How to Assess the Equine Pregnancy by Ultrasonography

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Introduction

Multiple routine and emergency circumstances in equine practice may require an in-depth evaluation of the pregnancy. Ultrasonography (US) offers an effective and noninvasive method to assess fetoplacental health throughout gestation. Proper fetal imaging is crucial in fetal gender determination and in the diagnosis and management of twin pregnancies, two diagnostic techniques that *practitioners* in the field should strive to perfect.[1–5]

Pregnant mares presenting with a vaginal discharge and/or premature lactation should be thoroughly evaluated for fetoplacental health using ultrasonography. In addition, significant derangement in feto-maternal exchange mechanisms and placental function, triggered by maternal medical or surgical conditions, may compromise fetal well-being and ultimately endanger fetal survival. Under these circumstances, the need for a comprehensive assessment and monitoring of fetal well-being is warranted. Regular monitoring of fetal well-being should continue once weekly for several weeks, even after maternal recovery from the original complaint. Finally, routine scanning of term mares is carried out on some breeding farms to assess presentation and identify other factors that may complicate birth, suggesting the need for assistance to the mare at delivery or to the neonate shortly after birth.

Ultrasound offers safe and continuous viewing of fetal life in the mare, from completion of fetal organogenesis (day 40) to term. The combination of transrectal and transabdominal scanning techniques provides extensive investigation of fetal growth and development and monitoring of the fetal environment.[6–13] Doppler ultrasonography represents an additional tool to assess fetal viability by characterizing blood flow through maternal, fetal, and placental circulations.[14] Clinical applications of Doppler blood flow velocimetry in the pregnant mare are currently being investigated, showing great promise as novel diagnostic instruments in the evaluation of fetal health.

Equipment and Technique

Linear, convex, and sector ultrasound technologies can all be successfully used to image the equine pregnancy. Complete US fetoplacental assessment is based on the acquisition of a series of biophysical parameters that requires both transrectal and transabdominal imaging. Transrectal US scanning provides access to the caudal aspects of the

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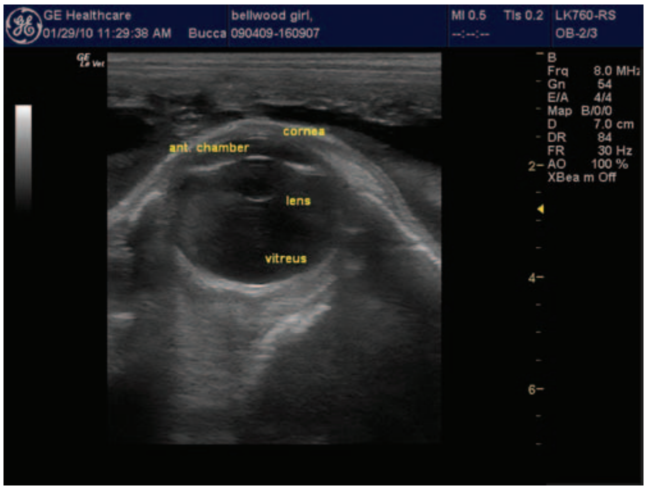

Fig. 1. Transrectal scan of the orbital area of a fetus in anterior presentation at 275 days gestation; mare's tail: right of sonogram.

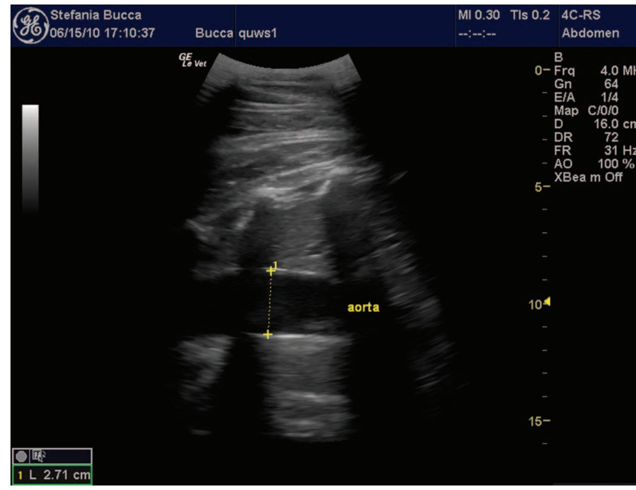

Fig. 2. Transabdominal scan of the cranial chest of a term fetus; measurement of the aortic diameter is taken at the aortic arch as it emerges from the heart in the left hemithorax, ventral to the spinal cord.

gravid uterus and should always be performed at any stage of gestation.

Transrectal US usually employs linear technology with frequencies ranging from 5 to 10 MHz. Convex and sector transducers better adapt to the curvilinear contour of the mare's abdomen and are preferred for percutaneous ultrasonography of the gravid uterus. The equine fetus becomes visible by this route from day 100 of gestation onward. A wide range of frequencies, spanning from 2 to 8 MHz, is needed by this route to reach scanning depths of up to 30 cm and to visualize the growing fetus from midgestation to term. Optimal skin preparation greatly enhances image quality, as per standard percutaneous ultrasonography.

Sonographic Profile of the Equine Fetus

The "sonographic" profile of the equine fetoplacental unit requires the establishment of a minimum database to ensure adequate fetal growth and development and demonstrate appropriate levels of activity and responsiveness within an adequate environment.

Fetal Growth and Development

Several parameters can be measured to estimate fetal size. Orbital diameters/eye volume[11,13,15,16] (Fig. 1), aortic diameter[11,13] (Fig. 2), bi-parietal diameter (Fig. 3), and to a lesser extent fetal chest and femur length[17] have all been reported as useful indicators of fetal growth. The aortic diameter correlates to fetal size more efficiently than any other anatomical structure and measurement should be taken in systole, on a longitudinal scan of the dorsal fetal left hemithorax, in close proximity to the spinal cord (Fig. 4). US provides excellent anatomical detail of the entire fetus in mid to advanced gestation (Figs. 4–8), when fetal sexing diagnosis can be easily accomplished and congenital abnormalities identified. Some of the developmental abnormalities detected during late gestational scans include microphthalmus, hydrocephalus, small and large intestinal segmental atresia, and renal abnormalities. After 9 mo gestation, the quality of the image may decline due to fetal size and positioning within the mare's abdomen. Ossified remnants of the vitelline sac can be visualized from early to late gestation (Fig. 9), usually with no need for concern.[18]

Fetal Activity and Responsive Patterns

Fetal activity and tone reflect central nervous system (CNS) function and development, with decreased activity and declining muscular strength resulting from depressed CNS function. Activity is required to ensure satisfactory muscular development and skeletal joint function, allowing for suc-

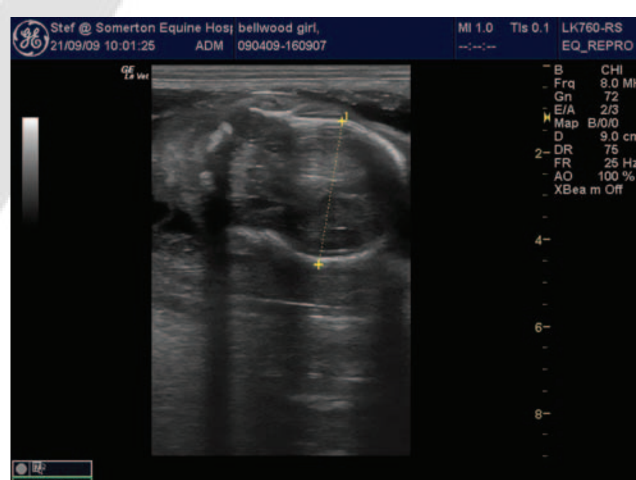

Fig. 3. Transrectal scan of a 110 days old fetus in anterior presentation, with measurement of the bi-parietal diameter. Mare's tail: right of sonogram.

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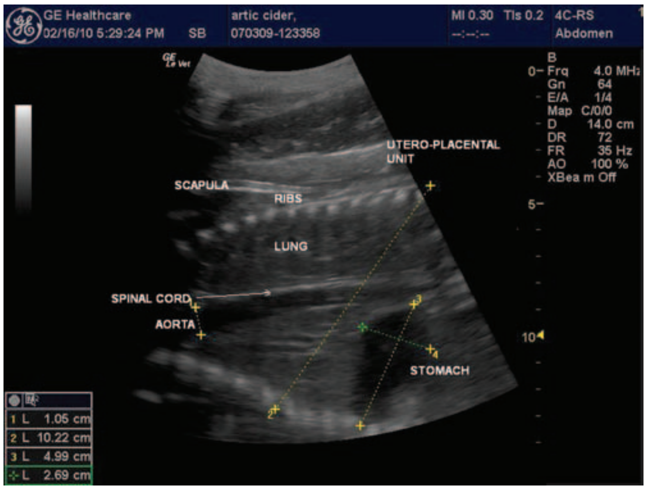

Fig. 4. Transabdominal scan of a 6 mo old fetus, displaying the anatomical features of the dorsal chest and cranial abdomen.

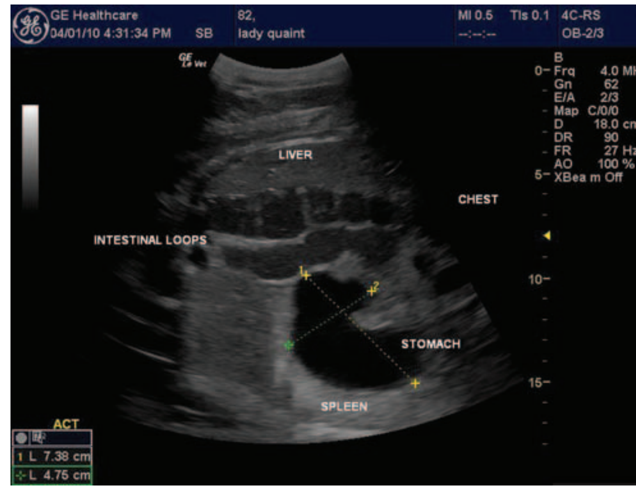

Fig. 6. Transabdominal scan of an 8 mo old fetus, displaying the anatomical features of the abdomen.

cessful postnatal adaptation. Dormant (inactive) phases are observed at all stages of pregnancy but are more common and prolonged in late gestation, where they can last up to 60 minutes or longer on occasion. Lack of fetal movements and sudden bouts of excessive activity followed by abrupt cessation have both been associated with a negative outcome.[5] Rhythmical breathing movements may be observed in all fetuses in advanced gestation (from 7 mo), when the diaphragm is visualized (Fig. 5). Nevertheless, fetal breathing is intermittent in nature and cannot be consistently evaluated.

Fetal Heart Rate

Fetal heart rate (FHR) and FHR reactivity represent the most sensitive indicators of fetal well-being. Cardiac frequency, obtained by M-mode echocardiography and automatically estimated by the cardiac calculation software (Fig. 10), declines as gestation progresses and increases during activity, with accelerations of 25 to 40 beats per minute of approximately 30 seconds duration. Sustained tachycardia[12,13] or a large range of FHRs may indicate fetal distress but could be brought on by painful maternal systemic problems or excitement. Sustained bradycardia,[12,13] inappropriate FHR for gestational age, or lack of heart rate reactivity suggests CNS depression, probably attributable to hypoxia and may indicate impending fetal demise. Fetal cardiac rhythm is usually regular, and cardiac arrhythmias[19] are commonly associated with a negative outcome. Cardiac activity may also be estimated by assessment of peripheral pulses, particularly by the fetal carotid pulse, easily accessible by US per rectum in the fetus in anterior presentation.[20]

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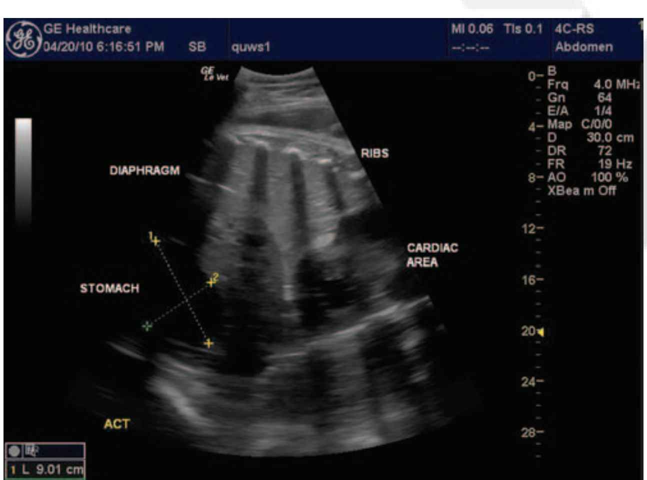

Fig. 5. Transabdominal scan of an 8 mo old fetus, displaying the anatomical features of the ventral chest, the cranial abdomen, and the diaphragm.

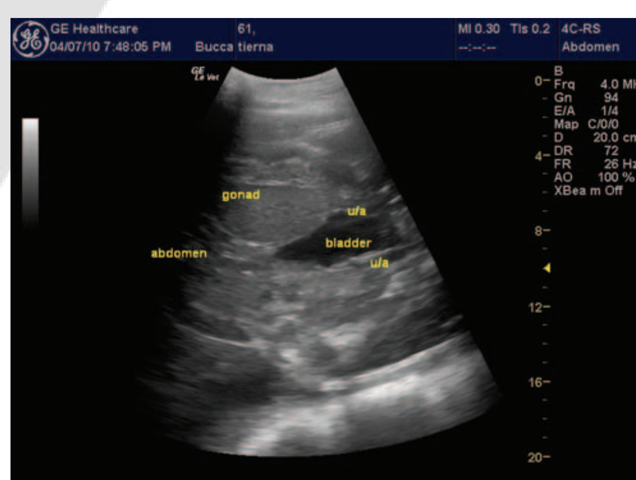

Fig. 7. Transabdominal scan of a 7 mo old fetus, displaying the anatomical features of the ventrocaudal abdomen.

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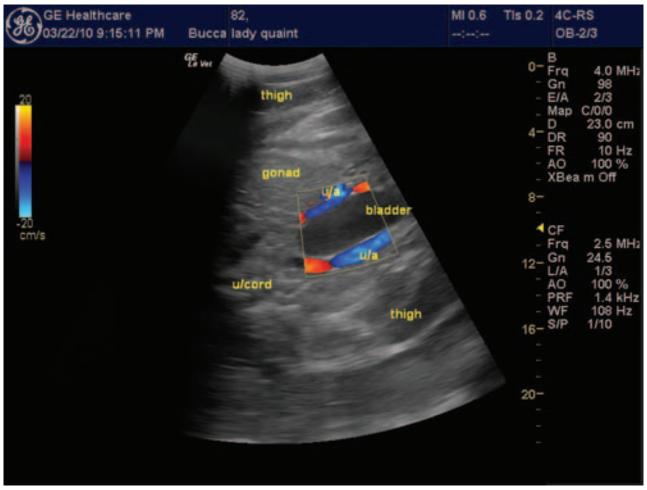

Fig. 8. Same scan as Fig 7 with additional color Doppler signal, identifying the umbilical arteries adjacent to the bladder wall.

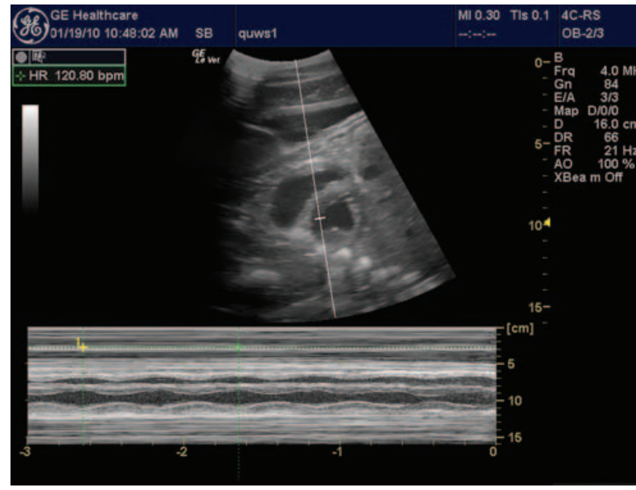

Fig. 10. Fetal heart rate assessment in a 6 mo old fetus, by transabdominal, M-mode ultrasonography.

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Adequate Environment

Evaluation of fetal environment includes assessment of fetal orientation, volume and quality of fetal fluids, combined thickness and contiguity of the utero-placental unit, cervical relaxation, and should confirm the presence of a single fetus.

Fetal Orientation: Presentation

Abnormal presentation causes dystocia, and early detection may prevent a serious perinatal crisis by implementation of specific strategies at delivery. Under normal circumstances, fetal mobility gradually declines as gestation advances, and after 9 mo rotation along the short axis is restricted by fetal body size and the encasing of the fetal hindlimbs within the gravid uterine horn.[21,22] Detection of an abnormal presentation after 9 mo gestation should raise concern and be investigated as term approaches to formulate an appropriate plan of action.

Volume and Quality of Fetal Fluids

The equine pregnancy includes an allantoic and an amniotic compartment. The distribution of allantoic fluid is directly related to fetal dynamics and uterine tone, with no preferential area of maximal fluid depth detectable. Amniotic fluid tends to collect more frequently around the cranioventral half of the fetus (Fig. 11). Minimal and maximal allantoic F11
and amniotic fluid depth values are reported in the literature.[10–13,23]

Free-floating particles (vernix) are commonly observed swirling within the fetal fluids and become more visible during episodes of fetal activity, particularly in the amniotic sac. The hippomane is defined as an allantoic calculus and can often be

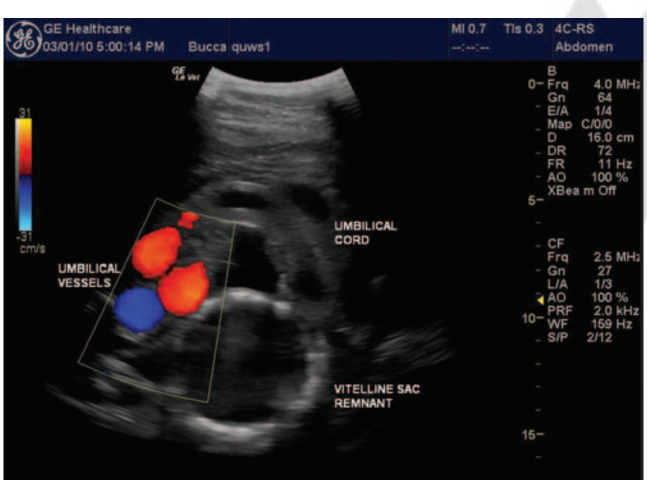

Fig. 9. Transabdominal sonogram of an 8 mo old fetal umbilical cord, with an attached ossified remnant of the vitelline sac.

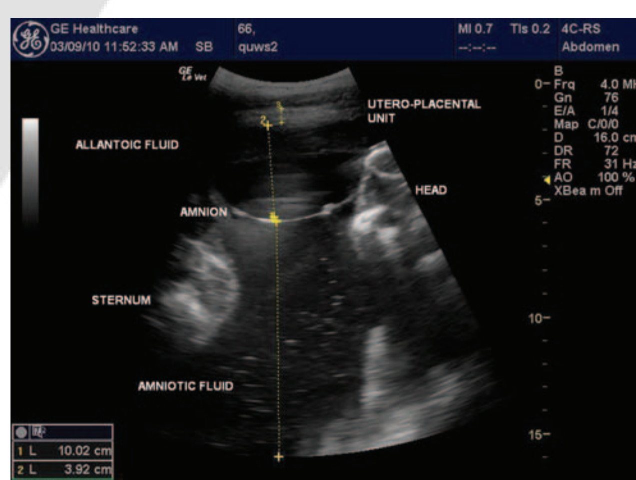

Fig. 11. Transabdominal sonogram of a 6 mo old fetus, showing measurement of fetal fluids depths.

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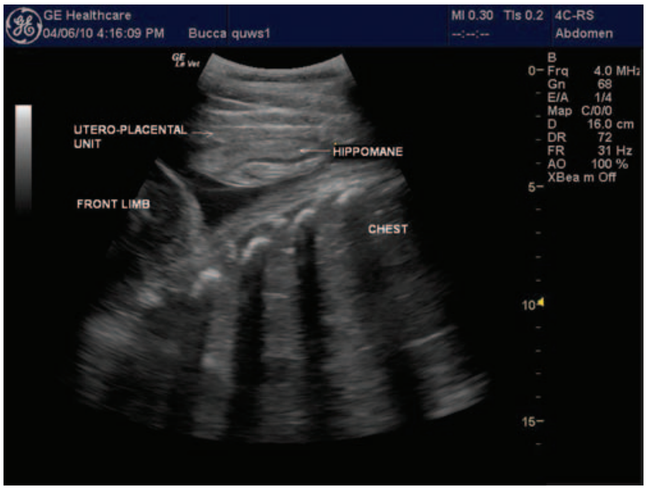

Fig. 12. Transabdominal scan of a term fetus, where a hippomane can be visualized between the fetal chest and the ventral uterine wall.

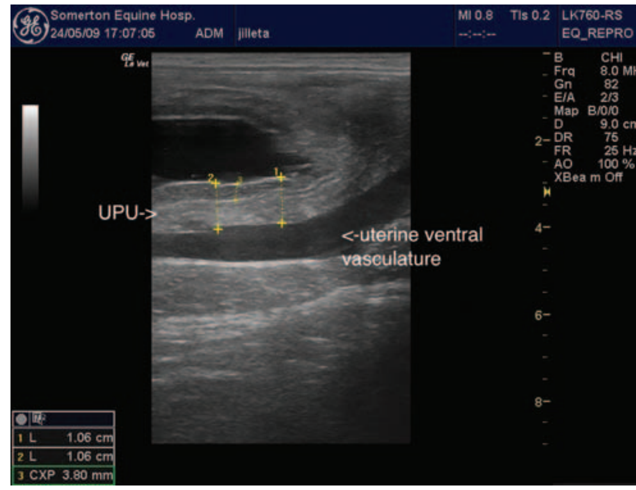

Fig. 13. Transrectal scan of the cervical pole in a term pregnancy and measurement of the CTUP.

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visualized floating within the allantoic fluid, with a typical oval shape and onion like, concentrical structure (Fig. 12). Sudden release of meconium (fetal diarrhea) in the amniotic compartment may sometimes be observed in highly distressed fetuses just prior to birth, stillbirth, or abortion. Pathological increases in fetal fluids have been reported (hydramnion and hydroallantois).[23–29] Markedly reduced volumes of amniotic fluid (olygohydroallantois) may be observed in mares suffering from severe systemic illness. An association of the condition with a poor fetal outcome has been reported.[30] Objective assessment of fetal fluid depth requires extensive scanning of the mare's abdomen and is best carried out during phases of fetal quiescence.

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Combined Thickness and Continuity of the Utero-Placental Unit

The literature reports reference values for the combined measurement of the utero- placental unit at different stages of gestation[31–36] (Fig. 13). Both uterus and placenta should present with similar echotexture up until term, when diffuse sonolucency of the allantoic layers of the placenta may be observed. Adequate utero-placental contact should also be maintained throughout gestation. However, small areas of separation of the placental membranes and uterus are commonly observed in normal pregnancies without any apparent effect on the health of the fetus. An average combined thickness of the utero-placental unit of 1.26 ± 0.33 cm has been reported in mares with normal term pregnancies. Measurements should be taken avoiding areas of compression of utero-placental thickness by the fetus, using the ventral uterine vasculature as landmark. The utero-placental thickness is affected by numerous factors, which may reduce the efficiency of placental function. Such conditions include inflammatory, degenerative, and vascular changes with/without associated edema of fetal membranes, potentially resulting in premature placental separation. Large and/or progressively enlarging areas of placental separation may lead to inefficient exchanges, adversely affecting fetal growth and well-being and resulting in red bag delivery at parturition and decreased neonatal viability. The non-pregnant horn presents with a folded, thickened appearance and, although normal, could be mistakenly interpreted as utero-placental thickening (Fig. 14). The lumen of the non-pregnant horn is relatively small but may suddenly increase to accommodate larger volumes of fetal fluids in response to uterine dynamics and fetal shifting; a marked reduction in CTUP of the non-pregnant horn can be observed under these circumstances (author personal observations).

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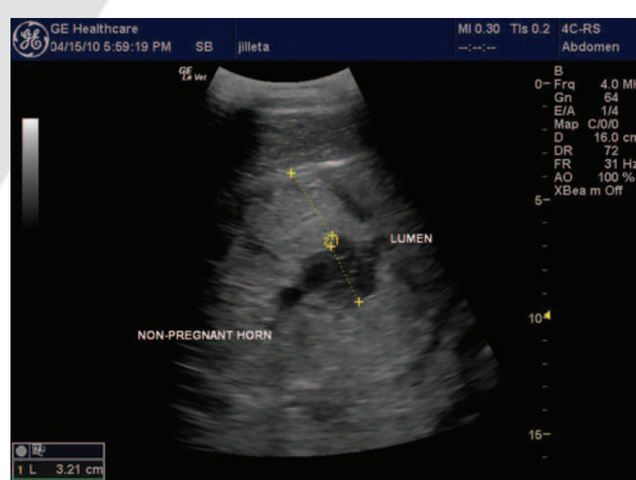

Fig. 14. Transabdominal scan of the non-pregnant horn in late gestation.

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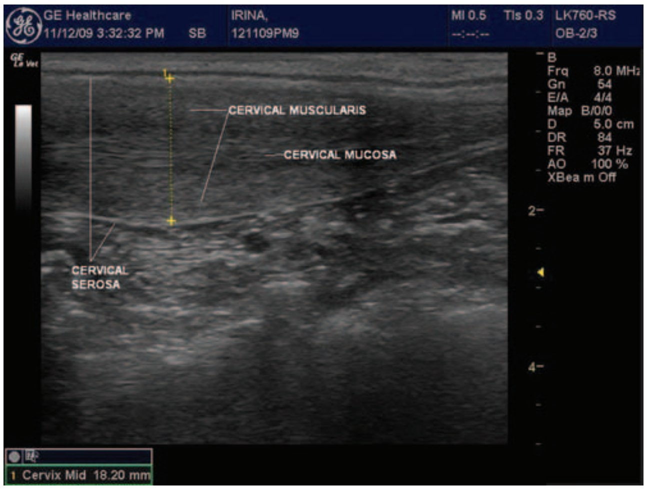

Fig. 15. Transrectal scan of the caudal third of a Grade 2[37] cervix at 6 mo gestation.

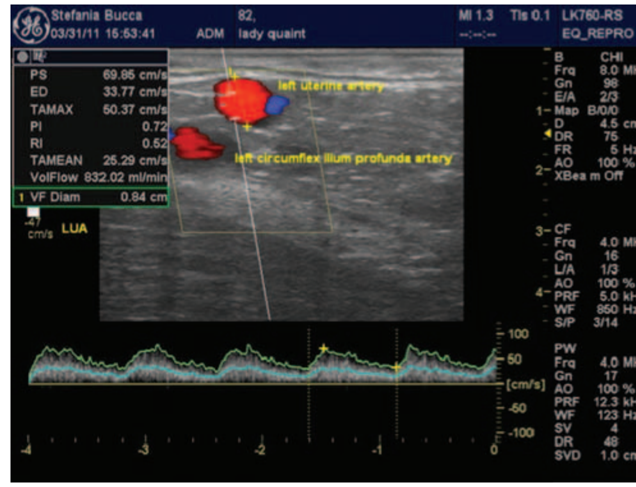

Fig. 17. Color and spectral Doppler flow evaluation of the left uterine artery at 8 mo gestation.

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Cervical Parameters

Recent data on cervical size and echotexture in the pregnant mare suggest a high degree of cervical tone maintained up to 9 mo gestation, followed by progressive cervical relaxation until delivery.[37] A high degree of correlation between cervical size and sonographic appearance was also demonstrated (Figs. 15 and 16).

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Doppler Ultrasonography

Doppler ultrasonography represents an additional diagnostic instrument to characterize blood flow in the pregnant mare and provides an insight on fetal (umbilical and carotid arteries), maternal (uterine arteries) (Fig. 17), and placental circulations (intraplacental vessels). In addition, two distinctive color Doppler signal patterns differentiate male from female fetal gonads, offering an auxiliary tool in the diagnosis of fetal gender.[38]

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Doppler ultrasonography has become an important clinical instrument for the assessment of placental performance in healthy and high risk human pregnancies, but applications to the equine pregnancies are still limited due to the lack of reference values. In normal pregnancies, haemodynamic changes in the uterine arteries progress from a high resistance/low flow pattern during the first half of gestation to a low resistance/high flow system in the second half.[39] The transition correlates closely with the onset of placental angiogenesis in response to fetal growth and the development of the placental microcirculation. Ousey et al (2012) reported a threefold total blood flow volume increment during late gestation (210 days to term) when fetal body mass seemingly increases three to fourfold.[39]

Doppler velocimetry indices of the umbilical vasculature and carotid artery are currently being investigated in order to establish fetal hemodynamic patterns throughout gestation. Signs of circulatory derangement indicating fetal hypoxia and intra-uterine-growth-restriction could then be identified as routinely done in the US evaluation of the human pregnancy.

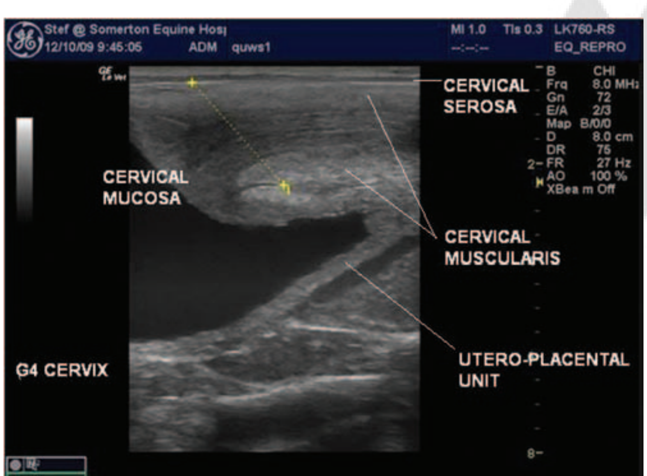

Fig. 16. Transrectal scan of the cranial third of a Grade 4[37] cervix at 10 mo gestation.

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