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Morphological Variations in Formation of Lumbarplexus and its Clinical Significance

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Abstract: ***Introduction: Lumbar plexus(LP) is one of the main nervous pathways supplying the lower limb which Frequently shows variations. Looking for the applied significance of lumbar plexus in form of its involvement in various injuries direct, indirect or iatrogenic and entrapment. Tubbs et al[(1)] referred lumbar plexus as "No man's land" because of relative inaccessibility of this region and there is infrequency in operating on retroperitoneal structures by neurosurgeons. Material and Methods: The study was conducted on 22 (18 male and 4 female) formalin fixed cadavers used for undergraduate dissection in Department of Anatomy, Osmania Medical College, Koti, Hyderabad, Telangana. Thorough dissection was performed to observe the formation of branches of lumbar plexus and measurements were taken from bony land marks. Results: Post fixation of lumbar plexus was found in one cadaver unilaterally. Ilioinguinal and Iliohypogastric nerve were arising from common stem in 10% and separately at level of (L1) in 90%.***

Keywords: Lumbar plexus (LP), Lumbar plexus block (LPB), Post fixation, NervusFurcalis, Femoral nerve (FN)

1. Introduction

The Lumbar plexus are formed within the substance of psoas major muscle by the union of ventral rami of upper three lumbar nerves and the larger upper part of the ventral ramus of fourth lumbar nerve. The lower smaller part of ventral ramus of fourth lumbar nerve joins with thefifth lumbar nerve to form the lumbosacral trunkand enters in the formation of sacral plexus. Hence the fourth lumbar nerve is named as "nervusfurcalis" since it contributes in formation of both lumbar and sacral plexuses. In my study the fifth lumbar nerve (L5) forms nervusfurcalis,and hence lumbar plexus are designated as "Postfixed".

The lumbar plexus, which is one of the main nervous pathways supplying the lower limb, is located retroperitonially. Of the main branches, the iliohypogastric (IH) (L1), ilioinguinal (II)(L1),lateral femoral cutaneous nerve (LFCN)(L2-3 dorsal) and femoral (FN) (L2-4 dorsal) appear in that order from above downward emerging at the lateral border of psoas major muscle, the genitofemoral nerve(GF) (L1-2) appears on the anterior surface and the obturatornerve (ON) (L2-4 ventral) emerges along medial border of muscle. These branches have both sensory and motor component except LFCN, which as the name implies does not have a somatic motor component. The pattern of formation of lumbar plexus is altered if plexus are pre fixed or post fixed, that is, fiber contribution is moved cranially or caudally respectively.

Lumbar Plexus Blockade (LPB) is a useful technique in provision of surgical anesthesia[2]for lower limb orthopedic surgeries, muscle biopsies[2], and skin graft harvesting[3].A successful blockade depends upon appropriate placement of needle and ideal distribution of local anesthetics. Accurate measurements of relationship of branches of LP to adjacent bony landmarks and branching pattern of plexus aid the surgeon to perform successful and safe LP blocks during hip[3] and knee[4] surgeries. Further anatomical variations must be considered at time of LPB to avoid nerve damage and maximize the success rate.

2. Material and Methods

Present study was undertaken on 22(Eighteen Male and Four Female) adult (aged between 30-70 yrs) formalin fixed human cadavers used for undergraduate dissection from Dept. of Anatomy Osmania Medical college.There were no signs of surgery,wound scars, or trauma in the abdominal region in any cadaver.

Following the removal of peritoneum and abdominal viscera, the Lumbar plexus (LP) were exposed by an anterior approach. The branches were identified as they were in relation to the anterior, medial, and lateral border of psoas major muscle. Measurements were made from these nerves to adjoining bony points eg: Thecentre of anterior superior iliac spine (ASIS), ileac crest and supracristal plane. The fibers of psoas major were then meticulously dissected at their origin from lateral surface of lumbar vertebrae and branches of lumbar plexus(LP) were traced till their roots at theintervertebral foramina. The measurements were made using thread and ruler with markings in centimeters.

3. Results

In present study major variations were seen in formation and branching pattern of femoral nerve.Rest of the nerves have no major contribution in variations. The lumbar plexus showed no variations with respect to psoas major muscle. Female cadavers were less than male and the sample size being less, no significant differences were found in

comparing the plexus in both male and female cadavers,hence sexual dimorphism cannot be explained.

3.1 Formation of branches of lumbar plexus

None of the investigated lumbar plexus showed contribution from T-12 in the formation of plexus. Iliohypogastric (IH) and Ilioinguinal (II) nerve were separate at origin (at level of L1) in 90%of cases, and from common stem in 10%. We did not found absence of Iliohypogastric (IH) nerve in any of the plexuses. These nerves were 1.5 cm apart all along their course across quadratuslumborum on the posterior abdominal wall. The genitofemoral (GF) nerve pierced the middle third of psoas major in all cases. The lateral femoral cutaneous nerve (LFCN) arose from L2 and L3 in all cases . The LFCN traversed to the thigh by passing below the inguinal ligament in all the cases. The LFCN exited the pelvis in two different modes:

Table 1: Mode of emergence of LFCN with respect to ASIS

Sno	Relation to ASIS	No of cases observed 22	Percentage
1	1cm inferomedial to ASIS	18	81.30%
2	2-3 cm inferomedial to ASIS	4	18.10%

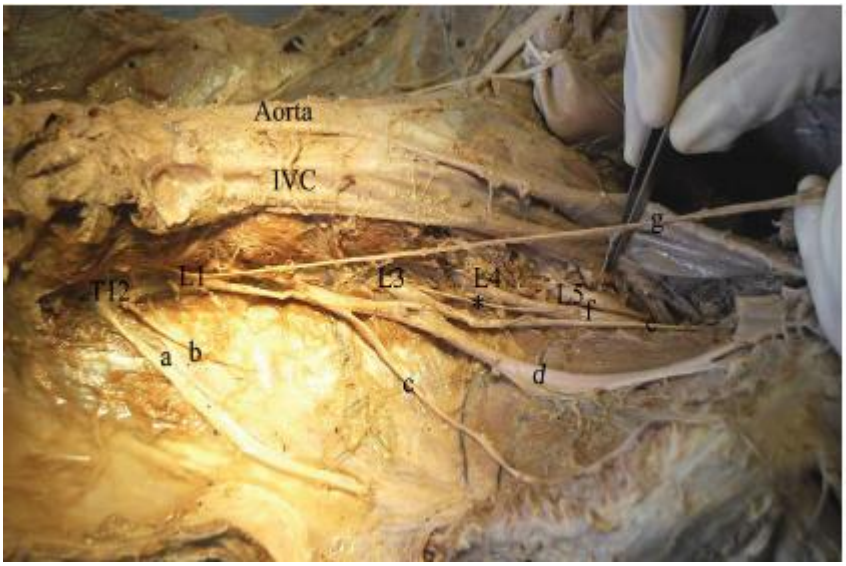
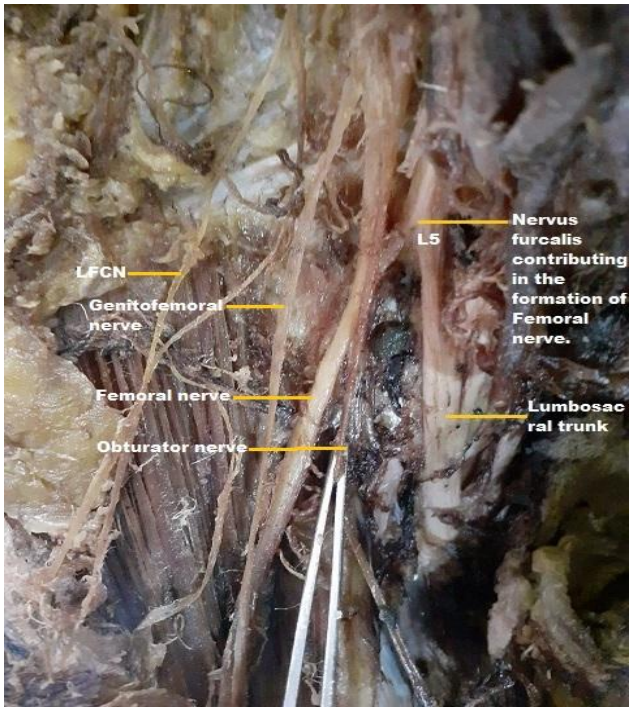


Figure 1: a) iliohypogastricnerve b) ilioinguinal nerve c) lateral femoral cutaneous nerve d) femoral nerve f) lumbosacral trunk g) obturator nerve

Femoral nerve the largest branch of LP , had usual orgin from L2, 3, 4 in all except in one case in which L5(nervus furcalis) contributed to the formation of the nerve along with its normal root value ie;(L2, 3, 4, 5,)and hence ”post fixed” plexus .The formation of femoral nerve in relation to ileac crest is shown in Table 2.The femoral nerve in 10% of the cases it emerged at a distance of 2-6 cm. The FN has a 8-10 emerges from lateralsurface of psoas major below the iliac crest at a variable distance of 3.5 to 6.5 cm in 90% cases. cm oblique course within the pelvic cavity oniliacus muscle. On the right side,the femoral nerve is in posterior relation to iliocaecal junction and on the left side posterior to sigmoid colon. After traversing a distance of 5cm the FN occupies the ilio psoas groove (lacuna musculorum),roofed by iliacus fascia in its pelvic course.In thegroin,femoral nerve (FN) travels in a rigid fibro muscular canal bound by the inguinal ligament, ilio psoas muscle, and iliacus fascia where it is liable to be compressed.



Nervus Furcalis (NF) Formation in Present Study

Number of cases	NFfrom L4	NFfrom L5
22	21	1(on right side)

Table 2: Formation of femoral nerve (FN) in relation to ileac crest

Formation of FN (distance inferior to iliac crest (IC) in cm)	No of cases (22)	Percentage%
5-6 cm below IC	20	90.90%
3-6 cm below IC	2	10.10%

The obturator nerve(ON) emerges at a variable distance from the level of iliac crest to 3.5 cm below the supracristal plane along the medial border o psoas major in all cases.

4. Discussion

Although the detailed anatomy of lumbar plexus was first described by Longnecker[5], variations in formation and position of lumbosacral plexus were briefly presented by Hollinshead[6]. These variations have clinical applications during LPB [6] for hip and knee arthoplasties, obstetric surgery, appendicectomy, and pelvic surgeries.

In the current study, the contribution of T12 thoracic nerve to lumbar plexus (LP) was not observed in any of the cases of 10 cases.Hollinshead[6] performed a series of studies on 250 lumbar plexus and reported this in 34%[8] and Woodburne[7] found it in almost 50% of cases. In present study theiliohypogastric (IH) andilioinguinal(II) nerves were arising from L1 in 90%, whereas Hollinshead[6] recorded it in 40%.Our findings coincide with those of Tubbs et al [1]that theiliohypogastric (IH) andilioinguinal(II) nerves were superior to supracristal plane with a mean distance of 4cm to 5cm respectively, and therefore Whiteside insisted on placing the laparoscopic trocar 2cm above a line transversely drawn between the right and left ASIS to prevent iatrogenic nerve transaction.

Regarding the origin, the GF nerve arose from L1-L2 in all cases.Tubbs et al reported that the GF nerve always pierced the psoas muscle more or less in the midline.In the present study the GF nerve pierced the middle third of psoas major in 100% of cases.Several authors (Standring[8]et al ,Hollinshead[6]) have described that the genitofemoral nerve (GF) sometimes divides into genital branch and femoral branch prior to emergence from psoas major. The prevalence of division of genitofemoral nerve within in the substance of psoas major is shown in Table 3.Entrapment or pinching of Lateral femoral cutaneous nerve (LFCN) at the level of Inguinal ligament (IL) leads to meralgiaparesthetia, a condition characterized by paindisesthesia, and hyperesthesia in anterolateral portion of thigh. In my study in none of the cases the LFCN was piercing the inguinal ligament.

Table 3

Authors	No. plexus studied	Cases found	Percentage
Tubbs at al [1]	22	0	0
Uzmanzel et al[9]	64	27	42
Analouge et al [10]	34	9	26.5
Present study	22	0	0

Femoral nerve the largest outflow of lumbarplexus, traverses below the inguinal ligament to the thigh. In the current study, in 90% of cases, the femoral nerve (FN) is formed 5-6 cm inferior to iliac crest similar to the findings of Tubbs et al [1].The femoral nerve block is performed 1 cm below the level of inguinal ligament to provide analgesia for hip and joint surgeries. Hollinshead[6]described a very variable origin of obturatornerve (ON) as arising from third and fourth lumbar nerves L3-L4 in 175 (76.7%) of 228 plexuses. In present study similar findings were seen.

Conclusion

In this study, the attempt is to add on more details in the branching pattern of lumbar plexus, which can aid the surgeons to avoid iatrogenic injuries to the plexus. The findings of this study do confirm the observations reported in earlier studies.

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