Ultrasound evaluation of occult spinal dysraphism

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 absence of spinal cord pulsation are noted.³

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; (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; (vi) the conus is recognised as a smooth tapering structure that ends at the lower end of L3 in a normal infant; (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; and (viii) the fine echogenic strands extending from the caudal portion of the conus represent the cauda equina.³
TIPS FOR THE RADIOLOGIST

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; (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) absence of cord pulsation; (iv) a thickened filum terminale (> 3 mm in diameter); (v) a lipoma within the filum; (vi) other dysraphic anomalies such as lipomyelomeningocele, myelocystocele, non-tapering of the cord; (vii) a distal cord syrinx; and (viii) an intra-spinal lipoma, a dermoid or a sacral teratoma.

Lipomyelomeningocele (Fig. 3)

Diagnose a lipomyelomeningocele if the following findings are present: (i) a subcutaneous lipoma that extends via a posterior bony defect and is attached to the cord. (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.

Myelocystocele

Diagnose a myelocystocele 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.

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); (ii) features of cord tethering; and (iii) multiple clefts within the cord along its length with a normal cord in between these clefts.

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.
Hypertrophic pyloric stenosis — an overview

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Definition
The term hypertrophic pyloric stenosis (HPS) refers to hypertrophy of the circular muscle of the pylorus that can cause obstruction (HPO).

Clinical findings
Clinical findings include the following: (i) non-bilious projectile vomiting; (ii) peristaltic waves that can be seen travelling across the left upper quadrant to the right and terminating beyond the midline; (iii) a palpable ‘olive’ (pseudotumour) over an empty stomach; (iv) age typically 2 - 8 weeks; (v) male-to-female ratio 5:1; (vi) uncommon in black patients; (vii) often the male offspring of an affected mother; (viii) gastric residual > 10 ml; and (ix) an association with oesophageal atresia.

Plain film findings
Plain film findings include the following: (i) gastric dilatation; (ii) paucity of small bowel and colonic air; (iii) frothy gastric contents; (iv) absence of an air-filled duodenal bulb; (v) gastric pneumatosis; and (vi) normal appearance.

Ultrasound technique
A high frequency transducer (7 MHz) is used, preferably a linear or vector probe (Acuson 128 XP/10). With the patient in the supine position start off scanning in the longitudinal section until the gall bladder is located. The ‘olive’ of the hypertrophied musculature should be located medial to it. Visualisation is good when the ‘olive’ has a foreshortened appearance (Fig. 1).

The transducer now has to be rotated and angled so that it is aligned with the long axis of the channel (Fig. 2). On this view, the beak sign can be identified as on a contrast meal. If the stomach is too full, the channel is distorted and accurate measurements won’t be possible. In such a case a nasogastric tube can be passed to empty some of the contents.

Once the long axis is obtained, one should note the position of the transducer and turn it 90 degrees. This way the bull’s eye of the pyloric channel can be identified end-on (Fig. 3).