Anatomical Structures and Ultrasound Guided Retrolaminar Block

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Abstract:
Paravertebral blocks have gained in popularity and offer the possible benefit of reduced adverse effects when compared with epidural analgesia. Nevertheless, pulmonary complications in the form of inadvertent pleural puncture are still a recognized risk. Also, the traditional paravertebral blocks are often technically difficult even with ultrasound guidance and constitute deep non-compressible area injections. Retrolaminar block (RB) is known to confer chest wall analgesia but, its mechanism has not been established.
Keywords: Retrolaminar block, US, RB.

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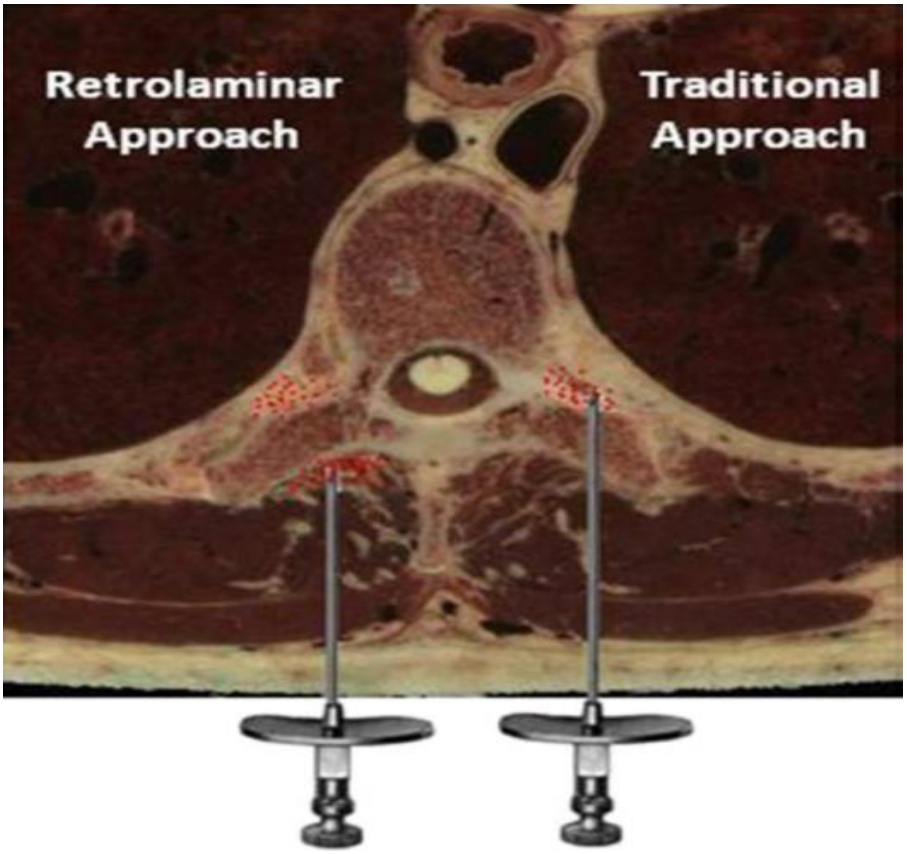
Pfeiffer recently reported a simplified "blind" paravertebral lamina technique, and Juttner et al. conducted a study on mastectomy patients after that. This strategy would presumably have the benefit of a decreased risk of pleural damage, but there is still a chance of an accidental epidural injection. By combining this method with ultrasound guidance, it is possible to quickly identify the lamina and reduce the risk of epidural injection that comes with the blind method. *(1, 2).*

The paravertebral space in the thoracic cavity has a triangle form. The superior costotransverse ligament, the transverse process, and the ribs define it posteriorly; the parietal pleura defines it anteriorly. The vertebral body, intervertebral discs, and intervertebral foramina define it medially *(3).*

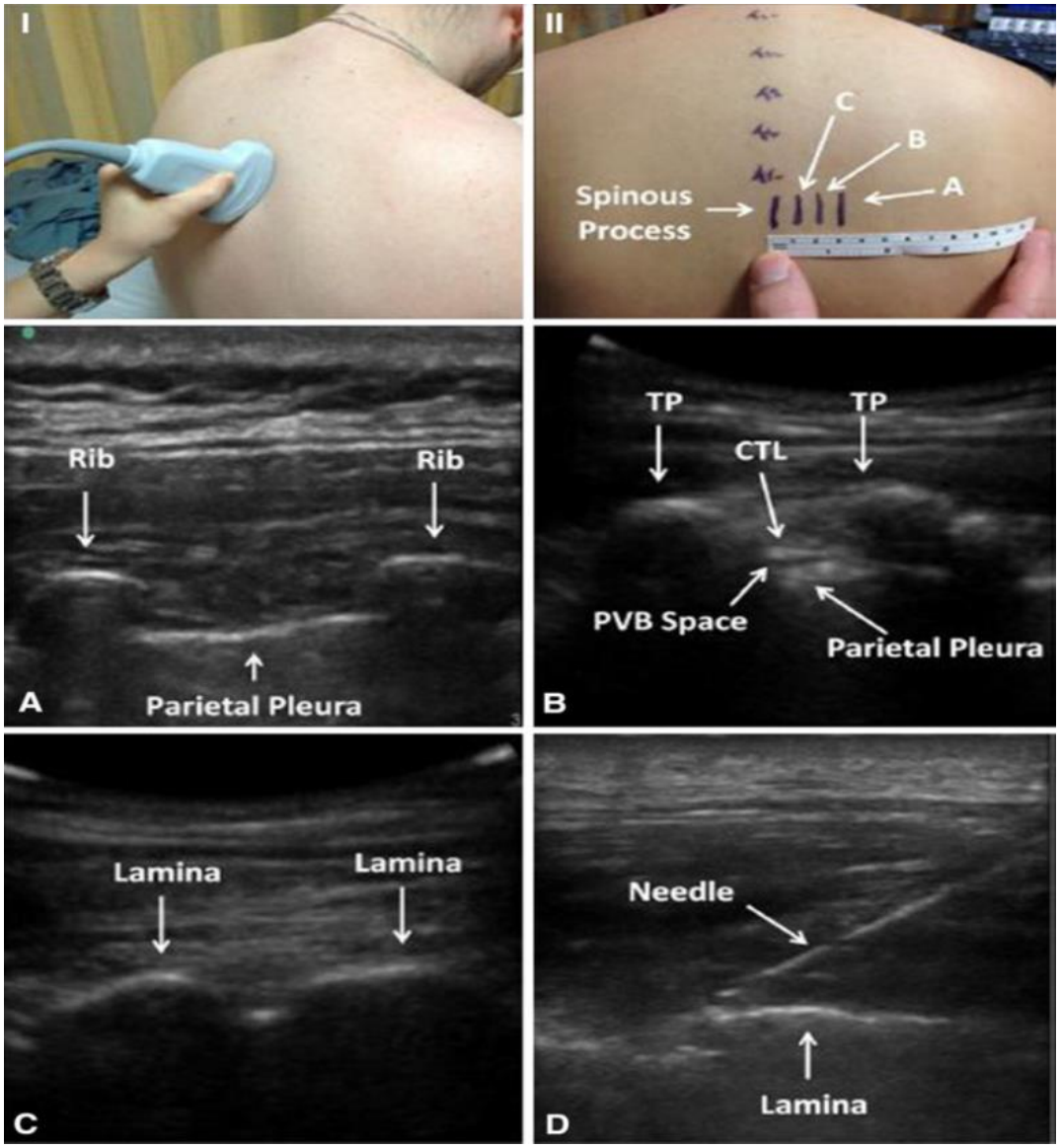
When a local anaesthetic is injected in this area, it usually causes varied unilateral sympathetic nerve blockade in addition to unilateral blockage of many spinal nerves. Local anaesthetic spread and analgesia might vary, and success rates are usually reported to be less than 90%. *(4).*

The conventional "blind" method of accessing the paravertebral area is using the block needle tip to tactilely identify a transverse process, followed by "walking the needle off" in either the cephalad or caudad direction, approximately 1 cm further, or until a "pop." The goal of the paravertebral lamina technique is to locate the needle's end point in contact with the vertebral lamina. *(2) (Fig. 1).*



(Fig. 1): Schematic of retrolaminar block vs traditional paravertebral techniques. The left side of the figure illustrates the retrolaminar block needle placement and presumed distribution of local anesthetic in the paravertebral space. The right side of the figure illustrates a traditional paravertebral block needle placement and distribution of local anesthetics. (Image modified with permission from Visible Human Web Server (http://visiblehuman.epfl.ch) courtesy of Prof. R.D. Hersch, Ecole Polytechnique Fe´de´rale de Lausanne (EPFL), Lausanne, Switzerland.)

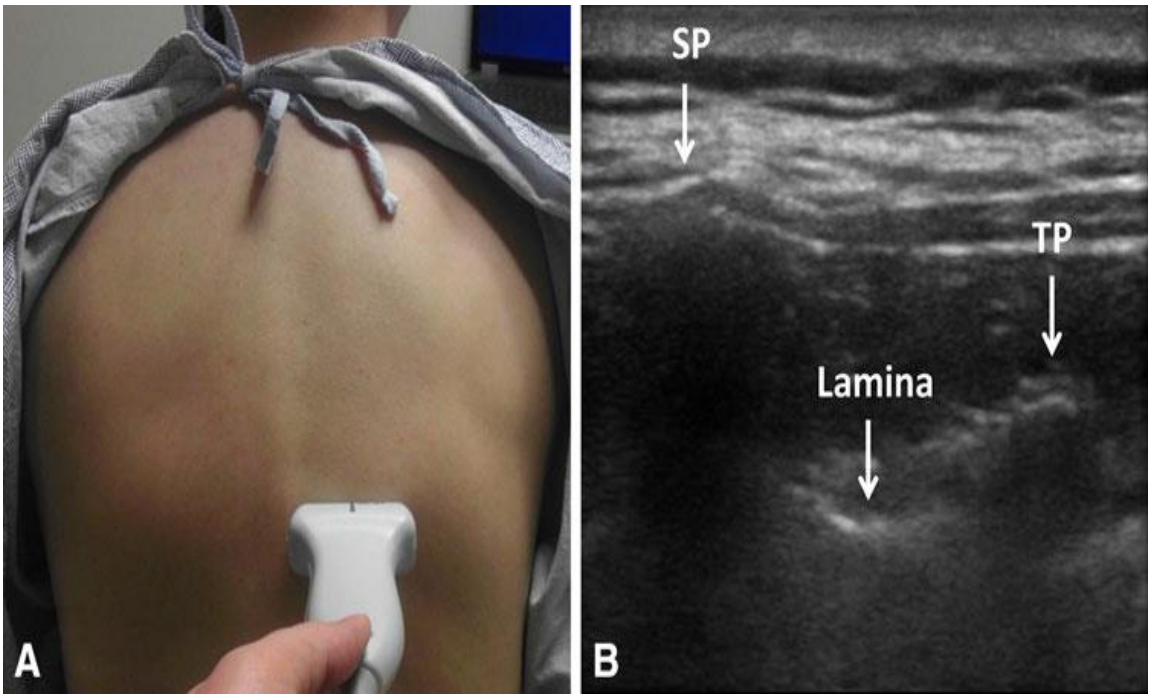
They postulated that when the needle point is in this lamina position, local anaesthetic can readily enter the paravertebral region through the porous costotransverse ligament. Given the likelihood of the costotranverse ligament not being a porous structure, they explain below their theory of how a local anaesthetic solution could enter the paravertebral region. ***(1, 2).***
A variation on the lamina method is the ultrasound-guided retrolaminar block. Sagittal paramedian is the recommended orientation for the ultrasound transducer. (cephalad- caudad direction), as shown in ***(Fig. 2).***



(Fig. 2): Ultrasonographic and skin surface anatomy landmarks for the vertical probe orientation (recommended) in-plane retrolaminar block. Picture I shows how the probe is held for orientation. Counting from the spinous process of thoracic level 1 to level 5, Picture II shows A) the surface marking of the beginning of the ribs, B) the transverse processes, and C) the lamina from the surface anatomic view. Picture A correlates with marking A on Picture II and shows the ultrasonography view of the ribs. Picture B shows the ultrasonographic view of the transverse processes. Picture C shows the ultrasonographic view of the lamina. Picture D shows the entry of a needle, under ultrasound guidance, coming into contact with the lamina. TP = transverse process; CTL = costotransverse ligament ***(5).***

Body habitus, anatomy, and equipment availability all play a role in the ultrasound probe selection process. Low-frequency curvilinear transducers are advised when sonographic landmarks and target structures can be seen at a depth of greater than 5 cm, while high-frequency ([9 MHz]) linear probes are advised when the target structures are not visible at a depth of less than 5 cm. Although the authors acknowledge that it may be more difficult to predictably prevent

unintentional epidural injection, a transverse plane orientation of the probe (lateral to medial) should also be taken into consideration. ***(Fig. 3).***



(Fig. 3): Ultrasonographic and skin surface anatomy landmarks for a possible horizontal probe orientation in-plane retrolaminar block. Picture A shows the probe orientation for a horizontal approach to the retrolaminar block. Picture B shows the spinous process, lamina, and transverse process under ultrasound imaging. SP = spinous process; TP = transverse process *(5).*

It is advised to visualise the approaching needle tip in-plane. The ribs, which correspond to the dermatomal levels of interest, are located 5–6 cm lateral to the spinous processes, where ultrasound scanning is initiated in the paramedian sagittal plane. This image usually shows a circular shape of the ribs, with a noticeable pleural line between them that is usually less than 1 cm deeper. *(5).*

When pneumothorax, pleural effusion, or other disease are absent, normal sonographic pleural pictures are seen. The transverse processes are then found by moving the scanning probe from lateral to medial. When the transverse processes are visible from the ribs, there is frequently a "step down" change in scanning from lateral to medial. The transverse processes' contour is typically more rectangular than the ribs. Furthermore, compared to the rib view, the pleural line visible between the transverse processes is deeper and frequently less defined. *(5).*

Furthermore, the costotransverse ligament is visible above the paravertebral gap in the transverse process view. As you proceed from the lateral to the medial side, the spinal laminae become visible. The laminar interfaces and facet joint areas can be seen as continuous flat hyperechoic structures with tiny "notches" that are regularly spaced apart. Starting from plane, caudad, or cephalad, the needle is inserted under real-time ultrasound guidance until it makes contact with the lamina. After that, the local anaesthetic is given intermittently while the needle is retracted by 1 mm each time an attempt at injection is met with resistance. When continuous

analgesia is required, the injectate is spread out and optimized along the plane formed between the lamina and the deep paraspinous muscles. Catheter insertion then follows. *(5)*.

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