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Original Research Article

Prevalence of Variations of Lumbar Plexus in the Cadavers of the South Gujarat Region

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ABSTRACT

Background: Anatomical variations are common, benign, and result from embryological development errors. Variations in the lumbar plexus matter when injuries or entrapments occur due to trauma or surgery.

Objectives: This study assessed the prevalence of anatomical variations in the lumbar plexus nerves in South Gujarat (India) cadavers. Results were compared to previous findings, and clinical implications were discussed.

Material and methods: The study was done on 23 formalin-embalmed human cadavers (46 lumbar plexuses) donated to the department of anatomy, Surat Municipal Institute of Medical Education & Research (SMIMER) over a period of 3 years. The variations in the formation, course and branching patterns of the lumbar plexuses were observed and their course and relationship to the ilio-psoas muscles, if any, were photographed and documented.

Results: Our study identified that 69.56% of lumbar plexuses examined showed at least one anatomical variation. Specifically, we found absence of the iliohypogastric nerve in 10.86% of cases, genitofemoral nerve variations in 39.13%, lateral femoral cutaneous nerve variations in 15.21%, and femoral nerve rootlet and branching variations in 32.60%. Postfixed plexuses were present in 13.04%, the accessory obturator nerve in 13.04%, and the psoas minor muscle in 17.37%. These findings highlight the diversity and frequency of anatomical variations in the lumbar plexuses of the South Gujarat cadaver population.

Conclusion: Knowledge of variations prevailing in the demography of the South Gujarat region will help the surgeons, orthopaedics, or anaesthetists working in this area to access them during posterior abdominal wall surgeries and lumbar plexus block to avoid iatrogenic injuries.

KEY WORDS: Lumbar Plexus variations, Ilioinguinal Nerve, Iliohypogastric Nerve, Femoral Nerve, Obturator Nerve, Lateral Femoral Cutaneous Nerve, Genitofemoral Nerve, Accessory Obturator Nerve.

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BACKGROUND

Anatomical variations are common in human bodies. The anatomical variations are benign in majority of the cases and results from the embryological developmental errors [1]. Variations in the lumbar plexus matter a lot when injuries

or entrapments occur due to trauma or surgery. The lumbar plexus is positioned deep inside the psoas major muscle, in front of the transverse processes of the lumbar vertebrae. It is formed by the ventral rami of first four lumbar nerves. The first lumbar nerve (L1) is amalgamated by a branch from the twelfth thoracic nerve (T12). This area gives rise to six major nerves [2]. The first lumbar nerve(L1) separates into a cranial and caudal branch, of which the former branch diverges into the ilio-hypogastric (IHN) and ilio-inguinal nerves (IIN). The lower branch of the L1 nerve connects with the anterior part of the L2 nerve to form the genitofemoral nerve (GFN). This nerve goes through the psoas major muscle (PM) and runs inferiorly on its anterior surface, just below the psoas fascia [2,3]. The second, third, and fourth ventral lumbar rami first splits into an anterior and posterior main branch. The posterior branch of the second to fourth lumbar ventral rami unite to form the femoral nerve (FN), which exits between the side of psoas major and iliacus muscle. The obturator nerve (ON) arises from the anterior branch of the second to fourth ventral lumbar rami and exits from its medial border at the pelvic brim. The accessory obturator nerve (AON), when present, arises from the third and fourth anterior divisions. The lateral femoral cutaneous nerve (LFCN) of the thigh arises from the posterior branch of the second and third lumbar ventral rami and emerges from the lateral border of psoas major and reaches towards the anterior superior iliac spine, crossing the iliacus muscle. The remaining fibres from the fourth lumbar ventral ramus join the fifth lumbar ventral ramus to form the lumbosacral trunk, which descends to join the sacral plexus [2,3,4].

The name “furcal” is also applied to any nerve or nerves that help to create the formation of both the lumbar and sacral plexuses, usually coming from the fourth lumbar root. Sometimes, the furcal nerve may come from the third or fifth lumbar nerves roots [5,6].

The nerves in the lumbar plexus can be damage during surgeries like inguinal hernia repair, iliac crest bone grafting, or gynaecological procedures, leading to various complications [7]. Accessing this area can be difficult and requires a deep understanding of diverse anatomical structures. In recent time, laparoscopic surgeries, including those using a retroperitoneal approach, are becoming more common.

So, the aim of this study was to assess the prevalence of the anatomical variations in the formation of lumbar plexus nerves in the cadavers of South Gujarat (India). Results of region-specific data were compared to previous findings of different demography, and clinical implications were discussed.

MATERIALS AND METHODS

The present observational study was performed on voluntarily donated 23 formalin embalmed human cadavers (13 males, 10 females, total of 46 lumbar plexuses) of the South Gujarat region in the Department of Anatomy, Surat Municipal Institute of Medical Education & Research (SMIMER), Surat, Gujarat, India, during the study period of 3 years (2023-2025).

Inclusion & Exclusion Criteria: All human cadavers of South Gujarat region, irrespective of age and sex, donated in the department were used. Cadavers with any signs of traumatic/surgical scars in the abdominal and lumbar regions were excluded from the study.

The cadavers were properly labelled for number, sex and sides(right/left). For example: 7MR = seven no., male body and right side of lumbar region. All the regions were dissected as per standard dissection guidelines given by Cunningham’s manual of Practical Anatomy [8]. Dissection was done by routine abdominal incision. After removal of all the abdominal viscera, posterior abdominal wall was approached. The iliopsoas fascia was exposed and branches of lumbar plexus were explored. The psoas major muscle was removed at places, piece by piece to further study the course or roots of the lumbar plexus. Lumbar plexus branches were traced up to iliac crest laterally and inguinal ligament anteriorly.

The variations in the formation, course and branching pattern of the lumbar plexus were observed and their relationship to the ilio-psoas muscles, if any, were photographed and documented in numbers and percentage.

The following parameters were studied:

1. Formation of lumbar plexus.

2. Relation of branches of lumbar plexus to psoas major (PM).

3. Formation of the ilio-hypogastric nerve (IHN), the ilioinguinal nerve (IIN) and subcostal nerve (SC).

4. Formation and division of genitofemoral nerve (GFN) into genital and femoral branches.

5. Formation of lateral femoral cutaneous nerve (LCFN), femoral nerve (FN), obturator nerve (ON).

6. Presence or absence of accessory obturator nerve (AON) and psoas minor (PMn).

RESULTS

Out of 46 lumbar plexuses we have studied, variation in formation of the plexuses were observed in 32 plexuses (17 males and 15 females) accounting 69.56% of total plexuses. In almost all cadavers the plexuses were formed within the posterior part of the substance of psoas major muscle. In relation to psoas major, nerves were emerging as per standard literature in majority of plexuses except in cases of variations mentioned in the study table. In 15 cadavers (8 male and 7 female) or 30 (65.21%) plexuses, the variations observed were present on both the side of body. These variations were bilateral symmetrical in 7 cadavers (14 plexuses) and different on both side or asymmetrical in 8 cadavers (16 plexuses). In 2 cadavers (1 male & 1 female) variations were seen on single side of the body. Multiple or more than one type of variations were seen in 12(26.08%) plexuses.

In 5(10.86%) plexuses (3 male and 2 female), T12 segment was contributing to formation of lumbar plexus and were considered as prefixed. In 6 (13.04%) plexuses (2 male and 4 female), L5 segment was contributing to formation of lumbar plexuses and were considered as postfixed. We did not find any significant left-side or right-side differences. Male to female gender differences was not significant in prevalence of any variation.

We observed variety of variations like, changes in the root values of nerves, absent IH, higher division of GFN, separate femoral and genital branch of GFN, LFCN arising from femoral nerve, multiple connections of LFCN with Ilioinguinal nerve and femoral nerve **(Figure 1)**, femoral nerve having multiple extra rootlets and presence of accessory obturator nerve **(Figure 2,3)**. We noticed Psoas minor muscles in 8(17.37%) plexuses (**Figure 4**). It was bilateral in 3 cadavers and unilateral in 2 cadavers**.**

Details of different variations in formation of lumbar plexuses, their root values and type of variation observed in current study have been presented in the **Table 1**.

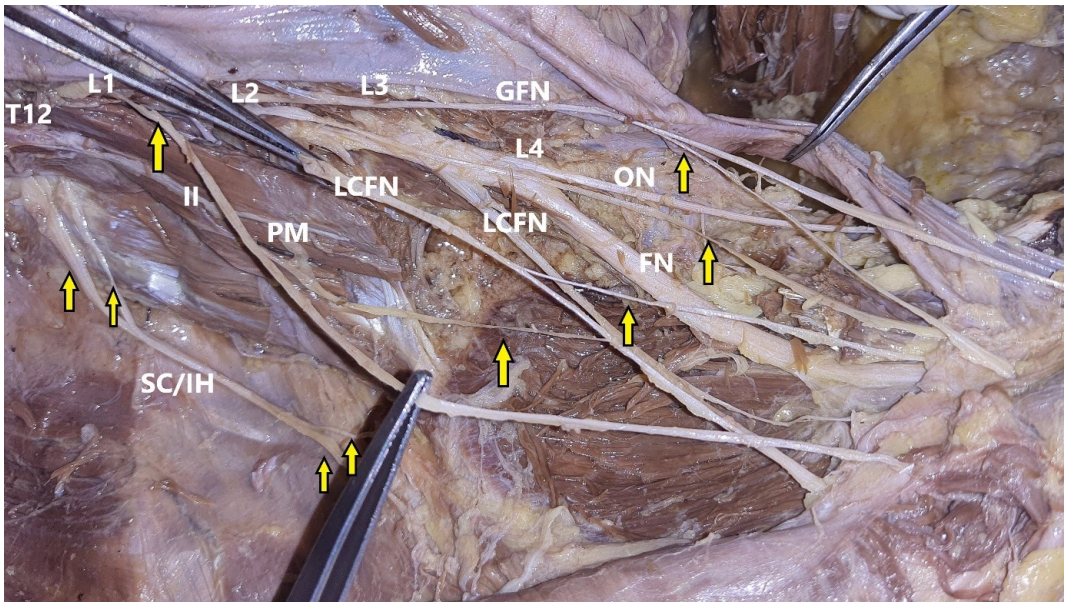

Fig. 1: T12 & L1 branch join to form common trunk which divides as SCN and IHN (Two roots & two branches). IIN emerges from the medial front of the psoas major. GFN has higher division. LFCN having two separate roots of origin. Multiple communications between II, LCFN & FN. PM cut at places.

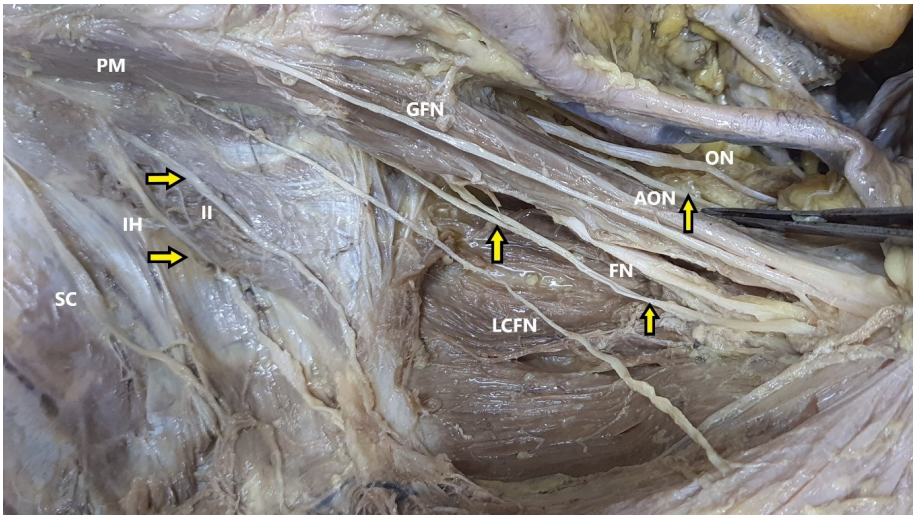

Fig. 2: AON present. Formation of FN outside PM muscle with accessary slips/extra rootlets from L2 & L3 uniting with main trunk distally just above the midinguinal point in iliac fossa.

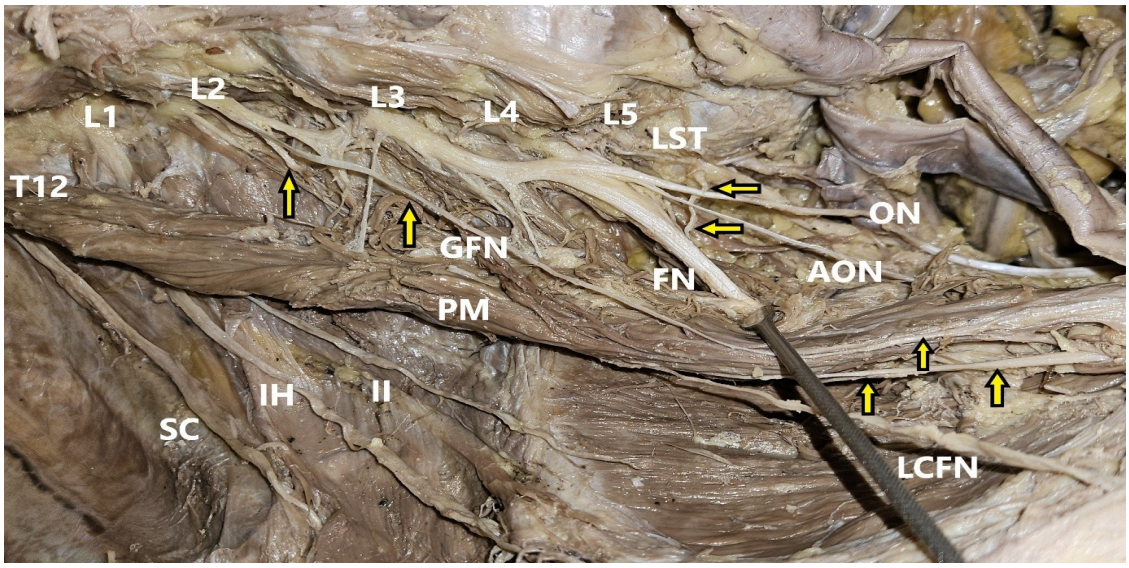

Fig. 3: GFN from L2 with higher division in PM, AON present & Communicating branch from LST to FN (?? furcal branch - postfixed). PM cut at places.

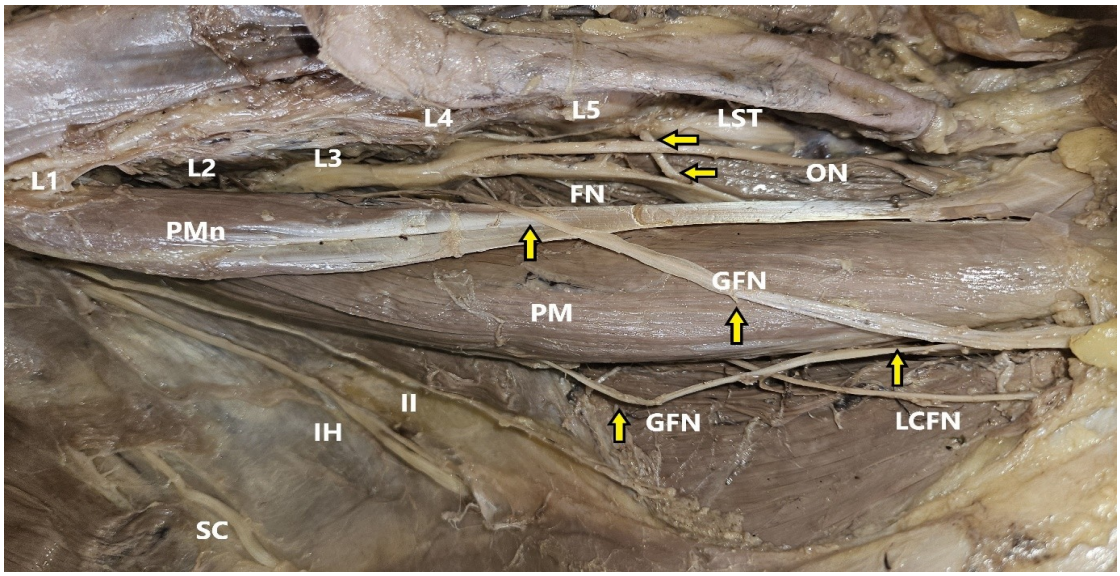

Fig. 4: Psoas minor present. Communication between LST and FN. GFN arise as two separate branches form medial and lateral side of Psoas muscles.

Table 1: Variations in formation of lumbar plexus in present study.

Name of Branches	Root values	Description of variations found in present study	Type of Variation: N= 46 (100%)	Total Variations N= 46 (100)
Ilio-hypogastric Nerve	T12 or L1 (89%) or T12 & L1 both	a) Absent IH or replaced by subcostal nerve	4 (8.69%)	5 (10.86%)
		b) Combined T12 & L1 roots divide into subcostal & IH nerves **(Figure 1)**	1 (2.17%)	
Ilioinguinal Nerve	L1 (100%)	a) II arise as a single nerve form L1 root	4 (8.69%)	5 (10.86%)
		b) II arising from the medial side of psoas muscle**(Figure 1)**	1 (2.17%)	
Genito-femoral Nerve	L1 or L2 or L1,L2 (97.8%)	a) Very thin GF nerve	1 (2.17%)	18 (39.13%)
		b) Arise from L2 root **(Figure 3)**	1 (2.17%)	
		c) Medial to psoas major	3 (6.52%)	
		d) Medial to psoas major and psoas minor	2 (4.34%)	
		e) Separate L1 & L2 roots from lateral side of Psoas major muscle	3 (6.52%)	
		f) 2 separate branches from medial & lateral side of psoas major muscle **(Figure 4)**	2 (4.34%)	
		g) Higher division in femoral & genital branch **(Figure 1**)	6 (13.04%)	
Lateral Femoral Cutaneous Nerve	L2,L3 (100%)	a) Arising from femoral nerve in iliac fossa	2 (4.34%)	7 (15.21%)
		b) Arising as two separate branches from L2 & L3 roots **(Figure 1**)	3 (6.52%)	
		c) Multiple connections with II and femoral nerves**(Figure 1**)	2 (4.34%)	
Femoral Nerve	L2,L3,L4 (80.4%) or L1,L2,L3,L4, L5 or L3,L4, L5 or LST	a) Accessary slips/rootlets from L1/L2/L3/L4 rami joining the main nerve	9 (19.56%)	15 (32.60%)
		b) L2 root uniting 8.4 cm distally with main trunk(L3,L4) just above mid-inguinal point outside psoas major **(Figure 2)**	2 (4.34%)	
		c) Postfixed with extra L5 root contribution	6 (13.04%)	
		d) Communicating branch from Lumbosacral trunk **(Figure 3,4)**	3 (6.52%)	
Obturator Nerve	L2,L3,L4 (91%) or L2, L3,L4, L5	a) Postfixed with extra L5 root contribution	2 (4.34%)	4 (8.69%)
		b) Only L3,L4 roots (no L2 root contribution)	2 (4.34%)	
Accessory Obturator Nerve	L3,L4 (100%)	a) Bilateral presentation**(Figure 3)**	4 (8.69%)	6 (13.04%)
		b) Associated with psoas minor	2 (4.34%)	

DISCUSSION

In present study, out of 46 lumbar plexuses, variation in formation of the plexuses were noticed in 32 plexuses accounting 69.56% of total plexuses. **Table 2** shows comparison of prevalence of variations in different studies, ranging from 15 to 88 % [7,9-14]. Bergman RA et al have described the frequent asymmetry in formation of lumbar plexuses [6]. Our study also identified varied results like: unilateral variations in 8.69% and bilateral variations in 65.21% of plexuses. Multiple or more than one type of nerve variations in a single plexus, were found in 26.08% of total plexuses of present study, very few studies have documented them in detail [15].

Prefixed plexuses (T12 root contribution) were noticed in10.86 % of plexuses in present study. Arora et al, Gandhi et al, Assis FP et al and Anandhi et al have described T12 root contribution ranging from 5% to 13.3% [7,11,12,13]. Postfixed plexuses were observed in 13.04 % of plexuses in present study. Gandhi et al have mention L5 root contribution in in 3.33% of plexuses [11].

Table 2: Comparison of prevalence of variations of lumbar plexus in different studies.

Author/ Year	No. of Lumbar plexuses: Variations/ Total (variation in %)	Pre fixed (%)	Post fixed (%)	IH (%)	II (%)	GFN (%)	LFCN (%)	FN (%)	ON (%)	AON (%)
Sim & Webb (2004) [9]	24/60 (40%)	--	--	2	2	9	4	0	3	12
Anloague PA (2009) [10]	30/34 (88%)	--	--	20.6	0	47.05	17.64	35.3	0	8.8
KR Gandhi (2013) [11]	53/60 (88%)	13.3	3.33	88/ 11.6	88 /11.6	21.7	11.6	5	5	0
Arora (2016) [7]	30/60 (~50%)†	8.5	--	8.33	14.97	13.36	8.33	43.32	46.68	0
Assis FP (2017) [12]	60 (~ 20%)†	5	2	5	10	20.2	18.3	15	0	11.6
Anandhi (2018) [13]	50 (~ 16%)†	2	--	14	16	8	--	2	2	4
Benes M (2024) [14]	260 (~ 48%)†	3	--	9.6	9.6	48.1	5	3.8	0	9.2
Present study (2025)	30/46 (69.56%)	10.86	13.04	10.86	10.86	39.13	15.21	32.6	8.69	13.04

(*): = Data in column 3 to 11 are in percentage(%), (†): = Symbol "~" denotes approximate number, (‡): — = denotes data not mention in study.

Formation of ilio-hypogastric nerve, ilioinguinal nerve: Variations in IH & II nerve were found in 10.86% plexuses of present study. Absent of iliohypogastric nerve was found in 8.69% plexuses and was replaced by a branch from subcostal nerve. In 1 plexus T12 root joined with L1 to form common trunk and then divide into subcostal and iliohypogastric nerve. Arora et al have found absent IH nerve in 13.34% while Anloague et al have reported absent IH in 20.6% plexuses [7,10].

In present study, Ilioinguinal was arising separately from L1 root in 10.86% plexuses, while in 89% it was conjoined with iliohypogastric nerve arising from L1 root. Root value were T12 or L1 in all plexuses. Gandhi et al have found T12 contribution in 13.3% plexuses similar to present study and separate IH and II origin from L1 root in 88% of plexuses [11].

Different studies have mention about the similar variation in formation of IH and II nerves ranging from 5% to 20.5% (**Table 2**). [7,9,10,11,12,13,14]. Absent ilioinguinal nerve was mention in 15% of plexuses by Arora et al and in 5% of plexuses by Assis FP et al [7,12]. We did not find such variation. Bergmann et al had reported different types of formation of the ilioinguinal nerve and the ilioinguinal nerve, arising from a common root in 86.5% (mostly from L1, rarely from L2) and arising from two different segments (T12 and L1, L1 and L2, or L2 and L3) in 11% of plexuses [6].

Formation and division of genitofemoral nerve: Variations of GFN were common in 39.13% of lumbar plexuses in present study. Various studies have reported such variations from 8% to 48% (table 2). Arora et al have reported prevalence of absent genitofemoral nerve in 11.64% of plexuses [7]. We did not find such variation in our study. In 3 plexuses (6.52%) GFN was arising from the medial side of psoas major & in 2(4.34%) plexuses GFN was arising from the medial side of psoas major and psoas minor muscles, a kind of unique variation of present study.

In 5 plexuses (10.86%), femoral and genital branches were completely separate in origin from L1 & L2 root respectively and in two plexuses both branches were arising from medial(genital) and lateral(femoral) side of psoas major respectively. In 6 plexuses (13.04%) higher division of femoral and genital branch was seen midway on psoas major muscle. Gandhi et al have reported bifurcation of GFN in psoas major substance in 21.7% plexuses [11]. Anloague et al have reported early split in 47% plexuses with 26.5% inside psoas major muscle and 20.6% higher division outside the muscle [10]. Benes et al have reported higher division inside psoas major muscle in 48.1% of plexuses [14]. Similar higher division have been reported in other studies also [9,10,11,16].

Root value was L1, L2 in 97.8% plexuses except one plexus where it was arising from L2. Gandhi et al have mention it in one case. According to Bergman this nerve arises as a single trunk in 80% and as two separate branches in 20%, of the cases. He also claimed that these roots may originate from L1 and L2, or L2 and L3 [17].

Formation of lateral femoral cutaneous nerve: Variations in LFCN were found in 7 plexuses (15.21%) of present study which was similar to other studies (**Table 2**). In 2 (4.34%) plexuses LFCN was arising from femoral nerve at lower level in iliac fossa. Sim et al have reported 10% of nerve arising from femoral nerve [9].

Arora et al, Gandhi et al and Astik et al have reported LCFN arising from FN in 11.6%, 8.33% and 6.22% of plexuses respectively [7,11,18].

In 3(6.52%) plexuses LFCN was arising as two separate division from L2 & L3 roots. In 2 (4.34%) plexuses LFCN was having multiple connections or communications with ilioinguinal and femoral nerves **(Figure 1).** Daniz u et al have reported a single case of multiple variation of LFCN and FN [19].

Arora et al have reported absent LCFN in 10(16.66%) plexuses however we didn't find such type of variation [7]. Arora et al and Sim et al have mention variation in root values, forming the LFCN either from L1, L2 or L2, L3 or L2 alone or L3 alone [7,9]. Root value was L2, L3 in 100% of plexuses in current study.

Femoral nerve: Variations in femoral nerve were found in 15 plexuses (32.60%). In 9 plexuses **extra rootlets** or accessary slips for femoral nerve were present other than 3 main roots. These rootlets were arising from either of L1, L2, L3 or L4 segments. Benes et al have reported 12.3% such cases where a smaller accessary nerve accompanying the proper femoral nerve supplying thigh muscle [14]. Astik et al had found fascicles from ventral divisions of L2, L3 and L4 roots passing through the femoral nerve and supplying the pectineus muscle in 3 plexuses [18].

In 2 plexuses (4.34%) branches from L2 roots were separately uniting with fused L3 & L4 roots to form femoral nerve at the distance of 86 to 90mm from emergence in iliac fossa just above mid-inguinal point, showing lower formation of the nerve outside psoas major. Astik et al have founded, abnormally long L2 root in 2 male plexus (1 cadaver) and early division of the femoral nerve in 2 plexuses [18]. Anloangue et al and Benes et al have reported higher division of femoral nerve in psoas major slips in 35.3% and 1.5% plexuses respectively [10,14]. Assis FP et al have reported late formation and higher root level bifurcation of femoral nerve in 5% and 10% respectively [12].

In present study root value of femoral nerves were L2, L3 & L4 in 80.4% of plexuses while in remaining plexuses it was contributed from L1 or L5 root. In 6 plexuses (13.04%) femoral nerve was postfixed with extra root from L5 root and in 3 plexuses (6.52%) from lumbosacral trunk via communicating branch. Such post fixation of femoral nerve by L5 root is also mention by Gandhi and Anandhi et al [11,13]. Nayak et al have reported one case about contribution of LST to femoral nerve and obturator nerve [15]. Whether to consider such postfixed branch from LST as furcal nerve or not is a matter of discussion.

Obturator nerve & Presence or absence of accessory obturator nerve: Variations in obturator nerve were found in 4 plexuses (8.69%) of our study. In 91% of plexuses root value were L2, L3 and L4. Arora et al have reported 53.32% plexuses having normal root value of L2, L3, L4 and in 46.68% of plexuses contribution from T12, L1 or L5 root [7]. In our study, in 2(4.34%) plexuses obturator nerve was postfixed with extra L5 root contribution with communicating branch from LST in 1 plexus. Gandhi et al and Anandhi et al also have mention such post fixation of obturator nerve by L5 root [11,13]. In 2(4.34%) plexuses of present study obturator nerve was formed by L3 & L4 roots only. Sim et al have reported such variation in 3% of the plexuses where nerve was arising from L3, L4 [9].

In present study, accessary obturator nerve was present in 13.04% of lumbar plexuses. It was bilateral in 2 cadaver and was associated with psoas minor muscle in 2(4.34%) plexuses. Many studies have mentioned the present of accessary obturator nerve ranging from 0 % to 12% (**Table 2**) [7,9-14]. Root value were L3 & L4 in 100% of plexuses of our study.

Psoas minor muscles were present in 8(17.37%) plexuses. In 3 cadavers, it was bilateral and in 2 cadavers it was present on one side only. Arora et al have found psoas minor in 5(8.33%) plexuses [7]. No other studies of lumbar plexuses have mention about it.

Embryology: Variations in the formation and the course of nerves found in present study can be linked to varied response to positional cues and/or the variations in the migratory paths of the myotomes towards the destination site. Different pathways taken by individual myotomes could have resulted into diverse nerve course or trajectories [15,16]. However, role of various

growth factor signals from apical ectodermal ridge or homeobox proteins are also thought to determine axonal migration and projection [4].

Clinical or Surgical Aspect: The lumbar plexus and its branches are essential to consider when performing surgery. An anterior abdominal approach in surgeries like appendicectomy, inguinal hernia repair, bone grafting and gynecologic transverse incision surgery can result in iatrogenic injury to various superficial branches either the iliohypogastric nerve, ilioinguinal nerves, genitofemoral nerve or lateral femoral cutaneous nerve leading to various complications like meralgia paraesthetica, groin pain and testicular pain [20,21]. Damage to the lumbar plexus is a well-documented iatrogenic injury following a minimally invasive lateral retroperitoneal transpsoas approach [20,22].

Genitofemoral nerve is most difficult to recognized during operations [21]. In patients with testicular torsion, the genital branch of the genitofemoral nerve which is motor to cremasteric muscle will become entrapped, and this reflex will be absent [20]. The genital branch may be injured during inguinal surgery (open and laparoscopic), leading to neuralgic pain [20,23].

Origin of LFCN from femoral nerve is important to consider while giving femoral block as it may also affect the territory of LCFN and vice versa [18]. Femoral nerve block can be ineffective if late formation or higher bifurcation or multiple extra rootlets or nerve slips are present. Similarly, obturator and accessory obturator nerve are important for clinical implication for obturator nerve block and hip surgery [9].

Uribe et al and Tubb et al have mention in their study about the direct injury to genitofemoral nerve and other nerves during the lateral retroperitoneal transpsoas approach for spinal surgery and described the various safe working zones and landmarks for lateral approach [24,25].

Limitations: In present study, we have calculated the prevalence based on number of variations found as the numerator and the total number of plexuses as the denominator. Few studies have used cadavers as the denominator and not mentioned the total number of lumbar plexus variations, which limits our ability of direct comparison of data. Variation found in present study are from cadaveric dissection and their ultimate impact on living patient can be proposed only and cannot directly corelated to clinical neuronal symptoms of an individual patient.

CONCLUSION

Results of present study have shown large number of variations (69.56%) in the lumbar plexuses of the South Gujarat region. Variations in root values and course of nerves of lumbar plexuses are quite common and has been mention in many studies but varied course of nerves, particularly genitofemoral nerve with two root from medial and lateral side of psoas major muscle, lateral femoral cutaneous nerve and their communications to surrounding nerves and femoral nerve having communicating branch directly from lumbosacral trunk were unique findings in present study making them important to understand the anatomy of the region.

knowledge of anatomical variations prevailing in the demography of South Gujarat region will help the surgeons, orthopaedics, gynaecologist or anaesthetists working in this area to access them during abdominal wall surgeries or lumbar plexus block to avoid iatrogenic injuries, to reduce the chances of complications and to eliminate the chances of any potential medicolegal issue arising out of it.

Abbreviations:

T12 - twelfth thoracic root, **L** - lumbar root & **L1** = 1st lumbar root/nerve, **SC** - Subcostal nerve, **IHN** - Iliohypogastric nerve, **IIN** - Ilioinguinal nerve, **LFCN** - Lateral Femoral Cutaneous nerve, **GFN** - Genitofemoral nerve, **FN** - Femoral nerve, **ON** - Obturator nerve, **AON** - Accessary Obturator nerve, **LST** – Lumbosacral trunk, **PM** - psoas major muscle, **PMn** - psoas minor muscle.

Competing interests: None

Authors' contributions:

Dr. Neeraj T. Master: dissection of cadavers, result, data analysis, discussion and manuscript drafting, **Dr. Hamzah M. Hafezji:** dissection of cadavers, result, data analysis, discussion and manuscript drafting. **Dr. Nishaben Parmar:** dissection of cadavers, result, data analysis, discussion and manuscript drafting. **4. Dr. Deepa S. Gupta:** guidance, approval and supervision of research.

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