PEDIATRIC SPINE

I. **Patient Preparation:** None

II. **Equipment:**

A. Performed with a real-time scanner using a linear array transducer with a frequency of 5.0 MHz or higher. Frequencies of 10-12 MHz are used for younger patients. An acoustic stand-off pad used to evaluate the subcutaneous tissues.

B. Longitudinal panoramic imaging

C. Cine clip longitudinal and transverse to demonstrate distal cord and root motion with cardiac related pulsations of spinal CSF.

D. M-mode can also be very helpful in documenting motion of the cord and nerve roots

III. **Procedure Protocol:**

A. Patient Positioning:

1. Place the patient in a left lateral decubitus or prone position.
2. The anterior abdomen rests over a pillow or towel when using the prone position during scanning.
3. Flex the thoracolumbar spine when possible. The knees may be flexed to the abdomen to allow adequate spacing of the spinous processes and visualization of the spinal canal contents.
4. An infant who has recently been fed will generally lie quietly during the examination. If feeding is not possible, a pacifier dipped in glucose solution will often be helpful in keeping an infant still for an optimal examination.
5. It is important to note that infants, particularly if not full term, have difficulty maintaining normal body temperature. Therefore, the examination should be

performed in a warm room**,** and the coupling agent should be warmed.

B. Normal pediatric cord anatomy:

"Imaging is limited as age and ossification of the spine advances."

1. Shape
    a. cervical cord – oval
    b. thoracic cord - smaller circular diameter
    c. lumbar cord - larger circular diameter
2. Echogenicity
    a. CSF appears anechoic within an echogenic ring that represents the spinal cord.
    b. The central echo complex appears as 1-2 echogenic lines in the longitudinal plane or 1-2 echogenic dots in the transverse plane within the anechoic CSF.
    c. The tip of the cord, the conus medullaris, tapers at its distal aspect.
    d. The roots of the cauda equina, appear as echogenic strands or single or double lines in the longitudinal plane and echogenic dots in the transverse plane. The cauda equina move rhythmically with respiration and synchronically with the heart beat.
3. Sonographic Landmarks
    a. The lowest rib traced medially to the vertebral body corresponds to T-12 +/- one. (patients may have 11 or 13 ribs)
    b. The caudal tip of the thecal sac often corresponds to S2.
    c. The top of the iliac crest corresponds to L5.
    d. After assessment of the normal lumbosacral curvature to locate the last lumbar vertebra or L5, the vertebral level of the conus is determined by counting the cephalad. This method tends to be more reproducible than the other methods described below, which rely on counting the number of rib-bearing vertebrae or the number of ossified sacral and coccygeal segments and can lead to less reliable results.
    e. The first coccygeal segment has variable ossification at birth but, if ossified, can be distinguished by its more rounded shape compared with the square or rectangular shape of the sacral bodies. Counting cephalad from S1 again can help determine the vertebral level of the conus.
    f. In normal patients, the conus should lie at or above the L2 to L3 disc space. In fetuses and extremely preterm infants the normal conus medullaris may be caudal to the superior endplate of L3. In a preterm infant with a conus that terminates at the L3 midvertebral body, a follow up sonogram after age correction of 40 weeks gestation but before age correction of 6 months is warranted. The level of termination of the conus and its configuration should be documented, as well as any deviations from normal

C. Sonographic Imaging:

"locate level of T12 by using sonographic landmarks outlined in "B"

1. Longitudinal
    a. scan midline between spinous processes or using parasagittal approach with transducer slightly lateral to spinous processes
    b. long axis views from the level of T12 to the coccyx to include distal aspect of the conus medullaris and thecal sac
    c. long axis view of the "sacral dimple" with stand-off pad to assess the subcutaneous soft tissue region
    d. The normal cord morphology and the level of termination of the conus should be assessed and documented. In order to do this, the vertebral body levels need to be accurately identified and numbered.
2. Transverse
    a. axial views from the level of T12 to coccyx, document level of conus medullaris and thecal sac
    b. axial view of the "sacral dimple" with stand-off pad if necessary to assess the subcutaneous soft tissue region "Any question of a low terminating conus medullaris, a KUB with a radiopaque marker at the level of the tip of the conus should be taken.
    c. Right and left labeled on transverse images
3. The integrity of the cord should be documented. Areas of abnormal fluid accumulation, such as hydromyelia or syringomyelia, anterior, lateral or posterior meningoceles or pseudomeningoceles, or arachnoid cysts, should be documented and their level identified. Transverse images are essential to identify and document diastematomyelia, with off-center scanning to avoid the potential pitfall of a reverberation artifact creating a lateral duplication, or ghost image
4. The subarachnoid space should be evaluated for a normal anechoic appearance, interrupted by normal hyperechoic linear nerve roots and dentate ligaments. The subarachnoid space, dura, and epidural space should be evaluated, and abnormalities such as hematoma, lipoma, or other masses should be documented.
5. In addition to the termination of the conus, the termination of the thecal sac, typically located at S2, should be documented. The normal filum measures less than 2 mm in thickness. If the filum is abnormally hyperechoic or appears thickened, it should be measured and documented. The nerve roots of the cauda equina should be delineated within the thecal sac.
6. Upright positioning can be used to demonstrate meningoceles or pseudomeningoceles in some patients. Anterior meningoceles or presacral masses should also be scanned from an anterior position.
7. The vertebral bodies and posterior elements should be evaluated for

deformities. Dysraphic defects with open posterior elements should be documented on transverse views.

P E D I A T R I C S P I N E
IMAGE SUMMARY

Image:	Label:
(longitudinal views may vary depending on age)	
1. long axis T12 - L2	1. level of conus
2. long axis L2 - L4	
3. long axis L4 - S I	
4. long axis S I - S3	4. Level of thecal sac tip
5. long axis S3 - S5	
6. long axis region of coccyx	
7. long axis sacral dimple with stand-off pad	
8. trans sacral dimple with stand-off pad	
9. trans T12	
10. trans L I - L5	10. Level of conus
11. trans S I - S5	11. Level of thecal sac tip
12. trans region of coccyx	

** any identifiable abnormality measured in three dimensions with and without calipers
** Cine Clip long and transverse to show root movement with respirations
** Longitudinal panoramic Image with documentation of levels, if possible.