

CHAPTER 10: ULTRASOUND NEURAXIS & POST ABDOMINAL WALL

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ULTRASOUND OF THE NEURAXIS AND POSTERIOR ABDOMINAL WALL

I have discussed some of the ultrasonography of the lumbar region in the description of lumbar plexus block. In this chapter I will review in some detail the ultrasonography of the neuraxis with some discussion of the associated muscles and fascias of the posterior abdominal wall. The posterior abdominal wall has the following important components:

1. The thoracolumbar fascia with its posterior and anterior layers
2. The erector spinae muscles on both sides of the lumbar spine
3. The quadratus lumborum muscle
4. The psoas muscle
5. The lumbar vertebrae

These layers are schematically represented in figure 10-1.

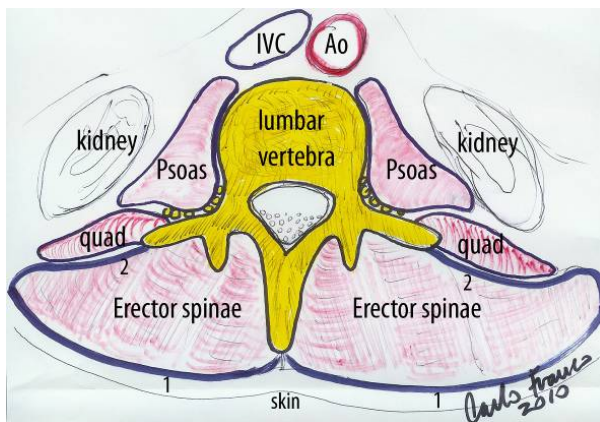


Fig 10-1. The posterior abdominal wall and lumbar spine. This diagram shows the erector spinae muscles on both sides of the lumbar spine surrounded by the thoracolumbar fascia with its posterior (1) and anterior (2) layers. The quadratus lumborum muscle (quad) inserts on the transverse process bilaterally with psoas muscle in front of it. Also shown are Aorta (Ao) inferior vena cava (IVC) and kidneys. Original drawing by Dr Franco. Image is copyrighted.

The spinal canal and its contents (i.e., spinal cord, cauda equina, meninges and ligaments) are protected by the close superposition of different vertebrae which by its dense nature are not

penetrated by the ultrasound waves. In order to visualize and identify the different structures the operator needs to use to his/her advantage the different acoustic shadows and acoustic windows present at this level. Figure 10-2 shows the different bone elements of the lumbar spine and the acoustic windows in between.

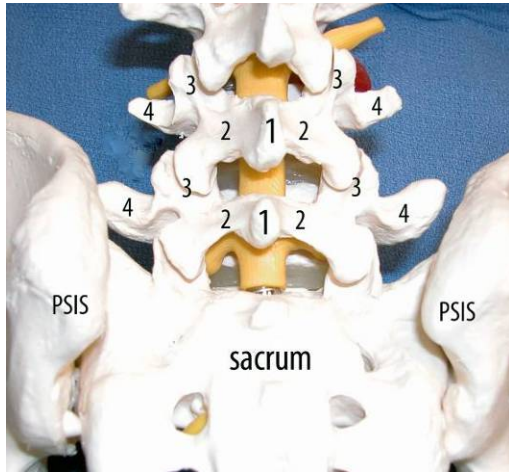


Fig 10-2. The lumbar spine. The bone elements of the lumbar spine are represented mainly by the spinous process (1), the laminas (2), the facet joints (3) and the transverse processes (4). At the lumbar level the space between the superior and inferior laminae is big enough to allow an “acoustic window” through which the canal and its content (in yellow) can be visualized.

ULTRASOUND VIEWS OF THE NEURAXIS TRANSVERSE SCANS

1. **SPINOUS PROCESS AND LAMINAS:** with the probe across the lumbar spine and centered over a spinous process, as shown in figure 10-3, we can visualize the spinous process, its corresponding laminae and associated muscles, as shown in figure 10-4.



Fig 10-3. Transverse view, over spinous process. The probe is placed transversally over the lumbar spine and centered over a spinous process. On a model with permission.



Fig 10-4. Transverse view, centered over a spinous process. The spinous process (1) and the bilateral laminae (2) cast posterior shadows giving together the appearance of a “caped figure”. Also observed are the erector spinae muscles (ESM) contained within the thoracolumbar fascia. Author’s collection.

- 2. SPINAL CANAL AND FACET JOINTS:** Maintaining the probe transversally across the lumbar spine, as shown in figure 10-3, it is displaced slightly cephalad or caudal until it clears the spinous process and comes to rest on an interspinous space. The acoustic window in between two spinous processes makes possible the visualization of the spinal canal and the facet joints, as shown in figure 10-5.

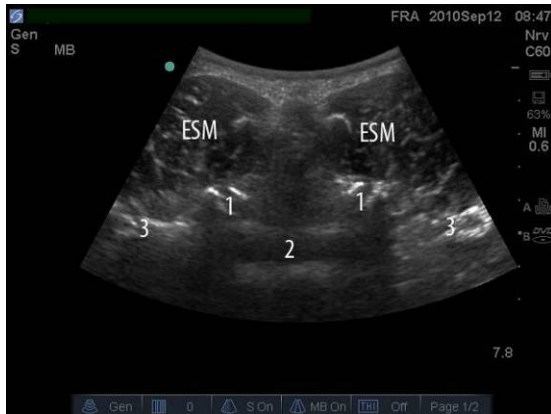


Fig 10-5. Transverse view, between two spinous processes. Using the space between two spinous processes as an acoustic window the bilateral facet joints (1) become visible along with the spinal canal (2) and the transverse processes (3). The hyperechoic line anterior to the canal represents the lig flavum-dura complex while the posterior line represents the posterior longitudinal ligament-dura complex. Author's collection.

- 3. TRANSVERSE PROCESS:** With the probe still located transversally across the lumbar spine, it is displaced laterally to one side to visualize the transverse process, and by extension the quadratus lumborum and part of the retroperitoneum, as shown in figure 10-6.

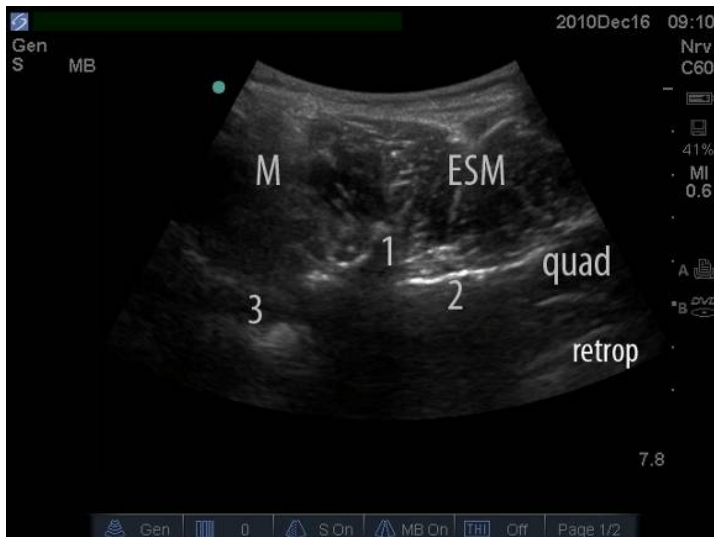


Fig 10-6. Transverse lateral view at the transverse process. Displacing the probe laterally toward one side of the midline (M) allows visualization of the facet joint (1) of that side, the transverse process (2) and still part of the spinal canal (3). Also visualized are the erector spinae muscles (ESM), the quadratus lumborum (quad) and part of the retroperitoneum (retrop). Author's collection.

- 4. THE ACOUSTIC WINDOW BETWEEN TWO TRANSVERSE PROCESSES:** If the probe is moved off the transversus process an acoustic window between two transverse process lets visualize the psoas muscle, as shown in figure 10-7.



Fig 10-7. Transverse lateral view off the transverse process. Displacing the probe off the transversus process and its shadow it is possible to locate the psoas muscle. Also shown are the midline (M), lamina (1), erector spinae muscle (ESM) and part of quadratus muscle (quad). Author's collection.

LONGITUDINAL SAGITTAL AND PARASAGITTAL SCANS

1. **SPINOUS PROCESSES:** To visualize the spinous processes in longitudinal view the probe is placed vertically over the midline, as shown in figure 10-8.



Fig 10-8. Spinous processes, longitudinal view. The probe is placed vertically along the midline over the spinous processes. On a model with permission.

With the probe placed vertically along the midline (sagittal) it is possible to visualize the spinous processes as small hyperechoic lines casting long posterior acoustic shadows, as shown in figure 10-9.



Fig 10-9. Spinous processes, sagittal view. The spinous processes (SP) are seen as superficial (close to the skin) faint hyperechoic lines with long acoustic shadows. Author's collection.

2. **LAMINAS:** Maintaining the probe vertically, it is displaced laterally to a parasagittal position, as shown in figure 10-10.



Fig 10-10. Probe in parasagittal position. The probe is placed closed and parallel to the midline. On a model with permission.

With the probe in this parasagittal position it is possible to visualize the laminae, which appear as hyperechoic interrupted lines, as shown in figure 10-11. This image of the laminae has been compared to “heads of horses”. For orientation it is important to remember that the more posterior (superficial) part of the laminae responsible for the “heads of horses” image are facing toward the sacrum, and as a mnemonic I like to think of them as horses heading “south” (sacrum).

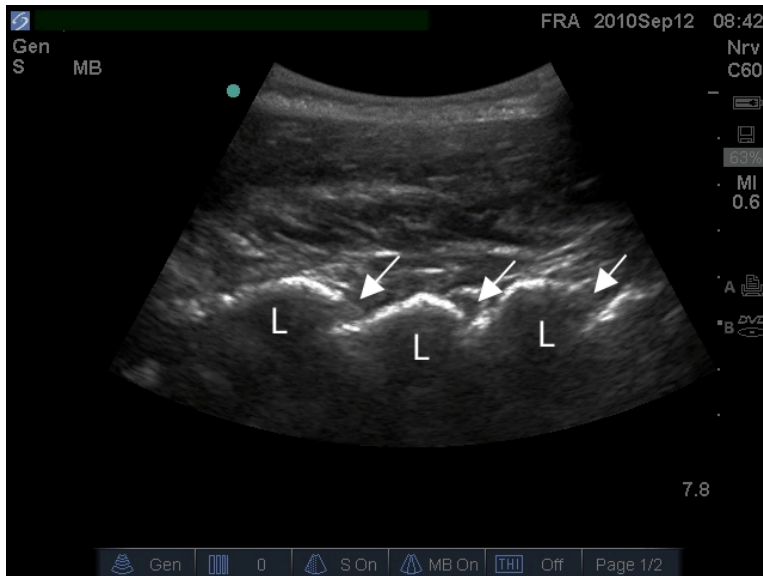


Fig 10-11. Laminae, parasagittal view. The laminae (L) appear as horses' heads facing towards the sacrum (distally). The interlaminae spaces are shown with arrows. Author's collection.

- 3. FACET JOINTS:** displacing the probe still more laterally in the parasagittal plane provides a visualization of the facet joints, which appear as small rounded hyperechoic structures. This uninterrupted curve line has been compared to a "camel's back". Figure 10-12 shows the facet joints in longitudinal view.

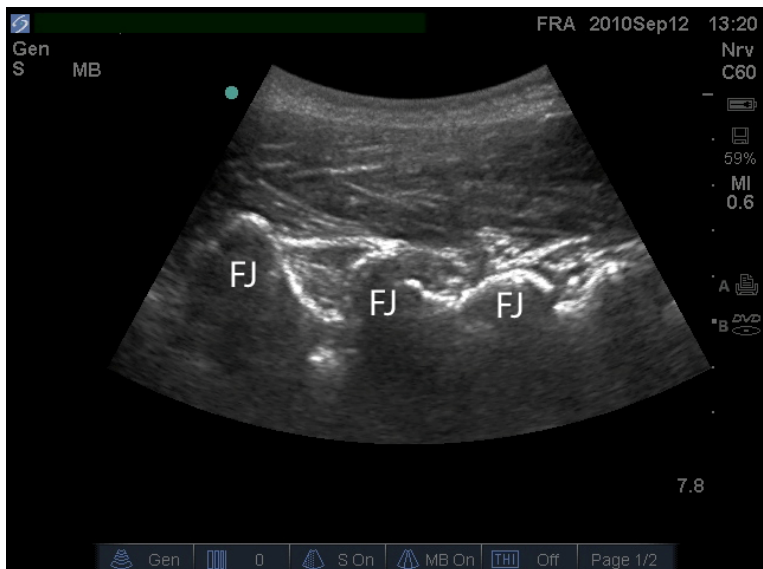


Fig 10-12. Facet joints, parasagittal view. The facet joints (FJ) are shown as a continuous rounded hyperechoic structures "camel's back". Author's collection.

- 4. TRANSVERSE PROCESSES:** With the probe still in parasagittal orientation it is slightly displaced more laterally until the transverse processes become apparent, as shown in figure 10-13.

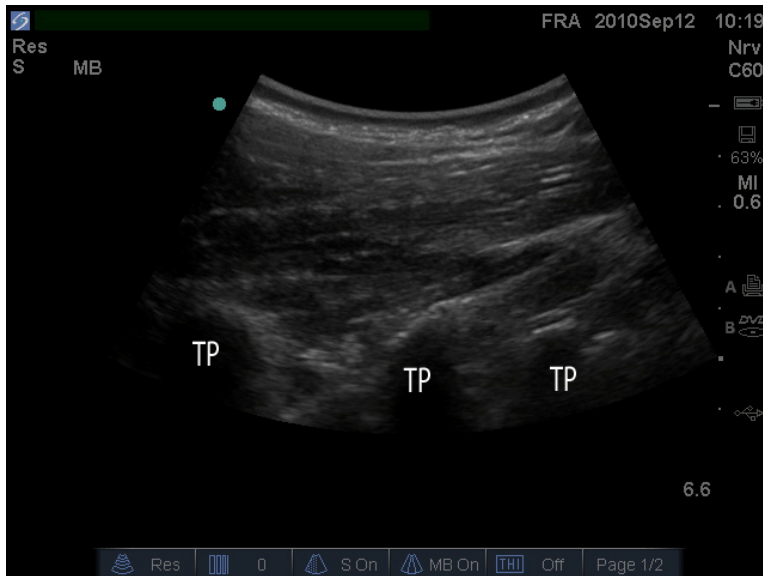


Fig 10-13. Transverse processes, parasagittal view. The transverse processes (TP) in parasagittal view are seen as small hyperechoic lines with acoustic shadows. Author's collection.

- 5. SPINAL CANAL AND DURAL SAC:** With the probe placed in the parasagittal orientation, close to the midline as shown in previous figure 10-10, a slight tilt of the probe toward the midline allows to visualize the spinal canal and dural sac through the acoustic windows provided by the interlaminar spaces, as shown in figure 10-14.

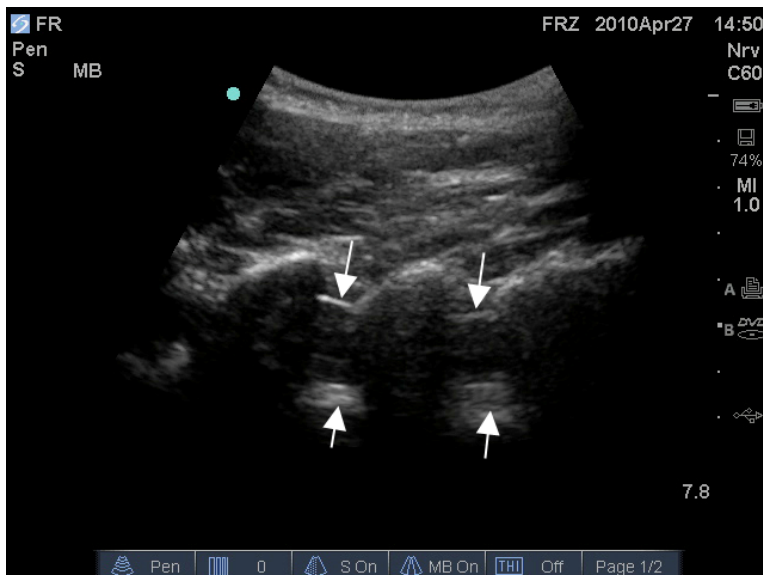


Fig 10-14. Spinal canal and dural sac. Parasagittal view with midline tilt of the probe. The dura is shown by the two downward facing arrows, while the arrows facing up show dura-posterior longitudinal ligament complex. In between the two set of arrows the spinal canal is shown as a horizontal hypoechoic cylinder interrupted by the anechoic acoustic shadows produced by the laminae. Author's collection.

- 6. SACRUM:** with the probe in longitudinal vertical position the sacrum can be scanned in two ways, parasagittal or sagittal. The parasagittal position demonstrates sacrum and laminae, as shown figure 10-15.

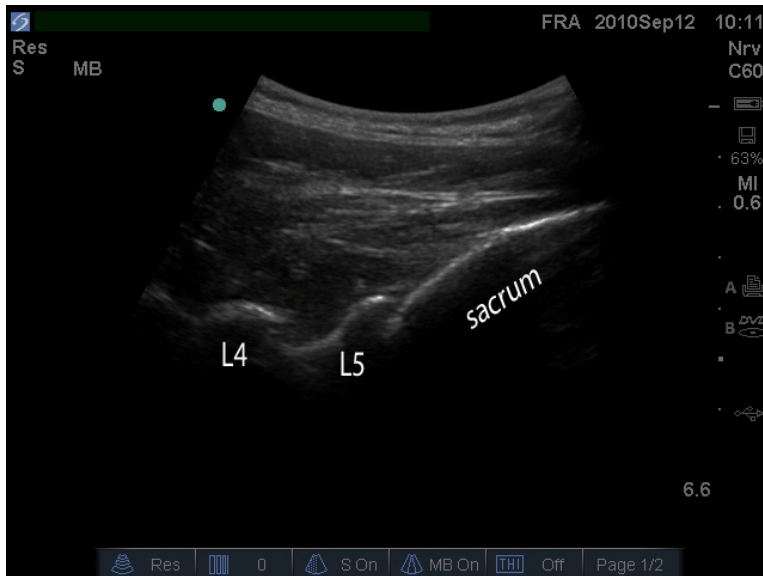


Fig 10-15. Sacrum, parasagittal view. The sacrum is observed as a continuous hyperechoic line at the parasagittal level where the laminae of L5 and L4 are also visible. Author's collection.

The sagittal view at the level of the sacrum provides an image of the spinous processes and interspinous spaces, as shown in figure 10-16.

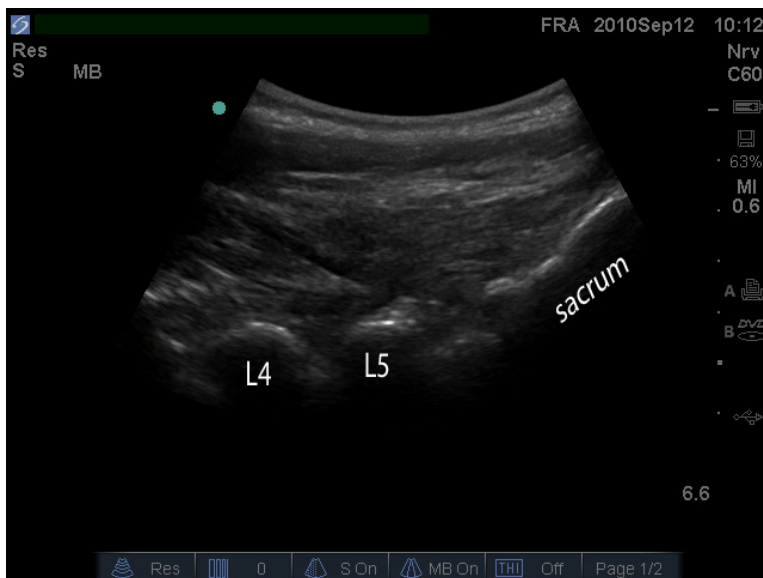


Fig 10-16. Sacrum, sagittal midline view. The sacrum is observed as a continuous hyperechoic line along with the spinous processes of L5 and L4. Author's collection.

Acknowledgement

I would like to thank Dr. Manoj Karmakar, Associate Professor of Anesthesiology and Director of Pediatric Anesthesiology at the Chinese University of Hong Kong for his

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