Ultrasound evaluation of occult spinal dysraphism

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Introduction

Occult spinal dysraphic lesions include midline fusion defects that are skin covered and have no exposed neural tissue or visible cystic mass. A palpable mass may or may not be present.[1]

High frequency ultrasound provides an ideal non-invasive technique for the evaluation of these lesions in children under 6 months of age. The aim of this article is to give practical advice on both the imaging technique used and the interpretation of abnormal findings.

Ultrasound technique

Ultrasound evaluation of the spinal cord and the surrounding contents of the spinal canal in children under 6 months makes use of the window provided by the unossified posterior elements of the vertebral column.[2] In our department we use the following technique:

1. The patient is placed prone with the hips and knees slightly flexed and a small cloth roll is placed under the pelvis to minimise the lumbar lordotic curve.[1]

2. A 7 MHz linear-array transducer is used to evaluate the lumbo-sacral region in both the longitudinal and transverse scan planes.The probe frequency is set at 7 MHz.

3. The distal spinal cord is identified in the thoracolumbar region and is followed caudally to its termination at the conus. The level of the conus is recorded in the following manner:

- By identifying the first sacral segment, it is then possible to count up from this reference point to the vertebral body/disc space adjacent to the conus. The first sacral segment is identified by the orientation of its spinous process which is the first to be angled dorsally.
- If it is not possible to identify this landmark, then a metal marker such as an unfolded paper clip can be placed under ultrasonic guidance on the skin overlying the site of the conus and then taped into position. Thereafter plain anteroposterior (AP) and lateral radiographs are taken with the marker *in situ*, and the level at which the conus terminates is assessed according to the vertebral level of the marker.

4. The morphology of the tapering of the conus is recorded. The position of the cord in the spinal canal and the presence or absense of spinal cord pulsation are noted.[2]

5. Visualisation of the internal structure of the spinal cord and the overlying dura, cerebrospinal fluid (CSF), cauda equina, filum terminale, bony elements, paraspinal muscles, subcutaneous tissues and skin is possible.[1]

Normal ultrasound anatomy

The normal structures identified are depicted in Figs 1a and 1b, and include the following: (*i*) a homogeneously hypoechoic spinal cord with a central hyperechoic line representing the depth of the paramedian sulcus;[2] (*ii*) the cord surrounded by the hyperechoic pia mater and the hypoechoic CSF; (*iii*) CSF is usually seen only dorsal to the cord as a normal untethered cord is dependent and lies in a ventral position against the posterior aspect of the vertebral bodies when the patient is prone; (*iv*) hyperechoic dura surrounding the CSF and the unossified bony elements dorsal to this are identifiable; (*v*) the paraspinal muscles are seen in a paramedian position covered by a continuous layer of subcutaneous fat and skin;[2] (*vi*) the conus is recognised as a smooth tapering structure that ends at the lower end of L3 in a normal infant;[2] (*vii*) the filum terminale is seen extending as a hyperechoic line from the tip of the conus in a caudal direction to the back of the first coccygeal segment and should never be more than 3 mm in diameter or have any structures within it;[2] and (*viii*) the fine echogenic strands extending from the caudal portion of the conus represent the cauda equina.[2]

Fig. 1. Structure of the normal cord on ultrasound
Fig.1a. Linear ultrasound demonstration of the lower lumbar cord demonstrates the hypoechoic cord substance (white X), the echogenic line of the paramedian sulcus (curved arrow), the echogenic line of the pia mater lining the cord surface (straight arrow), the dorsal hypoechoic CSF (white dot) and the echo shadows originating at the spinous processes (white arrow-head).

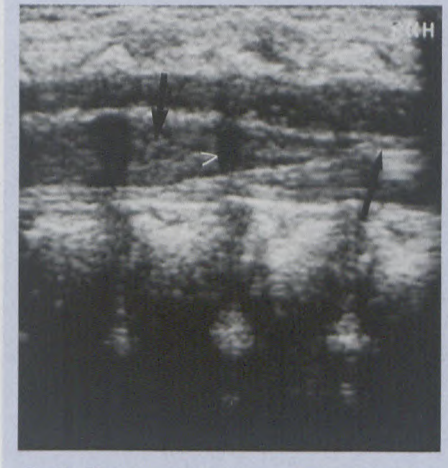

Fig.1b. The normal cord tapers to form the conus medullaris (thick arrow), and the nerve roots are seen as a mass of echogenic structures running caudally (thin arrow). The position of the conus is assessed as described by evaluating its verterbral level according to the echo shadowing of the spinous processes (white arrow-head).

Fig. 2. Tethered cord. *This scan shows that the cord does not taper to a normal conus and that it is low-lying. CSF is seen both dorsally and ventrally (thin arrow) indicating that the cord is suspended due to tethering and cannot lie in a dependent position. An associated distal cord syrinx (thick arrow) is a common association.*

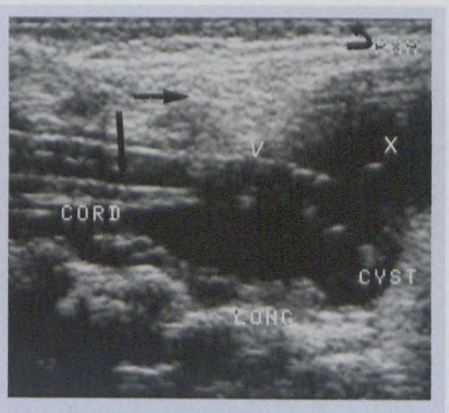

Fig. 3. Lipomyelomeningocoele. *The cystic portion of the lipomyelomeningocoele is seen as an echo-free area (white X) protruding from a dorsal bony defect and is covered by skin (curved arrow). There is an associated dorsal lipoma (thick straight arrow) and there are also cord elements protruding through the bony defect (white arrow-head). An associated distal cord syrinx is also present (thin straight arrow).*

Interpretation of abnormal ultrasound findings

Tethered cord (Fig. 2)

Diagnose a tethered cord if the following findings are present: (*i*) a low-lying conus, i.e. a conus that terminates below the lower end of L3 or a non-tapering cord extending to the sacrum;[3] (*ii*) a cord that is suspended in the spinal canal when the patient is lying prone, i.e. there is CSF both ventral and dorsal to the cord; (*iii*) absense of cord pulsation; (*iv*) a thickèned filum terminale (> 3 mm in diameter);[2] (*v*) a lipoma within the filum;[3] (*vi*) other dysraphic anomalies such as lipomyelomeningocoele, myelocystocoele, non-tapering of the cord; (*vii*) a distal cord syrinx;[3] and (*viii*) an intra-spinal lipoma, a dermoid or a sacral teratoma.[3]

Lipomyelomeningocoele (Fig. 3)

Diagnose a lipomyelomeningocoele if the following findings are present: (*i*) a subcutaneous lipoma that extends via a posterior bony defect and is attached to the cord,[1] (*ii*) a low-lying conus or non-tapering cord (tethered cord); and (*iii*) a CSF-containing sac extending from the spinal canal into the adjacent soft tissue (meningocoele). The presence and size of the meningocoele are variable.[1]

Myelocystocoele

Diagnose a myelocystocoele if the following findings are present: (*i*) a trumpet-shaped distal cord; and (*ii*) a syrinx that herniates through a dorsal bony defect into the subcutaneous tissue — the CSF-containing mass can be seen just under the skin.[1]

Diastomatomyelia

Diagnose diastomatomyelia if the following findings are present: (*i*) partial or complete split of the cord with an intervening fibrous or bony septum, and hemicords (often of unequal size);[1] (*ii*) features of cord tethering;[1] and (*iii*) multiple clefts within the cord along its length with a normal cord in between these clefts.[1]

Intraspinal lipoma

Diagnose an intraspinal lipoma if the following findings are present: (*i*) an echogenic intraspinal mass that may or may not extend through a bony defect into the subcutaneous tissue; (*ii*) the cord is attached to this either dorsally or at its terminal end; and (*iii*) no associated covered meningocoele is present.

Dorsal dermal sinus

Diagnose a dorsal dermal sinus if the following findings are present: (*i*) a tract that connects the skin to the intracanalicular space which may be median or paramedian; this may communicate with the subarachnoid space;[1] and (*ii*) an associated lipoma, epidermoid or dermoid with the sinus tract.[1]

Conclusion

High-resolution spinal ultrasound is a valuable means of diagnosing suspected occult spinal dysraphic lesions in neonates and infants before the posterior spinal elements ossify. Ultrasound has numerous advantages: it is portable and available with high-resolution capabilities, it is safe and requires no sedation, and it is relatively inexpensive. When findings are confusing, abnormal or equivocal, then MRI must be performed to delineate the pathology more accurately.

References

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