How to Perform Umbilical Sonograms in the Neonate

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Infection of the internal umbilical remnants is a common problem in neonatal foals. Accurate diagnosis and monitoring response to medical therapy requires knowledge of the ultrasonographic technique, anatomy, and dimensions of normal structures. Authors’ addresses: Department of Large Animal Medicine, P.O. Box 100136 (Franklin) and Department of Radiology, P.O. Box 100102 (Ferrell), College of Veterinary Medicine, University of Florida, Gainesville, FL 32610. © 2002 AAEP.

1. Introduction

Umbilical remnant abnormalities are a common problem in neonatal foals less than 8 wk of age.1,2 Sonographic examination of the umbilicus has been recommended in foals with palpable umbilical abnormalities (omphalitis), bacteremia, septic arthritis, failure of passive transfer of immunity, patent urachus, unexplained elevations in fibrinogen or white blood cell counts, and fever of undetermined origin.1–3 Comparison of ultrasound and surgical findings has been reported to have a sensitivity of 96.6%.2 The most commonly infected structure is the urachus.2 While infrequent, umbilical vein infections with secondary bacterial hepatitis represent the most severe type of abnormality.2

Externally, the umbilical stump represents the only evidence of fetal placental dependency. Internally, there are four umbilical remnants: the umbilical vein, paired umbilical arteries, and the urachus. The umbilical vein is the afferent source of blood from the placenta. From the umbilical stump, the vein courses cranially to the liver. After parturition, it atrophies and becomes the round ligament of the liver near the falciform ligament.4 The umbilical arteries provide efferent blood flow from the foal to the placenta. Each artery branches from the internal pudendal artery and courses along the sides of the bladder before entering the umbilical stump. The arteries also atrophy postpartum and become the round ligaments of the bladder.4 Fetal urine is excreted through the urachus, which connects the apex of the bladder to the allantoic cavity. In the umbilical stump, the urachus lies between the two umbilical arteries. Sonographic assessment of these structures is easily performed in neonates because of their close proximity to the ventral body wall.1 Examination using ultrasound is a significantly more sensitive method of determining umbilical remnant abnormalities when compared with external palpation alone.2

2. Materials and Methods

Patient Positioning and Ultrasound Technique

Foals are positioned in lateral recumbency or standing during examination. Sedation with diazepam...
(0.1 mg/kg IV) or butorphanol (0.05 mg/kg IV) is used as needed. The hair along midline is clipped from the xiphoid to the inguinal region. Alcohol is applied for removal of dirt and organic debris before application of ultrasound coupling gel. A linear array transducer of 5.0 MHz or greater should be used. A typical linear transrectal probe is ideally suited for most examinations. Because of the superficial location of the umbilical structures, image depth will be less than 5–6 cm. Power and gain should be adjusted to produce the clearest picture.

Two views are obtained of the umbilical structures. First, short-axis (transverse) images of all the structures are obtained by placing the probe on ventral midline in an orientation perpendicular to the lumbar spine (Fig. 1). This imaging plane provides a cross-sectional view of the umbilical structures. Second, long-axis (sagittal) images are obtained by placing the probe on ventral midline in an orientation parallel to the lumbar spine (Fig. 2). This orientation is most useful in assessing the attachment of the urachus to the apex of the bladder.

Ultrasound Anatomy

**External Umbilical Stump**

Foals are often presented for heat, swelling, or drainage of the external umbilical stump. The stump is scanned along its length, obtaining both short- and long-axis views (Fig. 3). Normal measurements for the external stump have not been described because of the wide variation in the sizes of normal structures. Several abnormalities can be observed in the external stump. Omphalitis is characterized by gross enlargement and inflammation of the umbilical stump. Ultrasound findings associated with omphalitis include an enlarged, thickened umbilical stump, which is filled with hypoechoic or hyperechoic fluid. In anaerobic omphalitis, small hyperechoic foci with acoustic shadowing will often be present. These hyperechoic foci represent small gas bubbles. The subcutaneous tissues of the external stump may be hypoechoic to mottled, consistent with edema or cellulitis (Fig. 4). Gastrointestinal segments within the stump would indicate an umbilical hernia. A patent urachus is suspected when urine is seen coming from the umbilicus and will be discussed below.

**Umbilical Vein**

The umbilical vein is imaged along its length between the umbilical stump and the liver (Fig. 1). The examination proceeds in the short axis just cranial to the stump and continues cranially to the liver where the vein attaches. Veins lack the rigid support of musculature within their walls; thus, the
The umbilical vein is often seen as a collapsed ovoid structure (Fig. 5). Normally, the umbilical vein varies in its diameter, being largest at the points near the external stump and liver. Measurements should be taken in front of the external stump, once midway between the stump and liver, and again just caudal to the liver (Figs. 5–7). Areas of suspicion are also measured. Measurements should be taken in two directions, horizontally and vertically, with a mean value recorded. The mean width of the umbilical vein should not exceed 1 cm in a normal foal. Omphalophlebitis is characterized by an increase in size of the vein and thickening of the wall. The lumen of the umbilical vein will be distended with hypoechoic material (Fig. 8). Hyperechoic gas foci may also be identified. Blood clots are normal findings in both the umbilical vein and arteries.
These appear as homogeneous anechoic to hypoechoic structures within a vessel and have measurements that are within normal ranges.5

Umbilical Arteries
Caudal to the external stump, the umbilical arteries are imaged as a pair of thick, hyperechoic-walled vessels. Just cranial to the apex of the bladder, a collective measurement of the umbilical arteries and the urachus is taken (Figs. 6 and 9). This value should be less than 2.5 cm in diameter with a horizontal measurement.1 The arteries then diverge along the lateral aspect of the bladder. The measurement of each artery’s width at this level should be less than 1.3 cm (Figs. 6 and 10).1 The arteries are followed alongside of the bladder toward the inguinal region until they are no longer seen. Omphaloarteritis is characterized by the same ultrasonographic findings described with omphalophlebitis.2 It is common to note a lack of symmetry of the umbilical arteries in normal foals.

Fig. 8. Omphalophlebitis. The umbilical vein is mildly enlarged. The wall is thickened and heterogeneous hypoechoic material fills the lumen. This foal responded to a 10-day course of broad-spectrum antibiotic therapy.

Fig. 9. Just cranial to the apex of the bladder, a collective measurement of the umbilical arteries and the urachus is taken. UR, urachus; UA, umbilical artery.

Fig. 10. The width of the umbilical arteries is measured individually alongside the bladder.

Fig. 11. A long-axis image of the insertion of the urachus to the apex of the bladder is made caudal to the umbilical stump. A urachal diverticulum is a common finding in young foals exhibiting signs of stranguria.
Urachus

The urachus is imaged just caudal to the external umbilical stump. Often, the urachus is collapsed and represents only a potential space that is impossible to definitively image.6 When filled with anechoic or hypoechoic fluid, the urachus is readily identifiable as being abnormal. The short-axis image of the urachus is made while examining the umbilical arteries as mentioned earlier (Fig. 9). A longitudinal view of the urachus’ attachment to the bladder should be obtained at the apex of the bladder (Fig. 11). Communication of the bladder and the urachus is commonly seen in foals with a patent urachus. Sonographically, it is viewed as an anechoic lumen that can be traced back to the bladder. However, blind communication of the urachus to the bladder, urachal diverticulum, may also occur. This is a common finding in young foals exhibiting stranguria and may result in development of a patent urachus or uroabdomen, although most spontaneously resolve.5

3. Results and Discussion

Normal values of umbilical remnants are presented in Table 1. Interpretation of sonographic findings should not be based on absolute measurements alone. Changes in echogenicity, capsular development of abscessed structures, and subtle normal variances are recognized by the experienced practitioner. Knowledge of normal anatomy and reference ranges are useful adjuvants to the competent examiner.

Management of umbilical remnant abnormalities is based on medical therapy and/or surgical intervention. Medical therapy should be planned with consideration of the most common organisms cultured from umbilical infections: gram-negative enteric pathogens and β-hemolytic streptococci.2 Recently, trends to defer surgery for as long as possible have occurred.7 This is based on clinical responses seen in foals treated with appropriate antimicrobials (in regards to infections) and identification of all problems associated with perinatal infections. In a report of 33 foals with umbilical remnant infections, there was no statistically significant difference in foals managed medically vs. surgically.2 Recommendations for surgery have historically been made when the structures were more than twice their normal size, when multiple structures were involved, or in patients with other severe perinatal infections.3

The risks involved with removing the umbilical remnants include unnecessary anesthesia in a neonate with other systemic illness, removal of sterile umbilical remnants, and development of adhesions secondary to laparotomy. Regardless, over-interpretation of small abnormalities in the umbilical remnants should not be made. If possible, the practitioner should attempt medical therapy for 3–5 days while frequently performing follow-up examinations.3,5 Several texts and atlases are available to compare abnormal findings, and the practitioner should refer to them regularly.5,8

Table 1. Normal Values of Umbilical Remnants

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<tr>
<th>Umbilical Vein</th>
<th>Combined Umbilical Arteries and Urachus at Apex of the Bladder</th>
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<td>(Mean of horizontal and vertical measurements)</td>
<td>&lt;1 cm</td>
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References
Axial sonogram through posterior fontanelle, oriented to correspond to CT scan (E). Loss of near-field resolution makes identification of torcular Herophili difficult. E, Contrast-enhanced axial CT scan. Massively dilated vein of Galen (VG) to left of midline. In the coronal plane through the anterior fontanelle, the cerebral arteriovenous malformation was poorly identified, but the dilated galenic vein was readily seen as an anechoic structure, free of internal echoes (fig. 1). The vein arises posterior to the foramen of Monro and superior to the third ventricle (structures easily identified on most neonatal sonograms). Although the dilated vein of Galen may be considerably off midline (case 5, fig. 2), it invariably lies between the bodies of the lateral ventricles.