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# Rare bilateral aberrant genitofemoral and left sided unsplit iliohyphogastric ilioinguinal nerves: clinical consideration

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**Abstract:** The knowledge of anatomical variation of lumbar plexus helps to interpret the causes of lumbar plexopathies and at the same time minimise iatrogenic nerve injuries. This report describes a unique variation in the branching pattern of lumbar plexus in a 63-year-old male cadaver. On both sides, the genitofemoral nerve emerged from the lateral border of the psoas major instead of from its ventral surface. Furthermore, on the left side, the iliohypogastric and the ilioinguinal nerve had a common trunk before its bifurcation which took place just proximal to the lateral end of the left inguinal ligament. The rest of the branches of the lumbar plexus on both sides were normal. In the present case, the bilateral genitofemoral emergence from the lateral border of the psoas major is a very rare aberration having immense relevance in the clinical management of genitofemoral neuralgia.

**Keywords:** genitofemoral nerve, genitofemoral neuralgia, psoas major, lumbar plexus, lumbar plexus block.

## Introduction

The lumbar plexus (LP) is the principal nervous pathway supplying a major portion of the lower limb, lower abdomen and the skin of external genitalia which is formed from the L1-L4 spinal nerves with occasional contribution from the T12 spinal nerve. The L4 contribution is relatively minimal and may not be always present. The plexus is formed retroperitoneal within the substance of the psoas major (PM) muscle at the level of lumbar transverse processes. The main branches of the plexus are iliohypogastric nerve (IHN), ilioinguinal nerve (IIN), lateral femoral cutaneous nerve (LFCN), genitofemoral nerve (GFN), femoral nerve (FN) and obturator nerve (ON). The segmental root values of the branches are iliohypogastric: L1, ilioinguinal: L1, lateral femoral cutaneous: L2-L3 dorsal, genitofemoral: L1-L2 ventral, femoral: L2-L4 dorsal and obturator: L2-L4 ventral. The ON emerges from the plexus medial to the PM muscle, GFN emerges

from within the PM at its ventral aspect and rest of the nerves emerge from the lateral border of the PM. The plexus is termed pre-fixed or post-fixed if it derives segmental contribution from T12 or L5 spinal segments respectively [1].

The GFN or the genitocrural nerve (root value L1-L2) has predominant contribution from the L2 segment [1]. After originating from LP, the nerve obliquely traverses the PM and appears on its ventral surface near its medial border approximately at L3-L4 vertebral level and divides into its terminal genital and femoral branches. Usual site of terminal bifurcation corresponds to its crossing with the ureter situated posteriorly, though variations in site of division including intra-posas division have been reported [2]. The intra-psoas course and emergence of the nerve from the muscle is also variable. The most frequent anatomical landmark of its emergence is roughly between L2 vertebral level and iliac crest [2]. The genital branch is related to the external iliac artery after its division until it pierces the fascia transversalis lateral to the inferior epigastric vessels to enter the deep inguinal ring and run further through the inguinal canal along with spermatic cord or round ligament of the uterus [1]. The femoral branch passes caudally lateral to the external iliac artery and enters the femoral sheath after passing deep to the inguinal ligament [1–3]. The GFN exhibits numerous variations in origin, course and terminal innervations of the external genitalia and upper medial thigh [3]. The IHN and IIN originate from the L1 spinal nerve [4]. The L1 spinal nerve divides into IHN and IIN once it leaves the L1-L2 intervertebral foramen and then runs dorsal to the PM to eventually emerge from the superolateral border of PM [1]. We present here a cadaveric case with rare anatomical variation in the GFN, IHN and IIN of the lumbar plexus.

## Case Report

Standard institutional guidelines with regard to the use of human cadaver for teaching and research were strictly followed. The authors hereby confirm that every effort was made to comply with all local and international ethical guidelines and laws concerning the use of human cadaver in anatomical research. Meticulous dissection was carried out on the both sides of the posterior abdominal wall in a 63-year-old male cadaver following standard dissection methods. The abdomen was entered after reflecting the anterior abdominal wall downward. Abdominal viscera and peritoneal folds were cleared and the retroperitoneal space was entered after stripping off the parietal peritoneum of the posterior abdominal wall. Piecemeal dissection of the PM muscle was carried out on the right side and was kept intact on the opposite side and LP exposed. The roots of origin and the branches of LP were observed and photographed.

GFN emerged bilaterally from the lateral border of the PM instead of from its ventral surface at the level of L3 vertebra. Furthermore on the left side, the IHN and IIN nerve had a common trunk before its bifurcation which took place just proximal to the lateral end of left inguinal ligament. The left sided common trunk of IHN and IIN nerves was fairly long measuring 11.62 cm from origin to bifurcation. The rest of the branches of LP on both sides had normal branching patterns and were in normal relationship to PM.

## Discussion

The LP is formed by the ventral rami of the upper four lumbar spinal nerves with occasional contribution from the ventral rami of 12th thoracic spinal nerve [1–3]. Though located deep within the abdomen, it is primarily responsible for a considerable extent of motor and sensory

innervations of the lower extremity [1, 2]. A great many variations of origin, branching patterns, intercommunications are reported in the literature whose knowledge is clinically relevant for administering regional anaesthetic blocks and to avoid unintentional nerve damage during exploration of abdomen. The increasingly popular trans-psoas approach to lumbar spines requires a thorough anticipation of the normal as well as variant anatomy of LP branches.

The GFN nerve also exhibits variations. Chandraphak *et al.* described GFN origin from single root (either L1 or L2) in 5.33% of cases [5]. Uzmansel *et al.* described an additional twig from L2 contributing to the genital branch of GFN [6]. Gandhi *et al.* observed that 81.6% of the GFN pierced the middle third of the anterior surface of the PM [7]. Rab *et al.* noticed intra-psoas division of the GFN into genital and femoral branches [3]. Nayak *et al.*, 2017, however described the genital and femoral branches exiting the PM separately after intra-psoas bifurcation. Paul *et al.*, 2019, also described intra-psoas division and made the observation that GFN can be absent in 1.6% of the cases. In case of absent GFN, the fibres destined to travel through GFN usually travel along alternate branches of the LP [1]. Iwanaga *et al.* proposed that the "medial branch" and "lateral branch" are more appropriate and practical terminology to indicate the proximal branches of GFN [8]. Moro *et al.* proposed a safety zone in the region of L4-L5 spines for endoscopic lumbar discectomy operation except for the GFN [9]. The GFN injury is clinically present in various forms; the most severe type is genitofemoral neuralgia which is characterized by chronic debilitating neuropathic pain in the sensory distribution of the nerve. GFN neuralgia has postural association with relief of symptoms in supine posture and exacerbations in standing, stooping or walking positions [2, 10]. The treatment of the condition is difficult and is achieved by drugs such as tricyclic antidepressant (TCAs), cryoablation, a variety of combination of analgesic and anaesthetic preparations and by surgical neurectomy [2]. A few relevant studies on the GFN have been tabulated in Table 1. Animal models have suggested important role of GFN in descent of testes by releasing a hormone calcitonin gene related peptide (CGRP) from the mammary branch of GFN in the inguinal region and through possible regulation of gubernacular proliferative response [11, 12]. The IHN and IIN can also exhibit several anatomic variations [7, 13]. The one observed here is formation of a common trunk by both the nerves which divides once the trunk

**Table 1.** Anatomical studies with notable observation on the anatomical variations of the genitofemoral nerve.

| Authors | Study type | Population and sample size | Observations |
|---|---|---|---|
| Chandraphak *et al.*, 2003 [5] | Autopsy | Thai, 150 LP, unilateral halves of LP | The GFN formed by single root (L1 or L2) in 5.33% of cases. |
| Moro *et al.*, 2003 [6] | Autopsy | Turkish, case report, Unilateral (right side) | Safe zone for retroperitoneal endoscopic surgical approach is at the level of L4-L5 level except for GFN. |
| Uzmansel *et al.*, 2006 [7] | Autopsy | Indian, 30 cadavers, bilateral LP | Accessory nerve branch joining to the genital branch of GFN. |
| Gandhi *et al.*, 2013 [9] | Autopsy | Japanese, 30 cadavers, bilateral LP | 81.6% of the GFN emerged through the medial third of the ventral aspect of PM. |
| Nontasaen *et al.*, 2016 [13] | Autopsy | Thai, 68 cadavers, bilateral LP | GFN arising from L2 and L2-L3 in 0.8 and 0.08% cases respectively. |

leaves the intervertebral foramen between L1-L2 [4]. Geh *et al.* observed 26% prevalence of this pattern having a common trunk between IHN and IIN [14]. Additionally the two nerves may communicate through small accessory fibres in the neurovascular plane between the transversus abdominis and the internal abdominis muscle. The area of innervations of the GFN, IHN and IIN overlap considerably thus making the diagnosis of single nerve injury difficult.

In conclusion, the bilateral variation of GFN and common trunk of IHN — IIN presented here has clinical relevance in abdominopelvic surgeries approached through the anterior abdominal wall, administration of regional anaesthetic blocks, retroperitoneal endoscopic discectomy etc. These variations should be borne in mind while evaluating a case of genitofemoral neuralgia or ilioinguinal neuralgia. Awareness of such variation and a strong clinical suspicion thereof will help avoid iatrogenic nerve damage during interventions.

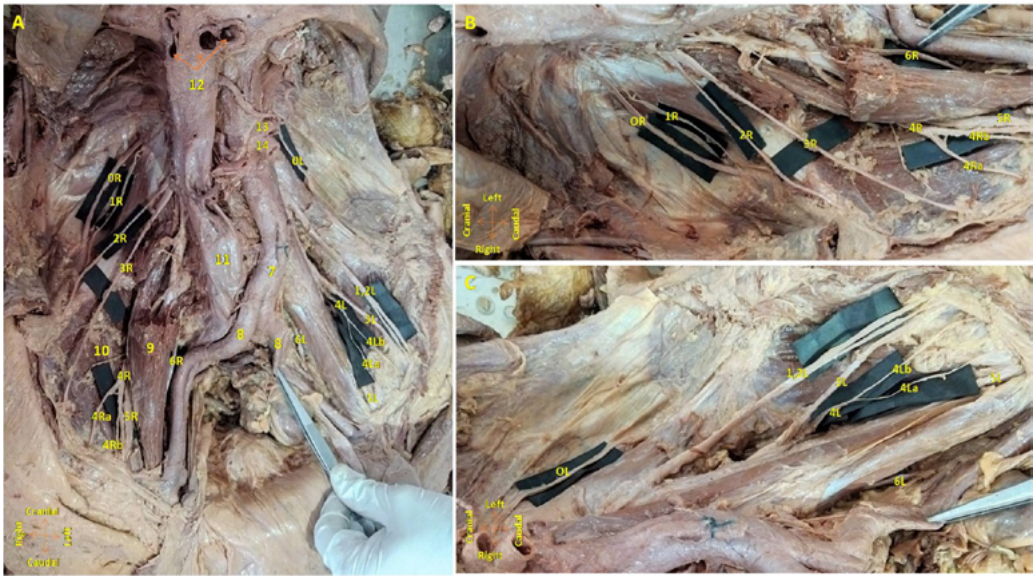


**Fig. 1.** Photographs showing dissected posterior abdominal wall with bilateral lumbar plexus [LP] branches; A — The posterior abdominal wall with LP, B — enlarged view of the right LP, C — enlarged view of left LP; 0R — subcostal (R denotes right side), 1R — iliohypogastric, 2R — ilioinguinal, 3R — lateral femoral cutaneous, 4R — genitofemoral, 4Ra — genital branch, 4Rb — femoral branch, 5R — femoral nerve, 6R — obturator nerve, 0L — subcostal (L denotes left side), 1,2L — unsplit iliohypogastric and ilioinguinal nerve, 3L — lateral femoral cutaneous, 4L — genitofemoral, 4La — genital branch, 4Lb — femoral branch, 5L — femoral nerve, 6L — obturator nerve, 7 — bifurcation of abdominal aorta, 8 — common iliac artery, 9 — psoas major muscle, 10 — quadratus lumborum muscle, 11 — inferior vena cava, 12 — hepatic veins opening into IVC, 13 — celiac trunk, 14 — superior mesenteric artery.

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## Authors' contributions

D.B. — Protocol development, reviewed literature, cadaveric dissection, manuscript writing; R.K. — Protocol development, reviewed literature, photography, manuscript writing; A.G. — Reviewed literature, manuscript writing, editing; S.S. — Protocol development, reviewed literature, manuscript writing.

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## Data availability

The data that support the findings of this study are available from the corresponding author, upon request.

## Conflict of interest

None declared.

## Ethical approval

The present report was on the basis of findings during dissection on a cadaver. The cadaver used in this report was donated to the department with written and informed consent for carrying out whole body dissection for education and research purpose. All norms related to use of human cadavers in teaching and research were followed strictly as per the institutional guidelines.

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