BMUS

Guidelines for Ultrasound Examination of the Neonatal Spinal Cord

Produced by the British Medical Ultrasound Society

Paediatric Clinical Interest Group

March 2026

Introduction and Clinical Background

Ultrasound is a reliable method of screening for spinal cord abnormalities up to 3-4 months of age, until closure of the acoustic window due to normal ossification of the posterior spinal elements. It is a useful screening technique and can characterise pathology, normal anatomy and normal variants. [1] [2,3,4]

A full neonatal ultrasound survey of the spine includes assessment of the lumbar and sacral vertebral bodies, conus medullaris and filum terminale termination point and dynamic assessment of the nerve roots of the cauda equina. Other associated ultrasound spinal findings include a thickened filum terminale, fibrolipoma, spinal dysraphism, syringomyelia, scoliosis, congenital spinal masses such as lipomas or dermoid cysts, and sinus tracts that contain fluid [2, 3,4,5]

A tethered cord, or low-lying conus medullaris, is caused by incomplete regressive differentiation and failed involution of the terminal cord. Symptoms occur due to traction on the abnormally anchored filum terminale and adjacent nerve roots. Treatment involves surgical release of the filum and preservation of nerve root function.[5]

A tethered cord is commonly associated with a range of anomalies known collectively by the acronym **VACTERL.** [,5, 6,7]

- Vertebral defects
- Anal atresia
- Cardiovascular anomalies
- Tracheoesophageal fistulas)
- Renal anomalies
- Limb defects (most often of the radius)

Clinical Indication for Spinal Ultrasound:

- **Congenital anomalies** placing an infant at increased risk of spinal abnormalities. This includes patients with a diagnosis of **VACTERL**, where vertebral anomalies occur in 60%–90% of cases. [7]
- The spectrum of caudal regression syndrome, including patients with sacral agenesis and patients with anal atresia or stenosis. [8]
- Congenital spinal dysraphism is broad term to describe the abnormal embryologic development of the vertebrae, spinal cord, and nerve roots that can be classified based on the presence or absence of a soft-tissue mass and skin covering. Open or large spinal dysraphism are easily recognized and ultrasound is not indicated in these cases. Ultrasound is indicated in closed or smaller anomalies may present as cutaneous abnormalities overlying the defect. Ultrasound assessment is indicated for atypical dimples which are at higher risk of occult spinal dysraphism, **simple typical dimples are not indicated for ultrasound assessment.** [2,3,4 8]

Summary: Indications for Ultrasound

Atypical dimples:

- ***Larger than 5 mm***
- ***Located greater than 2.5 cm above the anus,***
- ***Not in midline***
- ***Associated cutaneous markers including pigmentation, hairy patch., abnormal skin texture, lipoma, cyst, skin tag, soft tissue mass***

Typical Dimples:

- ***Guidance suggests that simple sacral dimples less than 5 mm in size and less than 2.5 cm from the anus no matter whether the base can be seen or not, with no other associated***

Contraindications for Ultrasound Assessment:

Magnetic Resonance Imaging (MRI) is indicated for infants requiring spinal surgery, and those with an open spinal dysraphism or obvious cerebrospinal fluid (CSF) drainage from a skin dimple or sinus tract, due to risk of infection and improved image quality [3,4 ,8]

Suggested Scan Timing / Urgency & Follow-Up

The ultrasound examination should be performed on infants as soon as possible, ideally up to 3-4 months of age. [1,3,4,8] Early diagnosis of tethered cord is important as normal function may be irreversibly lost if treatment is delayed, and early surgical treatment has shown a significant outcome benefit. [5,7] Retethering of the spinal cord is common with normal growth and may require further imaging and re-release surgery. [5, 8]

Scanning Protocol

Neonatal spine ultrasound should be performed with a high frequency (7-15MHz) linear array transducer using B-mode and colour Doppler imaging.

The infant is undressed and placed in the prone position, ideally over a small pillow, to create a relative kyphosis with the upper body slightly higher than the lower body. This opens the spinous processes and encourages lumbar cistern distension optimising the ultrasound image quality [1,3,8.]

Equipment optimisation is required, with depth adjustment and focal zone positioned over the area of interest. An extended field of view can be used for improved image quality. [1,2,3,4]

The use of gel to create a stand-off may improve image quality and resolution in assessment of superficial tracts. [8]

Images are obtained in the longitudinal and transverse positions. Normal nerve root motion can be demonstrated on cine or M mode. Colour or power Doppler can assist in characterising soft-tissue masses found on the skin or in the spinal canal. [3,4]

The clinical preset used for the scan should display the appropriate thermal index (TIS, TIB or TIC), depending on the anatomy within the scan plane and ultrasound beam focus. Further details on the appropriate thermal index can be found in the BMUS guidelines for safe scanning [9]. For all scans ALARA (as low as reasonably achievable) principles should be followed.

Scan Assessment

The spine should be examined in a systematic manner in sagittal and transverse planes, and the following should be assessed:

Vertebral Bodies: The coccyx is seen as a non-ossified mass of cartilage. The ossified sacral vertebral bodies, are seen superior to the coccyx **(Image 1).** The L5/S1 junction is identified at the inflection point between the obliquely oriented sacral vertebrae and the more horizontal lumbar vertebrae **(Image 2).** [1, 2]The vertebral bodies and posterior elements should be evaluated for deformities. Dysraphic defects with open posterior elements should be documented on transverse views. [1, 8]

Conus Medullaris: The tip of the conus medullaris is commonly located at L1 or L2 disc space (Image 4) but can extend to L2 to L3 disc space). A conus tip below L2 to L3 disc space in a term infant is abnormal and evidence of a tethered cord (Image 5)[1,2,3,5,8] The level of the conus medullaris is assessed by counting down from 12th rib-bearing vertebral body or counting up from the last ossified vertebral body

Filum Terminale: The conus medullaris is continuous with the fibrous filum terminale that extends from the conus to the caudal end of the spinal canal. This is a thin echogenic cordlike structure which should measure less than 2 mm thick at L5-S1 level (Image 6). The filum terminale crosses through the subarachnoid space to attach to the dorsal aspect of the first sacral segment S1. [1,3]

Cauda Equina and nerve roots: The conus medullaris is surrounded by echogenic nerve roots which arise from the cord along the length and are seen beyond the conus, this is the cauda equina ("horses tail") (Images 9 and 10). The nerve roots should oscillate and move freely, which can be demonstrated on cine and M mode imaging. [1,3,4,8]

Subarachnoid space posterior and anterior: The subarachnoid spaces should be anechoic and must not contain other structures except for the spinal cord and the nerve root. [1,3,8]

Standard Images:

Longitudinal images

- Image of the sacral and lumbar vertebral bodies and lumbosacral junction (standard 5 lumbar and 5 sacral segments and a barely ossified coccyx). **Images 1 &2**
- Conus medullaris and labelled image of level of termination point where it tapers, in relation to lumbar vertebrae (below mid-level of L2 abnormal). **Image 3**
- Filum terminale with measurement of thickness (2 mm or less). **Image 4**
- If present, image demonstrating site of sacral dimple for presence of dermal sinus tract.

Transverse images

- Conus medullaris surrounded by echogenic nerve roots**. Image 5**
- Image of the strands of hyperechoic dorsal and ventral cauda equina nerve roots; cine to demonstrate oscillatory movements with respiration in dynamic imaging. **Image 6**

Image 1: Midline sagittal spine demonstrating non ossified coccyx with ossified sacral bodies.

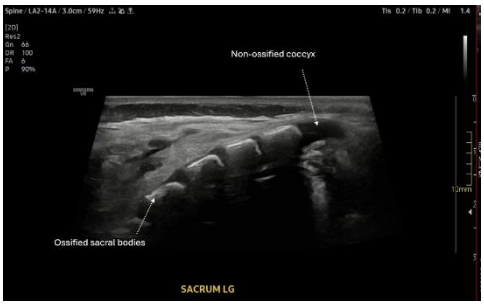


Image 2: The L5/S1 junction is identified at the inflection point between the obliquely oriented sacral vertebrae and the more horizontal lumbar vertebrae.

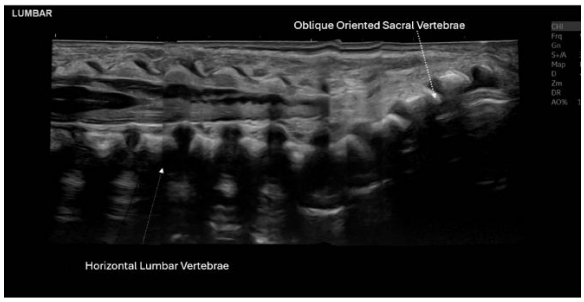


Image 3: Demonstrating normal position of conus medullaris.

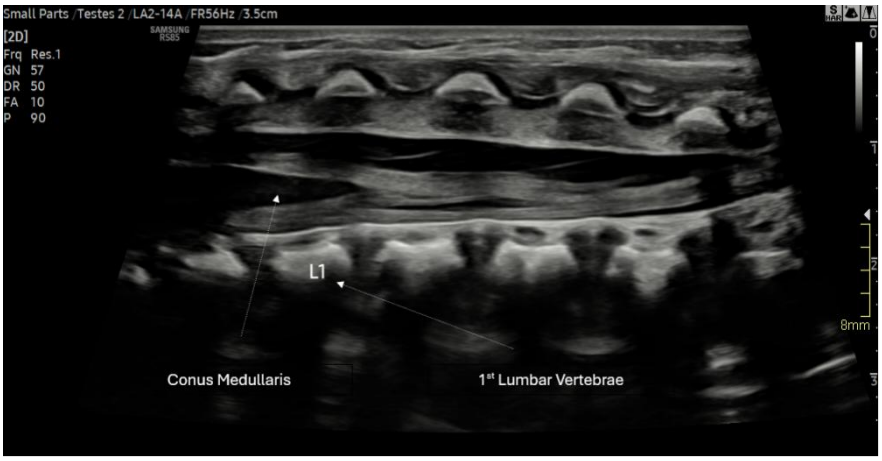


Image 4: Normal Filum Terminale.

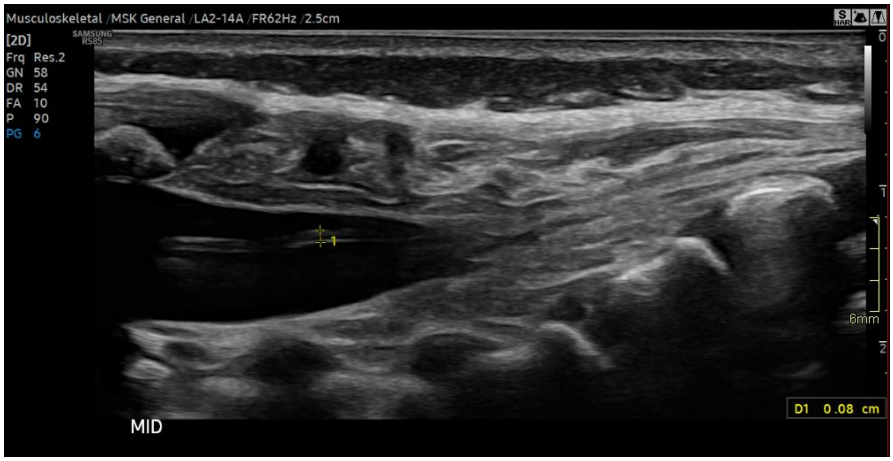


Image 5: Transverse image demonstrating normal posterior spine.

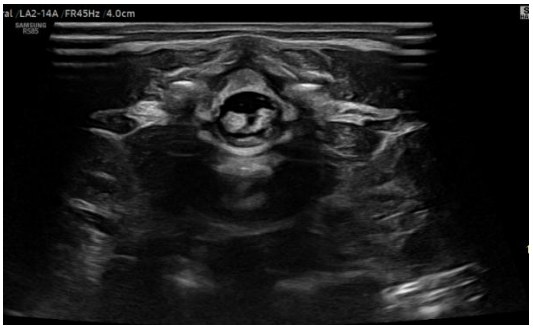
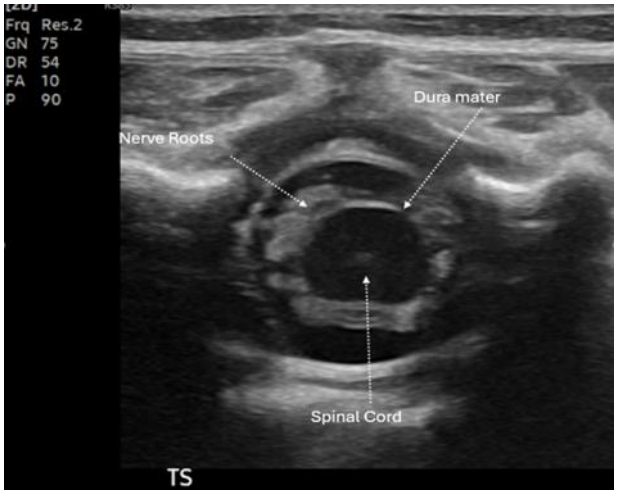


Image 6: Normal spinal cord with paired echogenic anterior and posterior nerve roots.



Indication of a Tethered Cord:

- The presence of a low-lying conus (below the L2-L3 disk space)
- Lack of normal nerve root motion during real time sonography. The normal nerve roots pulsate freely with cardiac and respiratory motion, layer dependently with variable patient positioning, and are not adherent to each other. This can be assessed and demonstrated on cine or M mode imaging.
- Normally the cord and nerve roots are positioned ventrally within the spinal canal, a dorsal position of the cord is commonly seen in tethered cord.

The conus can be normally positioned but still tethered, this is tight filum terminale syndrome and assessment of nerve root to demonstrate normal motion is key.[1,3,4,8]

Take Home Message

- A lumbar spine ultrasound examination should be performed as early as possible. Examinations performed > 4 months of age are unlikely to be useful due to ossification of the vertebral bodies.
- All patients with "typical dimples", specifically: those that are <5mm, and where the base of the dimple is visualised, and is situated </= 2.5cm from the anus, and is in the midline, and have normal neurology, would not require an USS lumbar sacral spine.
- Ultrasound is contraindicated in infants with ***open spinal dysraphism or obvious cerebrospinal fluid (CSF) drainage from a skin dimple or sinus tract.***
- Ultrasound examination is indicated in all infants with “atypical dimples”, specifically: those that are large (>5mm), or high on the back (>2.5cm from the anus), or those with a base not visualised, or not in the midline, or appear with a combination of other lesions for example cutaneous markers.
- Ultrasound of the lumbar spine is indicated in all infants with typical or atypical dimples, who present with abnormal neurology.
- Ultrasound of the lumbar spine is indicated in all infants with congenital abnormalities associated with a tethered cord including VACTERL abnormalities.

References

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The British Medical Ultrasound Society produces recommendations and guidelines as an educational aid to inform safe practice. They offer models and pathways associated with established clinical imaging techniques and best professional practice, based on published evidence.

BMUS recommendations and guidelines are designed to inform local protocols issued by employers, but are not intended to be inflexible or prescriptive. Therefore, the choice of imaging examination and subsequent management of all patients is ultimately a local decision based on agreed schemes of work, the clinical information provided, and the ultrasound practitioner's professional judgement.