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# The morphology of lumbar sympathetic trunk in humans: a cadaveric study

K.R. Gandhi[1], V.K. Verma[2], S.K. Chavan[1], S.D. Joshi[1], S.S. Joshi[1]

[1]*Pravara Institute of Medical Sciences, Loni, Maharashtra, India*
[2]*Department of Orthopedics, People's Medical College, Bhopal, India*

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*The vasospastic diseases and chronic pain related to lower limb have been successfully treated by surgical ablation of lumbar sympathetic trunk for last 80 years. Precise knowledge of anatomy of lumbar sympathetic trunk and its adjoining structures is mandatory for safe and uncomplicated lumbar and spinal surgeries. We aim to study the detailed anatomy of entry and exit of lumbar sympathetic trunk, the number, dimensions and location of lumbar ganglia in relation to lumbar vertebra. Thorough dissection was carried out in 30 formalin embalmed cadavers available in the Department of Anatomy, Pravara Institute of Medical Sciences (PIMS), Rural Medical College (RMC), Loni, Maharashtra. A total of 238 ganglia were observed in 60 lumbar sympathetic trunks. The sympathetic trunk traversed dorsal to the crus of diaphragm in 72.6% and in 13.3% it entered dorsal to the medial arcuate ligament. The most common site of the location of lumbar ganglia was in relation to the second lumbar vertebra, sometimes extending up to the L2–L3 vertebral disc. There was a medial shift of sympathetic trunk in lumbar region and it coursed over sacral promontory to reach the pelvic region in 96% of specimens. These variations should be kept in mind in order to prevent hazardous complications like accidental avulsion of first lumbar ganglia and genitofemoral neuritis.* (Folia Morphol 2013; 72, 3: 217–222)

**Key words: lumbar ganglia, crus of diaphragm, medial arcuate ligament, sacral promontory**

## INTRODUCTION

In performing chemical or endoscopic lumbar sympathectomy, the initial exposure and identification of lumbar sympathetic trunk (LST) often presents a real problem because of the depth of the wound and the proximity of vital structures. The similarity in location and resemblance in appearance of the sympathetic trunk to the crura of diaphragm, genitofemoral nerve, tendon of psoas minor and lumbar lymphatic system further increases the risk of injury.

Normally, LST enters deep to the medial arcuate ligament and is situated on the anterolateral aspect of lumbar vertebral bodies. Usually there are 4 ganglia in each trunk. The right trunk is posterior to the lateral edge of vena cava and the left trunk lies just along the lateral edge of abdominal aorta. The trunk courses medial to psoas major muscle and it exits over ala of sacrum to the pelvis [1–3, 9, 11, 13]. Variations from this normal pattern in the LST may lead to complications — especially by inexperienced hands. There is a paucity of literature

Address for correspondence: Dr K.R. Gandhi, Assistant Professor, Department of Anatomy RMC, PIMS, Loni, Maharashtra, India, tel (mobile): 919689484225, fax: 912422273442, e-mail: gandhikusum.r@gmail.com

describing gross features of LST in Indian population. The present study describes the normal and variational patterns of entry, exit and course of lumbar portion of sympathetic trunk.

## MATERIALS AND METHODS

The study was conducted on 30 (24 males and 6 females) formalin embalmed cadavers, available in the department over a period of 3 years, with ages ranging from 47 to 78 years. Approval of the Institutional Ethical and Research Committee was obtained before starting with the project. The cadavers having normal retroperitoneal anatomy were included in the study. We followed the LST from the lower thoracic segments, where the sympathetic trunk lies on the heads of the ribs. It was observed that at the level of eleventh thoracic vertebra the sympathetic chain deviates abruptly to the medial side and descends over the anterolateral aspect of the bodies of twelfth thoracic and lumbar vertebra and the intervening intervertebral disc. Meticulous dissection of the crus of diaphragm was performed to know the exact point of entry of the trunk to the lumbar region, as illustrated in Figure 1. After retracting the abdominal aorta and the inferior vena cava medially on their respective sides, the dimensions of the sympathetic ganglia were measured by means of scale in millimetres. The location of lumbar ganglia was noted in relation to the lumbar vertebra. The lumbar region was divided into 15 segments, each lumbar vertebra was divided into upper and lower half and the vertebral disc was considered as a separate entity, as shown in Table 1. The exit of the LST to the pelvis was observed after

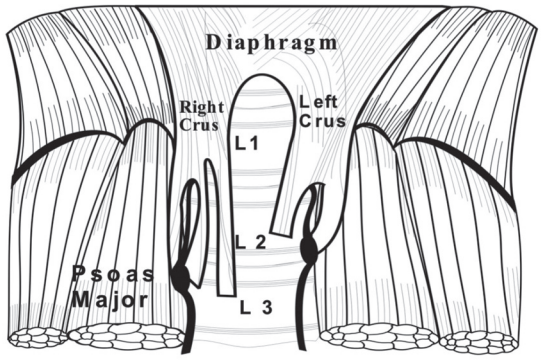


**Figure 1.** Illustration showing the mode of attachment of crus of diaphragm to the lumbar vertebra. On tracing the right crus of diaphragm inferiorly it divides into three parts (medial, intermediate and lateral) and the left crus bifurcates into two parts (lateral and medial). On the right side the lumbar sympathetic trunk is running between lateral and intermediate parts while on the left side the sympathetic trunk is traversing between lateral and medial parts of crus of diaphragm.

**Table 1.** Location of ganglion in relation to the lumbar vertebra

| Lumbar segments | Division of the lumbar vertebra | Number of the lumbar sympathetic ganglion | | Total number of ganglia | Percentage |
|---|---|---|---|---|---|
| | | Right | Left | | |
| 1st lumbar vertebra | Upper portion | 10 | 4 | 14 | 9.24 |
| | Lower portion | 4 | 4 | 8 | |
| L1–L2 intervertebral disc | | 10 | 11 | 21 | 8.82 |
| 2nd lumbar vertebra | Upper portion | 10 | 13 | 23 | 17.64 |
| | Lower portion | 9 | 10 | 19 | |
| L2–L3 intervertebral disc | | 11 | 14 | 25 | 10.50 |
| 3rd lumbar vertebra | Upper portion | 5 | 8 | 13 | 10.08 |
| | Lower portion | 7 | 4 | 11 | |
| L3–L4 intervertebral disc | | 12 | 11 | 23 | 9.66 |
| 4th lumbar vertebra | Upper portion | 6 | 8 | 14 | 11.76 |
| | Lower portion | 6 | 8 | 14 | |
| L4–L5 intervertebral disc | | 6 | 8 | 14 | 9.24 |
| 5th lumbar vertebra | Upper portion | 4 | 3 | 7 | 5.46 |
| | Lower portion | 3 | 3 | 6 | |
| Lumbosacral disc | | 12 | 14 | 26 | 10.92 |

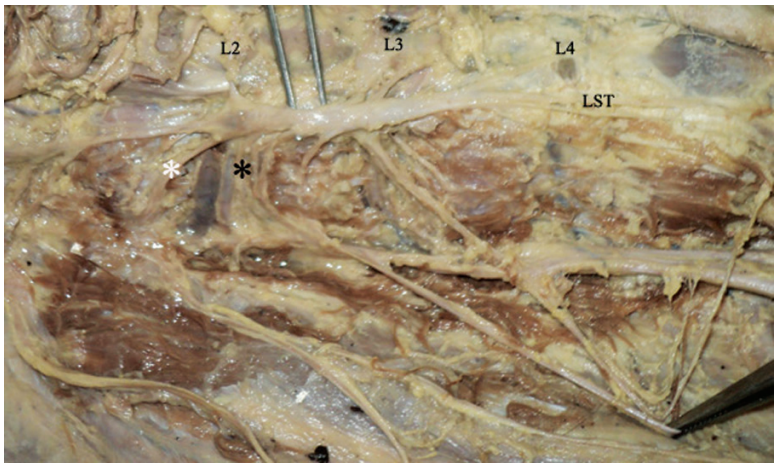


**Figure 2.** Lateral aspect of right lumbar sympathetic trunk (LST). The largest lumbar ganglia found in relation to second and third lumbar vertebra and intervening disc. White asterisk shows white rami connecting the ganglia with lumbar spinal nerve and black asterisk shows the grey rami which is medial to the white rami and runs along with lumbar vessels in the concavity of lumbar vertebra.

**Table 2.** Different patterns of entry of the sympathetic trunk to the abdomen

| Entry of the sympathetic trunk from the thorax to the abdomen | Side | | Total number of cases | Percentage |
|---|---|---|---|---|
| | Right | Left | | |
| Dorsal to the crus of diaphragm: | | | | |
| between medial and lateral crura | Nil | 21 | 21 | 35 |
| between lateral and intermediate crura | 22 | Nil | 22 | 36.66 |
| Dorsal to medial arcuate ligament | 5 | 3 | 8 | 13.33 |
| Between medial arcuate ligament and crura of diaphragm | 4 | 5 | 9 | 15 |

retracting the common iliac vessels and iliac group of lymph nodes over the sacral promontory and ala of sacrum.

## RESULTS

The total of 238 ganglia were found in 60 lumbar sympathetic trunks. The number of ganglia in a single LST ranged from 2 to 6. The mean length of the ganglia was 17 mm, ranging from 6 mm to 33 mm. The mean width measured was 5 mm (3–12 mm). A large lumbar ganglion is shown in Figure 2. The course of the LST was anterior and medial to the psoas major muscle all throughout in the abdomen.

### Mode of entry of LST in abdomen

Three different patterns of entry of sympathetic trunk into the abdomen were observed (Fig. 1, Table 2). The entry was found in relation to the crus of diaphragm and medial arcuate ligament (medial lumbocostal arch) shown in Figures 1 and 3. Gender and side differences were not statically significant ($p > 0.05$).

### Method of exit of LST to the pelvic cavity

The LST traversed to the pelvic region in 2 different manners; either it passed over the sacral promontory or over corresponding ala of sacrum. In 58 (96.6%) cases it traversed over the sacral promontory (Fig. 4), and over the ala of sacrum in only 2 (3.33%) cases. The findings were symmetrical on both sides.

### The number and distribution of ganglia in LST

In 46.6% of the cases, 4 ganglia were observed in the trunk. The number and distribution of the lumbar ganglia is described in Table 3.

### The location of lumbar ganglia in relation to lumbar vertebra

The lumbar ganglion was most likely to be found along the second lumbar vertebra in 28% of the cases.

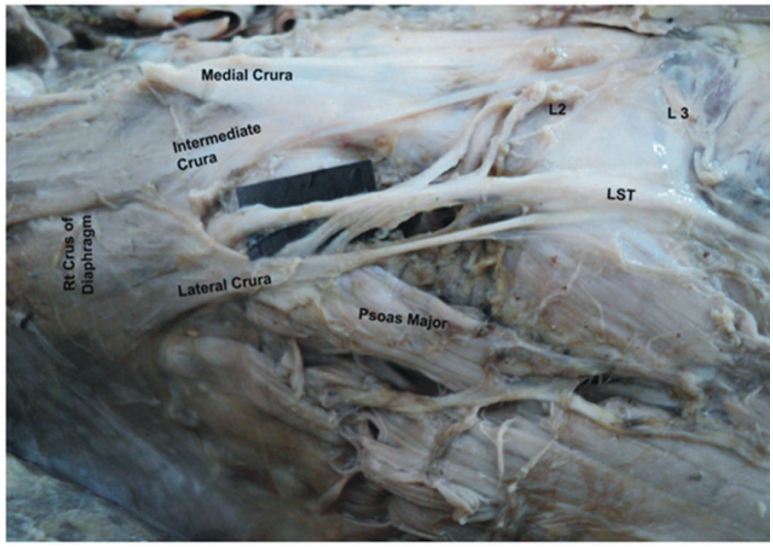


**Figure 3.** Right lateral view of paravertebral lumbar sympathetic trunk (LST) taking entry between the lateral and intermediate part of the right crus of diaphragm. Note the thin and tendinous crura at its attachment to lumbar vertebra which may lead to unsuccessful lumbar sympathectomy. The LST was always in anterior and medial relation to the psoas major muscle all along its course in abdomen.


**Figure 4.** Anatomical dissection — superior view of the lumbar sympathetic trunk (LST) traversing over the lumbar vertebra (L2, L3, L4, and L5). As the lumbar sympathetic trunk descends caudally it is shifted more medially and crosses over the sacral promontory to enter pelvic cavity.

**Table 3.** Number and distribution of ganglion in lumbar sympathetic trunk

| Number of the lumbar ganglia in each trunk | Number of cases | | Total number of cases observed | Total number of lumbar ganglia | Percentage |
|---|---|---|---|---|---|
| | Right | Left | | | |
| Two | 2 | 1 | 3 | 6 | 5 |
| Three | 8 | 6 | 14 | 42 | 23.33 |
| Four | 13 | 15 | 28 | 112 | 46.66 |
| Five | 6 | 6 | 12 | 60 | 20 |
| Six | 1 | 2 | 3 | 18 | 5 |
| Total ganglia | | | | 238 | |

## DISCUSSION

Lumbar sympathectomy was first introduced by an orthropaedic surgeon, Norman Dawson Royle, and his colleague Hunter on 1st September 1923 in Sydney. The procedure was performed on a human volunteer, a 30-year-old male suffering from unmanageable spastic paralysis [3]. Since then lumbar sympathectomy has gained popularity for severe plantar hyperhidrosis, Buerger's diseases and intractable pain of genito-urinary organs [1, 5, 7, 8, 14, 16].

Most of the anatomy textbooks and available literature on the LST do not appreciate and describe the details of the morphology of LST [2]. It was Lowenberg and Morton [9] who gave a detailed account of entry of LST in their study on 29 cadavers. Out of the 4 different patterns of entry mentioned by them, the most common was under the crus of diaphragm (41.17%), followed by entry between crus and medial arcuate ligament (29.41%), which was followed by course under the medial arcuate ligament (17% of the cases). The least common manner seen by them was passage through the crus of diaphragm (11.76%). Pick [11] reported that sometimes the trunk pierced the medial crus of diaphragm and it often passed through the tendon of the medial arcuate ligament. Jit and Mukerjee [6] described diagrammatically that in majority of cases the trunk passed through the crus of diaphragm. Feigl et al. [5] mentioned that the sympathetic trunk traversed medial to the left crus of diaphragm in 1 case only in their study on 56 cadavers. In the present series, the most common pattern of entry observed is dorsal to the crura of diaphragm in 71.66% (between lateral and intermediate crura of right crus of diaphragm and lateral and medial crura of left crus of diaphragm), as illustrated in Figures 1 and 3. At this level, the interganglionic portion of LST may be confused with the tendinous crus as the fleshy crus becomes thin and tendinous towards its lumbar attachment. During chemical lumbar sympathectomy the tendinous crura may be confused with genitofemoral nerve, what can result in genitofemoral neuritis in 5–10% of neurolytic lumbar blocks [4].

The published data relative to the best site for lumbar ganglion block is variably reported by previous authors and confirms the statement by Yeager and Cowley [16] that lumbar part of sympathetic trunk is most variable portion of sympathetic trunk [10, 13–16]. Rocco et al. [13] suggested that middle of the body of the third lumbar vertebrae is the best site for lumbar sympathectomy. Webber [15] reported the most constant ganglia at the level of fifth lumbar vertebrae, whereas Datta and Umeshraya [4] proposed that the most constant ganglion was located between the second and fourth lumbar vertebra. Livingston stated that the third lumbar ganglion is the "central point" for surgical attack [14]. Lowenberg and Morton [9] reported that the ganglion was located mostly in the neighbourhood of third lumbar vertebra. In the current study, the most constant ganglion was found in relation to the second lumbar vertebra, mostly in its lower half or sometimes crossing the L2–L3 intervertebral disc to lie on the body of the third lumbar vertebrae, as in Figure 2. It is important to note that in 3 (5%) of specimens the first lumbar ganglion was descended down to the anterolateral surface of the second lumbar vertebra, which is the common site for placement of needle during surgical sympathectomy. Accidental avulsion of this first lumbar ganglion instead of second or third lead to inability to ejaculate in male patients, resulting in sterility [12]. We propose that retrograde counting of ganglia from the level of sacral promontory is quite safe and easy method to confirm the identity of the ganglia being resected during laser and endoscopic lumbar sympathectomy.

Lowenberg and Morton [9] encountered 202 ganglia in 56 trunks and the ratio was 1:3.6. Our results are in agreement with Murata et al. [10], as they also found 2 to 6 lumbar sympathetic ganglia on one side of the LST — the ratio being 1:3.9. Murata et al. [10] found 393 ganglia in 100 sympathetic trunks — on an average there are 4 ganglia in each LST.

"Gray's anatomy" [2] describes that the LST continues as pelvic sympathetic trunk posterior to the common iliac artery, without mentioning its exact location. In the present series the exit of LST was observed over the sacral promontory (Fig. 4) in 96.6% of the cases and these findings are in accordance with Rutherford [14]. Only in 3.33% of the cases it traversed over the corresponding sacroiliac joint. The findings of entry and exit of LST favours the concept that there is a medial shift of the LST as it traverses caudally.

## CONCLUSIONS

We believe that this study will supplement very useful anatomical landmarks of entry and exit of LST which may help neurosurgeons, orthopaedicians and anaesthetists to carry out surgical procedures successfully.

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