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An Original Contribution

Paradiscal Extraforaminal Technique for Lumbar Sympathetic Block: Report of a Proposed New Technique Utilizing a Cadaver Study

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Knowledge of the relationship of the lumbar sympathetic chain to the vertebral bodies is needed to perform sympathetic block and sympatholysis. This information should be correlated with fluoroscopy to determine the best method to perform this technique clinically. Twenty cadavers were dissected to demonstrate the lumbar sympathetic chain. In five cadavers, a 17 G Hustead needle was introduced inferior to the transverse process in the concavity of the body of L2 vertebra utilizing an extraforaminal (paraforaminal) approach and images were obtained in both the anteroposterior and lateral views. Needles were placed by utilizing either the loss of resistance technique (just piercing the psoas muscle) or by placing the needle posterior to the anterior border of the vertebral body. The cadavers were then dissected to demonstrate needle position in relationship to the lumbar sympathetic chain.

Each lumbar sympathetic chain was located on the anterolateral aspect of the vertebral body at the medial attachment of psoas major to the vertebral body. When needles were inserted using the loss of resistance technique, dissection revealed needle tips considerably anterior to the ganglia and missing it. When the needle was placed just on the anterior border of the vertebral body, the tip was close to the sympathetic chain. In all of the dissections, lumbar segmental vessels were found in the concavity of the vertebral body ventrodorsally and closely related to the sympathetic chain. The chain varies in both size and location of the ganglia. In the majority of cases, lumbar ganglia were 3 in number.

We believe the extraforaminal technique of lumbar sympathetic block is superior to the paramedian approach considering that there should be a reduced chance of passing through viscera and a lower incidence of genitofemoral neuralgia. However, with the extraforaminal technique, two important possible complications need to be highlighted. Chances of injury to the segmental lumbar vessels and the anterior ramus are present. Therefore, the extraforaminal technique needs to be modified. We advocate the extraforaminal paradiscal technique for lumbar sympathetic block. The initial target point for entry should be the lateralmost tip of the transverse process. Advancement of the needle should be extraforaminal with minimal chance of injury to the nerve or the anterior ramus. Final target point should be paradiscal. The needle tip should be positioned just posterior to the anterior border of the vertebral body. Loss of resistance technique should not be utilized and is potentially dangerous. Use of at least two needles is advisable (L2 and L3 vertebral body). Care should be taken to avoid the lumbar vessels. A transdiscal technique recently advocated may also avoid some of the complications with the paramedian technique, but chances of discitis, nerve root injury, accelerated disc degeneration, disc herniation and rupture of the anterior annulus have to be considered when using this technique.

Keywords: Lumbar sympathetic ganglion, lumbar artery, lumbar sympathetic chain, lumbar sympathetic block, transforaminal technique

The concept of a dysfunctional sympathetic system contributing to neuropathic pain is not new. The term "Sympathetically Mediated Pain" (SMP) is defined as pain maintained by sympathetic efferent innervation or by circulating catecholamines and was originally coined by Roberts in 1986 (1). Roberts (1) presented a hypothesis on a sequence of events that lead to the generation of SMP:

1. Injury causes C-nociceptor response which sensitize Wide Dynamic Range (WDR) neurons in lamina V of the dorsal horn
2. Sensitized WDR neurons become responsive to large-diameter A-mechanoreceptors activated by light touch.
3. A-mechanoreceptor activity is facilitated by sympathetic efferent action on sensory receptors and augments WDR responses: it is this last phase that represents SMP.

Many neuropathic pain syndromes, particularly reflex sympathetic dystrophy and causalgia (currently called Complex Regional Pain Syndrome [CRPS], types I and II, respectively), are thought to be SMP. Historically, this has led to attempts to temporarily or permanently interrupt the sympathetic nervous system. Shumaker (2) in 1948 reported the dramatic cure of causalgia by either surgical sympathetectomy or alcohol injection in 81% of 57 post-war cases. However, long-term follow up was missing from this series. The bulk of experience concerning lumbar chemical neurolysis comes from the treatment of occlusive vascular diseases, but this procedure is also performed to treat cancer pain, CRPS types I and II, post-discectomy syndrome, phantom limb pain, herpes zoster and the early stages of postherpetic neuralgia.

Two articles by Haynsworth (3) and Noe (4) published in 1991 and 1993, re-

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ported on the results of a randomized trial comparing radiofrequency sympatholysis with phenol sympathetectomy. Seventeen consecutive patients (8 in conventional radiofrequency and 9 in phenol group) participated in the study. Phenol sympathetectomy was done with 3 ml of 6% phenol injected at each level of the lumbar vertebra (L2, L3 and L4) under fluoroscopic guidance. Conventional radiofrequency was done by inserting needles lateral to L2, L3 and L4 vertebral bodies. The needle tips were directed to the junction of the middle and lower thirds of the vertebral body at L2, and to the junction of middle and upper thirds of L3 according to lateral fluoroscopy. The mid-vertebral body was targeted at L4. Coagulation was performed at 70° C for 120 seconds. This was done approximately 0.5 cm posterior to the anterior vertebral edge as judged by lateral fluoroscopy and then was repeated after pulling the needle back 2-3 mm. In the phenol group, 100% of the patients fulfilled the criteria for effective sympatholysis immediately upon the procedure; with the effect persisting at eight weeks follow up in 89% of the patients. In the conventional radiofrequency group, 37% showed evidence of sympatholysis at four weeks, and only 12% at eight weeks. The incidence of post-sympathectomy neuralgia was 33% in the phenol group and 11% in the radiofrequency group.

As these results did not demonstrate a favorable outcome of the radiofrequency sympatholysis, in 1993 the authors conducted a series of modified radiofrequency techniques and compared the results with the previously published phenol group (4). The modified radiofrequency procedure used a larger probe size and an increased series of lesions. With this modified technique, 75% of the patients met the criteria for sympatholysis at 8 weeks. Post-sympathetectomy neuralgia occurred transiently in 50% of the patients.

Rocco (5-8) in 1995 used a combination of the phentolamine test, anatomical studies and modification of the two-person technique for localization of the anterior border of the psoas muscle for achieving better results with radiofrequency sympatholysis. His results were not impressive. In 20 patients, fifteen had temporary relief or no relief at all. He concluded that a single technique of radiofrequency sympatholysis does not appear to be applicable to all patients. Despite early successful sympathetic block with radiofrequency, as confirmed by a warm foot, long lasting pain relief is difficult to obtain.

Considering the poor results with the present techniques of lumbar sympathetic block and a lack of uniformity in the way the block is performed, we believe the technique needs to be revisited. An accurate knowledge of the relationship of the lumbar sympathetic chain to the vertebral bodies is needed to perform sympathetic block and sympatholysis, either by chemical or radiofrequency methods. The sites should be defined in three dimensions: cephalo-caudad in the sagittal plane, anteroposterior plane and laterally in the horizontal plane. This information should be correlated with fluoroscopic images to determine the best way to perform this technique clinically.

Methods

Twenty cadavers were dissected to demonstrate the lumbar sympathetic chain. In five cadavers, a 17 G Hustead needle was introduced inferior to the transverse process in the concavity of the body of L2 vertebra utilizing an extraforaminal approach and images were obtained in both the AP and lateral views. Needles were inserted utilizing either the loss of resistance technique or just posterior to the anterior border of the vertebral body. The cadavers were then dissected to demonstrate needle position in relationship to the lumbar sympathetic chain.

Results

Each lumbar sympathetic chain was located along the anterolateral aspect of the vertebral body. The psoas muscle was always posterior and considerably lateral to the sympathetic chain (Fig. 1 & 2). The ganglia were most well formed adjacent to the intervertebral discs.

When needles were inserted using the loss of resistance technique, dissection always revealed the needle to lie considerably anterior to the ganglia and missing it. When the needle was placed just on the anterior border of the vertebral body, it was seen lying close to the sympathetic chain. Radiographic images demonstrating needle position in a patient are shown in (Fig. 3, 4 & 5).

In fifteen of the dissections, lumbar arteries were found to be very close to the middle of the vertebral bodies. The chain was found to be quite large with variability noted in both size and location of the ganglia. In most cases, lumbar ganglia were three in number. The chain did not course more medially as it continued inferiorly.

Discussion

Our findings are in agreement with the early anatomic studies of the lumbar sympathetic ganglia as cited by Bonica (9). He reported that the number of ganglia varied from 2-5 with an average of 3, usually located between the second and fourth lumbar vertebra. Often none were found in relation to the first lumbar vertebra (9, 10). The lumbar ganglia may be represented either as a single fused elongated mass or up to six separate ganglia. The rami of a ganglion on a specific lumbar vertebra do not necessarily have the same destination. Thus, the sympathetic innervation of the lower extremity may vary not only among patients but also on opposite sides of the same patient. The upper lumbar ganglia may be connected to as many as four lumbar nerves whereas in the lower lumbar regions, ganglia are commonly distributed to only one nerve. The length and course of the rami may vary. Bradley (10) found a ramus passing from the second lumbar ganglion to the first lumbar nerve that was 48 mm long. Edwards (11) and Bogduk (12) found that some rami bypassed the ganglia and traveled directly to the psoas muscle to the genitofemoral nerve.

Considering the above anatomic factors, Rocco (6) suggested that the area just cephalad to the middle of the body of the L 3 vertebra is the best starting point for the following reasons: ganglia are more likely to be present in the area of the L3 vertebra; the least variation in the location of the sympathetic chain in the horizontal (axial) plane ventrally is also in the L3 area; and the psoas muscle may terminate at the lower part of the L3 vertebra. The initial target area was rostral to the middle of the vertebra to avoid contacting the somatic nerve root or the lumbar artery. The distance from the midline of the back to the entry point ranged from 6 to 8 cm. They advocated using a loss of resistance to saline. Cell bodies may be located in the rami communicantes (10). Intermediate ganglia may be hidden under the fibrous arches of the attachment of the psoas muscle to the vertebral body and the discs (11). Rocco (6) concluded that it may be necessary to perform lesions at vari-

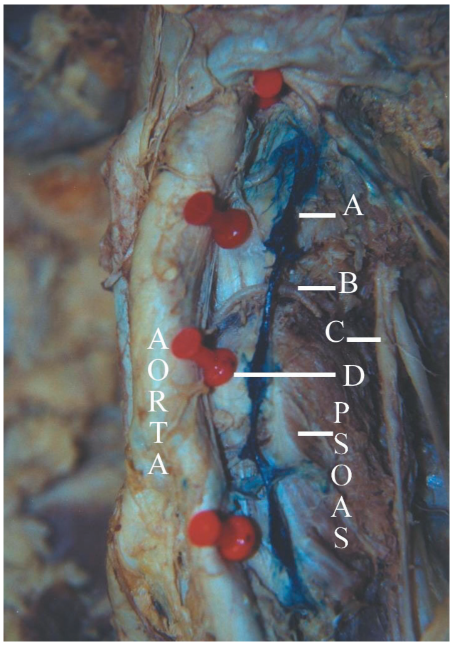

Fig 1. *Cadaver study of the lumbar sympathetic chain: Lumbar sympathetic chain (A) is very closely related to lumbar vessels in the concavity of the vertebral body, stressing chances of injury when needle is placed according to Sluijter's (13) technique. Markers have been placed at the level of the intervertebral discs (D). Note at this point, the ganglion is most well formed and away from the lumbar vessels (B). Lumbar nerve roots (C) have been dissected. The psoas major muscle is lateral to the sympathetic chain. Note also the relatively straight course of the lumbar sympathetic chain.*

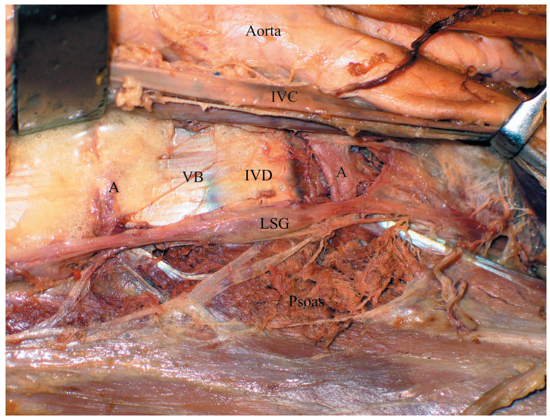

Fig 2. *Cadaver dissection of the lumbar sympathetic chain. Note how the lumbar sympathetic ganglion (LSG) is most well formed at the level of the intervertebral disc (IVD). The lumbar artery (A) is intimately related to the middle of the lumbar vertebral body (VB) stressing chances of injury when needle position is in the middle of the vertebral body. Also note that the Psoas Major muscle is an extremely bulky muscle. Loss of resistance technique may have a false result as the needle may pierce anywhere on the bulk of the muscle, and may lead to erroneous needle position far anterior to the actual position of the sympathetic chain. The aorta and the inferior vena cava (IVC) have been retracted away from the field.*

ous distances from the anterior border of the vertebral column not only because the location of the psoas muscle posteriorly from the anterior border of the vertebra varies, but also because the ganglia may lie in the substance of the psoas muscle.

On the other hand, Sluijter (13) believes that the key level for blockade of the sympathetic chain is L2 since this is the lowest level where the sympathetic chain receives presynaptic fibers from the spinal cord. He advocates the target point to be 1 mm lateral to the concavity of the vertebral body. The course of the anterior rami of the spinal nerves is important since during a sympathetic block contact may be made with those nerves. Since the anatomy of the anterior rami varies for each segmental level, a thorough understanding is essential.

At the L3 level the situation is uncomplicated. The L2 segmental nerve passes well medial to the needle path by the extraforaminal technique; this is true for the L3 segmental nerve as well. At the L4 level, it should be kept in mind that the anterior ramus of L3 runs in a more lateral direction than L2. At the L5 level the situation is again different. Here, the anterior ramus of L4 is not a problem because the L4 nerve runs in a more lateral direction than L3 and is therefore well lateral to the needle path. It is now the L5 nerve itself that may be contacted since the direction of exit is quite horizontal. Under normal circumstances, the needle passes cranial to this nerve but occasionally the iliac crest necessitates a very marked rotation of the fluoroscope. The needle then follows a more caudally directed course and contact with the nerve is then possible. At the level of L4/5 disc, the sympathetic chain was in a more superficial position. The end point for an L5 sympathetic block is at the inferior 2/3 of the vertebral body.

Weyland et al (14) and Rocco et al (6) measured the mean distance from the sympathetic chain to the horizontal tangent to the anterior border of the lumbar vertebra. They found their measurements to be similar except for the measurement at L3 (0.64 versus 0.3 cm). The range of measurements was wide except at the L3 vertebra. Rocco (6) found the most anterior part of the sympathetic chain was at the L3/4 disc by examining the photographs and at the L3 vertebra by measurements, whereas Weyland's measurement would tend to place the most anterior part of the sympathetic chain at L4. While we agree with the measurements, we believe interventional pain specialists will be bet-

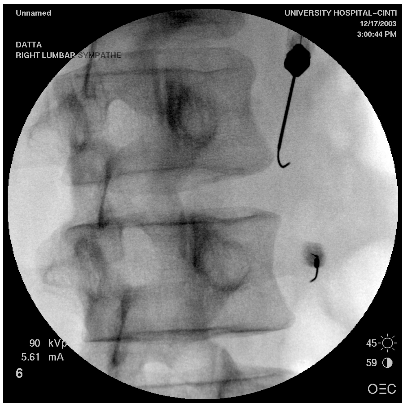

Fig 3. *Oblique view with needles placed at transverse process of L 2 and L 3 vertebra. Needles are positioned in paradiscal and extraforaminal position.*

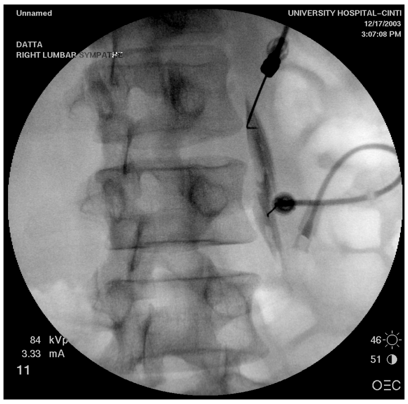

Fig 4. *Dye study. Note lateral spread of dye in relation to the vertebral body. Some spillage of the dye is present on the Psoas Major muscle. However, the psoas shadow is clearly more lateral to the dye.*

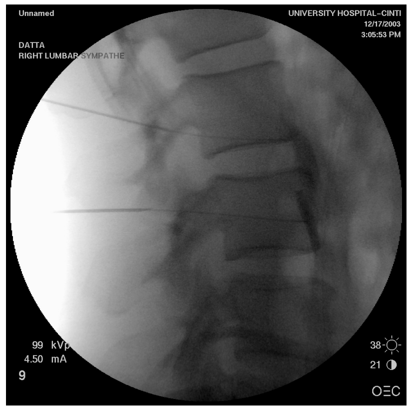

Fig 5. *Lateral dye study on the same patient utilizing paradiscal extraforaminal technique at L 2 and L3 vertebral body. The L 2 needle is in ideal paradiscal position. The L 3 needle is positioned in the lower third of the vertebral body avoiding the lumbar vessels. Loss of resistance technique has not been utilized to position the needles. Final needle position is approximately 0.5 cm from anterior vertebral edge. Note excellent dye spread outlining the sympathetic chain at both the levels.*

ter served by noting the relationship of the sympathetic chain to the psoas muscle and the vertebra. Rocco et al (6) noted in their study that in four patients the location of the sympathetic chain laterally from the center of the vertebra could not be determined secondary to osteophytes. There will be differences among males and females, and also in the relationship to the length and width of the vertebra.

Rocco (8, 15) advocated a loss of resistance to saline as a means of identifying the end point of the needle position. We started with this premise, and were surprised at the results obtained when the cadavers were dissected. In all cases, the needle was found piercing the psoas muscle and considerably in front of the vertebra. Also, the needles were invariably more lateral than the junction of the psoas major with the vertebra. The psoas muscle is not radio-opaque. Considering this, the needle may not be at the junction of the insertion of the psoas muscle to the vertebra, based on fluoroscopy. Rather, the needle may pierce the psoas muscle laterally when using the loss of resistance technique. Thus, using the loss of resistance technique appears to be unreliable.

Genitofemoral neuritis is the most common complication after a neurolytic sympathetic block, with an incidence of approximately 5-10% (16, 17). In the traditional paravertebral method of a lumbar sympathetic block, the needle must pierce the tendinous arch to reach the target point, the anterolateral aspect of the vertebral body. Thus, the injected solution may spread backward along the needle track into the psoas muscle through the needle hole of the tendinous arch and genitofemoral neuritis may occur. To avoid this complication, Ohno et al (18) advocated a transdiscal approach. They performed the blocks at the L2/3 and/or L3/4 level. They used a combination of loss of resistance to saline, as well as lateral fluoroscopy to confirm that the needle had pierced the anterior surface of the disc and the anterior longitudinal ligament. However, with this technique, potential of complications from puncture of the intervertebral discs is important to mention. Disc penetration may cause the same complications as those associated with lumbar discography; these include nerve root injury, discitis, accelerated disc degeneration and disc herniation. Rupture of the anterior annulus itself may cause axial pain. They concluded that the transdiscal procedure should be confined to patients in whom conventional paravertebral block was not successful (18).

Our results are in agreement with the work of Umeda et al (19) where they found that the points where the sympathetic chain and the lumbar arteries crossed were at the middle third of the vertebral body in both the second and third lumbar vertebra. Sluijter's (13) viewpoint that the target point should be 1 mm lateral to the middle of the concavity of the vertebral body was considered. This will place the needle right across the course of the lumbar arteries with likely injury to the lumbar vessels. We have found in our study that the ganglia almost always lie at the level of the discs (Fig. 1) or just paradiscal (Fig. 2) in position. To avoid the potential pitfalls of the extraforaminal technique, we advocate a paradiscal extraforaminal approach. The tip of the needle should be at the lower third of the second vertebral body or the upper third of the third vertebral body, in a paradiscal position. The needle should not be across the middle of the foramen (paraforaminal) to reduce the chance of injury to the anterior ramus, but rather extraforaminal. This means that the target point should be the lateral tip of the transverse process on the oblique view, rather than the 6 o'clock position of the pedicle (Fig. 3 & 4).

In conclusion, we believe that the extraforaminal technique is superior to the paramedian (Mandl's) approach to the lumbar sympathetic block considering that there should be a reduced chance of passing through viscera. We also believe that there will be less incidence of genitofemoral neuralgia with the extraforaminal technique. However, the chances of injuring the nerve or anterior ramus should always be borne in mind when utilizing this technique. Thus, the extraforaminal technique should be modified to avoid the above-mentioned complications.

We advocate the extraforaminal paradiscal technique for lumbar sympathetic block. Our target point for entry is the lateralmost tip of the transverse process. Advancement of the needle should be extraforaminal with minimal chance of injury to the nerve or the anterior ramus. Final target point should be paradiscal. The needle should be positioned just posterior to the anterior border of the vertebral body (Fig. 5). Loss of resistance technique should not be utilized and is potentially dangerous (4). Use of at least two needles is advisable (L2 and L3 vertebral body) considering the wide variation in the position of the ganglia. Care should be taken to avoid the lumbar arteries. The transdiscal technique may also prevent some of the complications of the paramedian approach (18). However, chances of discitis have to be borne in mind when using this technique.

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