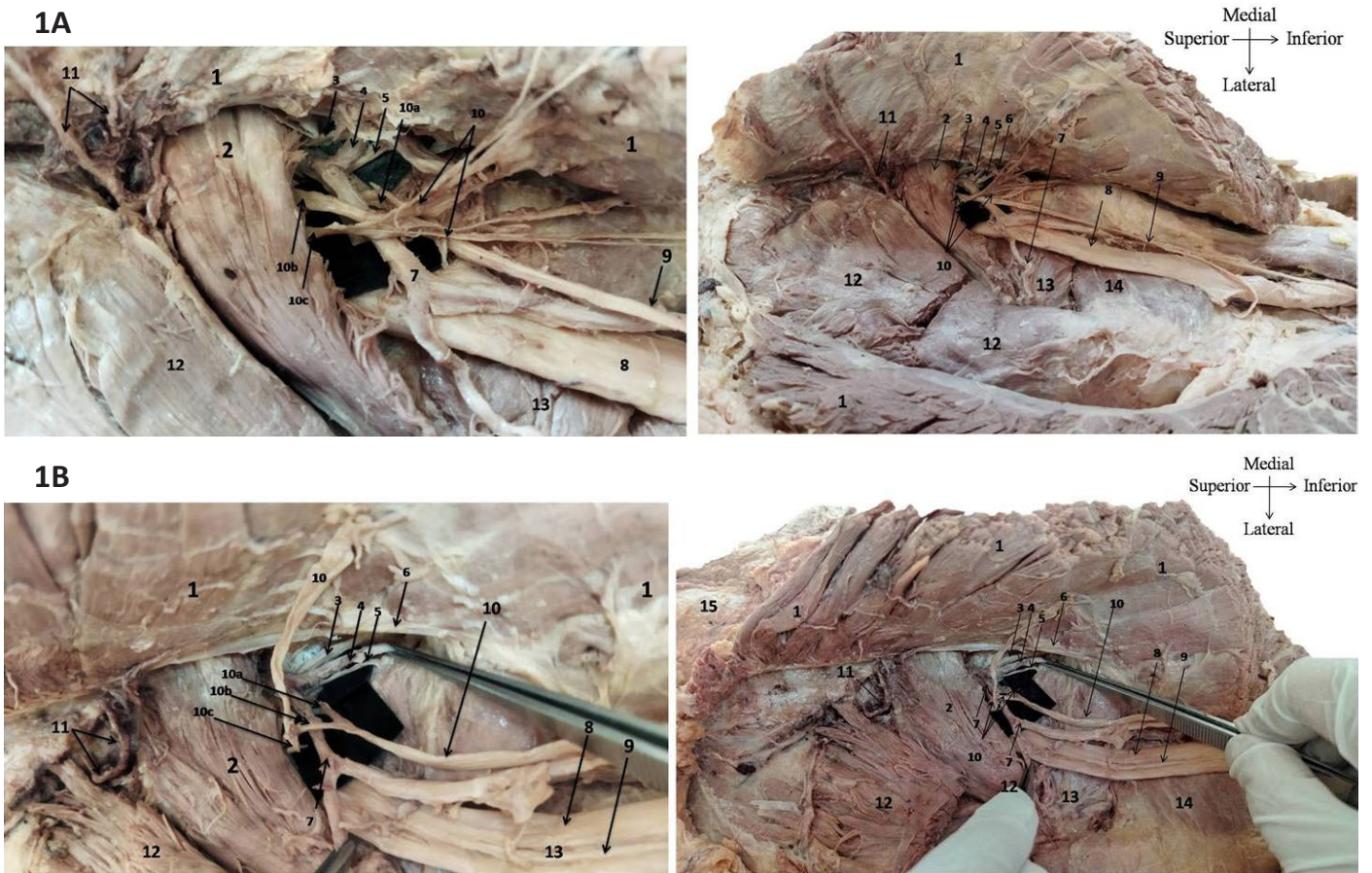
### Case Report

The neurovascular structures entering the gluteal region of both sides through the greater sciatic foramen below the piriformis were sciatic nerve, posterior cutaneous nerve of the thigh, IGN, IGA, pudendal nerve, internal pudendal vessels, nerve to obturator internus and nerve to quadratus femoris. The IGA and the internal pudendal artery took origin from a common arterial trunk dorso-lateral to the sacro-tuberous ligament on both sides. On the right gluteal region, three roots of the IGN were seen. The upper root independently supplied the medial part of the GM from its deeper aspect. The other two roots of the IGN run close to the IGA for approximately 0.6 cm, until they embraced the IGA on its dorsal aspect to form a common nerve trunk which then supplied the inferior part of the GM. On the left side, three roots of the IGN were observed. The upper two roots followed the left IGA for about 0.7 cm, which then united dorsal to the artery and supplied the left GM. The middle root in this case originated in common with the posterior cutaneous nerve of the thigh. The lower root of the left side traversed independently superficial to the sciatic nerve, supplying the medial part of left GM. The IGN nerve did not supply any other adjacent structure on both sides. The pudendal nerve, internal

pudendal vessels, and nerve to obturator internus (typically described as the PIN structures) were seen at their normal position dorsal to ischial spine on both sides. The course of the IGA after it arose from the common trunk was normal anatomically on both sides. The other neurovascular structures exhibited no anatomical variation (Figures 1A and 1B).

### Discussion

On both sides, the twigs of IGN innervated the GM from its deeper aspect after ramifying extensively. It is rare for the IGN to be split by IGA which is expected to traverse the region as a single nerve in the normal circumstances. The splitting of IGN by IGA might have tremendous clinical repercussions because of two reasons. Firstly compressive injuries can occur with IGA aneurysms, and more importantly several roots of IGN are definitely more prone for iatrogenic injuries in posterior surgical approach to the hip joint. Aneurysms are frequently described in the extra-pelvic portion of the IGA, leading to compression of adjacent nerves<sup>6</sup>. Studies often report aneurysms and pseudoaneurysms of IGA in its extra-pelvic course which can be due to traumatic or atherosclerotic origin. Pseudo-aneurysm of IGA due to traumatic origin is relatively rare, but existing literature suggest that even trivial injury



**Figure 1.** 1A-Dissected right gluteal region with structures under cover of GM, 1B- Dissected right gluteal region with structures under cover of GM, 1-gluteus maximus muscle, 2-piriformis muscle, 3-pudendal nerve, 4-internal pudendal artery, 5-nerve to obturator internus, 6-sacro-tuberous ligament, 7-inferior gluteal artery, 8-sciatic nerve, 9-posterior cutaneous nerve of the thigh, 10-inferior gluteal nerve(IGN) [10a-upper root of the IGN, 10b-middle root of the IGN, 10c-lower root of the IGN], 11-superior gluteal artery, 12-gluteus medius muscle, 13-obturator internus tendon with two gemelli muscle, 14-quadratus femoris muscle, 15-sacrum bone.



such as fall from bicycle can trigger formation of a pseudoaneurysm. Most cases of moderate to large sized IGA aneurysm may present with neurological symptoms similar to the piriformis syndrome or sciatica. But a small aneurysm or pseudoaneurysm having an insidious onset often goes unnoticed at times. And if such aneurysm happens to be intimately related to variable roots IGN, like in the present case, the only recognizable clinical sign can be gait abnormality. IGA aneurysm and pseudo-aneurysms of traumatic origin can be successfully managed by ultrasound guided transcatheter embolization with thrombin injection or with coil embolization<sup>7,8</sup>. In fact USG guided coil embolization is the current recommended method in management of aneurysms in peripheral arteries<sup>9</sup>. Relatively late presentation of pseudo-aneurysm of IGA has been reported which required endovascular lysis therapy<sup>10</sup>. To the best of our knowledge, there are only few studies on the anatomical variations of IGN and inferior gluteal vessels. Anatomical variation of IGN in relation to structures in the gluteal region has some mention in erstwhile studies which are summarized in Table 1.

The IGN is reported to be more prone for injury during posterior surgical approach to the hip. Apart from direct traumatic injuries, the IGN can be injured by stretching or traction on the nerve and also by postoperative complications like subfascial hematoma(11). Studies reported that peripheral nerve injuries are encountered during hip replacement surgeries in up to 8% of cases<sup>12</sup>. Surprisingly very few studies have explored the IGN injuries in context with hip surgeries. The IGN innervates the GM from its

deeper aspect and extensively ramifies. The exact entry point in the GM is more towards the midline, therefore it is not recommended to incise the GM beyond 5cm medial to the tip of the greater trochanter in posterior hip approach<sup>11</sup>. In addition to that, gait abnormalities are more often seen as postoperative complication in the posterior hip approach, which is linked to IGN injury<sup>13</sup>. Similarly entrapment neuropathy of IGN can also occur as postoperative sequelae of total hip arthroplasty and ilio-sacral screwing procedure. Other modes of possible injuries to IGN may be due to fractures of the ischial spine, sacrum and any inflammatory process of the pelvis<sup>14</sup>. High precision neuro-imaging studies like magnetic resonance (MR) neurography are increasingly being used these days for evaluation of entrapment neuropathies in the gluteal region in conjunction with conventional magnetic resonance imaging (MRI). However IGN compression and neuropathy is not easy to detect in imaging studies. Signal changes in the supplied muscle (in case of IGN the gluteus maximus muscle) can be indirectly visualised and correlated with compression neuropathy. It is therefore imperative that a high index of clinical suspicion at first place is the only clue towards diagnosing IGN entrapment neuropathy. Furthermore, in the present case, the IGN on the left side had a common origin with the posterior cutaneous nerve of the thigh which corroborated with few previous reports<sup>1,17</sup>. Whether the IGN carries important sensory fibres is still a matter of debate and needs to be investigated by electrophysiological studies. Awareness and familiarity with possible anatomical variations of the extra-pelvic course of IGN will definitely minimise postoperative complication

**Table 1.** Studies looking at the positional relationship of IGN with adjacent structures and its anatomical variations in the gluteal region.

Authors	Sample size	Population group	Anatomical variations
Ling ZX <i>et al.</i> , 2006	1	Turkish	The common fibular nerve courses between the two split parts of piriformis muscle. The IGN & IGA placed lateral to the common fibular component of the sciatic nerve.
Skalak AF <i>et al.</i> , 2008	15	American	Variable relationship between IGN and IGA branches in the gluteal region. IGN location cannot be accurately predicted on the basis of vascular anatomy in the gluteal region.
Kim DD <i>et al.</i> , 2003	94	Japanese	4 out of 94 total cases had IGN exiting the pelvis above the piriformis through supra-piriformis foramen in greater sciatic notch.
Sumalatha S <i>et al.</i> , 2014	1	Indian	The nerve supplying the GM originated from the medial trunk of the common fibular nerve which itself divided high up in pelvis.
Prasad AM <i>et al.</i> , 2015	1	Indian	IGN arose from a common trunk with posterior cutaneous nerve of the thigh. The common trunk originated in turn from common fibular nerve.
Thomas H <i>et al.</i> , 2017	1	Indian	Dual innervation of GM from IGN and sciatic nerve.
Iwanaga J <i>et al.</i> , 2018	6	American	IGN often has a cutaneous branch.
Golmohammadi R <i>et al.</i> , 2021	1	Iranian	Thick IGN on the right gluteal region and a very thin IGN on the left gluteal region, both branching from the common fibular nerve.
Park K-R <i>et al.</i> , 2021	1	Korean	Origin of IGN from the common fibular nerve both of them then pierced piriformis muscle independently.

like gait abnormality. Also, in view of the occurrences of extra-pelvic IGA aneurysm and pseudo-aneurysms, anatomical variation of IGN in relation to IGA should be kept in mind while evaluating a case of nerve compression.

## Conclusions

Aberrant extra-pelvic course and relations of the IGN might manifest with sensory loss and motor deficits in a patient. The spectrum of symptoms will

be more intense if it is associated with aneurysm or pseudoaneurysm of the IGA. It is very rare to see multiple roots of IGN coursing the gluteal region and encircling the IGA. In the present case, the IGN on both sides entered the gluteal region by multiple roots and formed the main trunk after encircling the IGA. Awareness about extra-pelvic anatomical variations of IGN will minimize iatrogenic neuropathy during posterior hip joint approach and in management of hip fractures.

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## Mini Curriculum and Author's Contribution

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