In: **Recent Advances in Equine Reproduction**, B. A. Ball (Ed.)
Publisher: International Veterinary Information Service (www.ivis.org), Ithaca, New York, USA.

**Fetal/Placental Evaluation in the Mare**  
(17-May-2001)

**M. Troedsson and A. M. Sage**

Department of Clinical and Population Sciences, College of Veterinary Medicine, University of Minnesota, St Paul, Minnesota, USA.

**Introduction**

Improved diagnostic techniques and advances in the understanding of equine reproductive physiology and pathology have resulted in increased pregnancy rates in mares. In contrast, the incidence of early pregnancy loss has remained fairly constant at a rate of 10 - 15 % [1]. Pregnancy losses during late gestation (> 5 months) represent an even greater problem for the equine breeding industry. Affected mares will not only fail to produce a foal, but will often have a lower conception rate during the next breeding season.

Pregnancy losses during late gestation could be the result of fetal illness, placental dysfunction, or maternal illness. Monitoring of maternal health and preventive treatments of the pregnant mare against diseases that may cause abortion have been performed routinely for decades. However, monitoring of the fetus and the placenta during late gestation has only recently gained recognition in equine veterinary medicine.

**Fetal Evaluation**

Indications for examination of the fetus include premature lactation, vaginal discharge, maternal systemic illness, larger than normal abdominal size, suspected twin pregnancy, overdue pregnancy and a previous poor outcome of parturition [2-5]. Transabdominal ultrasonography of the equine fetus can be performed reliably after 90 days of gestation. After this time, the uterus drops over the pelvic brim and is visible from the ventral abdomen. The assessment of fetal well-being is obtained through measurement of heart rate, size, movement and tone of the fetus. The thickness of the fetal membranes, echogenicity and quantity of the allantoic and amniotic fluids and the number of fetuses provide information to evaluate the fetus.

The fetus is visible in the inguinal area and between the mammary glands in early gestation [5]. As pregnancy progresses, the fetus is located progressively more cranial. It is necessary to clip the hair on the abdomen to obtain a diagnostic image of the fetus. In late gestation, the ventral abdomen of the mare should be clipped from the mammary glands to the xyphoid extending to the level of the stifles on both sides of the abdomen. The skin is then cleaned of loose hair and dirt and an ultrasound coupling gel is applied.

Variable gestational length, size and body type of the mare and position of the fetus will affect the choice of transducer. The highest frequency transducer that will penetrate to the desired depth should be chosen. Generally a 2.5 or 3.5 MHz transducer is required to image the fetal heart in late gestation since a depth of 30 cm is often required [5,6]. A second higher frequency transducer (7.5 - 10.0 MHz) is used to image the uteroplacental unit [6]. Either a curvilinear or sector scanner is preferred because they produce a pie-shaped image that allows an increasingly larger field of view in the deeper section of the image. Sedation of the mare will affect the heart rate, tone and movement of the fetus and should be avoided if possible. The ventral abdomen of the mare is scanned in both the sagittal and transverse plane.

The entire uterus is scanned to determine the number of fetuses and the position of the fetus. After eight months of gestation, the fetus should be lying in the sagittal plane in cranial position [5,6]. In late gestation the head of the fetus is near the brim of the pelvis. Orbital diameter can usually only be obtained by transrectal scanning. In many cases, the fetus is in dorsal recumbency with the vertebrae closest to the ventral abdominal wall [6]. To determine fetal orientation, scan the uterus in sagittal section, and locate the thorax of the fetus by the recognizable striped pattern (Fig. 1). Shadowing of the transverse processes of the vertebrae and the ribs causes the striped pattern. The heart is found in the cranial aspect of the thorax.

![Figure 1. Transabdominal ultrasound image of the fetal thorax obtained with a 2.5 MHz sector scanner transducer. The shadows are caused by the vertebrae and ribs. The ventral plane is the top of the image and the dorsal plane is the bottom. - To view this image in full size go to the IVIS website at www.ivis.org »)](http://www.ivis.org)
The fetal heart rate is used as an indicator of fetal well-being. A poor outcome of parturition was associated with bradycardia or tachycardia in the fetus. Heart rate of the fetus peaks at 3 months of gestation to a mean of 196 beats per minute and then gradually decreases throughout pregnancy [7]. The decrease in fetal heart rate is a result of increasing parasympathetic tone to the heart [2]. The normal range of fetal heart rate reported by Reef for the last month of gestation was 60–90 beats per minute [6]. Fetal heart rate can be obtained either by using a stopwatch while monitoring the B mode image or utilizing M-mode. M-mode displays movement at a fixed position of the transducer. The M-mode cursor is moved so that it intersects the heart. The M-mode image is activated. The image displayed will show movement of the heart over time (Fig. 2). The heart rate is automatically calculated by measuring the time between 2 cardiac cycles. M-mode analysis is more accurate in assessing the fetal heart rate than the stopwatch method [7]. Movement of the fetus and mare make holding an image on the screen for 10 seconds or more difficult [7]. The high fetal heart rates in the early months make counting by stopwatch difficult. In addition to resting heart rate, the fetal heart rate should increase 15–20 beats with fetal activity [5,6]. Because it is difficult to obtain a heart rate during activity, the heart rate is obtained after the fetus has moved.

Aortic diameter has been shown to correlate to maternal weight and is a good indicator of fetal size [6]. The aorta is visualized as it exits the heart and courses dorsally in the fetus adjacent to the vertebrae. Aortic diameter is measured at the caudal border of the heart during systole. Normal aortic diameter obtained in 32 light breeds of mares with normal pregnancies ranged from 18.5–27 mm [6]. A smaller than normal aortic diameter was associated with abnormal foals with low birth weight [8]. In addition to normal fetal heart rate, fetal tone should be present. A flaccid fetus that is seen to float in the fluids is weak or dead. The fetus should exhibit movement during the ultrasound scan. Movement may be extension or flexion of the limbs or rotation on the fetal long axis [5,6]. As the fetus ages it will display more complex movements [3]. The amniotic membrane is seen as a thin hyperechoic structure floating within the fetal fluids. The membrane is thin in the normal pregnancy although cysts may be seen [3]. In regions of the uterus where the foal is making contact with the uteroplacental unit the amnion is rarely discernable. The amount of fetal fluids should be assessed in 4 areas within the uterus (right and left; cranial and caudal). Generally the largest fluid depths are located around the fetal thorax in the region of the elbow (Fig. 3) [6].

The depth of the allantoic and amniotic fluids is used to assess total volume of fetal fluids. The normal mean for maximal allantoic and amniotic fluids is 13.4±4.4 cm and 7.9±3.5 cm, respectively. The allantoic and amniotic fluids should contain a moderate amount of particles. Echogenic free-floating particles are normal from month 4 to the end of gestation [6,9]. The hippomane may be seen floating within the allantoic fluid. It has an oblong shape with a layered or onion appearance to the more echogenic center.

**Placental Evaluation**

The equine placenta consists of the allantochorion, the allantoamnion, and the umbilical cord. The chorionic part of the allantochorion is attached to the endometrium through microcotyledons, which contact the endometrium throughout the uterus with the exception of a small area at the internal os of the cervix, the so-called cervical star. The allantochorion supports the fetus in utero. It provides respiratory and nutrient exchange between the mare and the fetus, and it is an endocrinologically active organ with hormone synthesis and metabolism of importance for maintenance and normal development of the fetus. The “free floating” allantoamnion allows the fetus to move freely within the uterus. It is not
attached to the allantochorion with exception of a small area at the umbilical stalk. The only attachment between the fetus and the allantoamnion is at the umbilicus. The umbilical cord has an amniotic portion and an allantoic portion. The umbilicus contains two umbilical arteries, one umbilical vein, and the urachus. The length of the cord, and the length of the allantoic and amniotic portions can vary, but is normally 50 to 100 cm long.

Evaluation of the equine placenta is routinely performed after parturition. A thorough examination of the placenta post partum provides valuable information on disease processes or dysfunctions that could have affected the well being of an aborted fetus, or potentially cause illness in the neonatal foal. However, this examination does not aid the clinician in decisions that are aimed to prevent abortion or neonatal diseases of the foal. Evaluation of the placenta in the mare can be performed by the use of ultrasonography and endocrine tests.

**Ultrasonographic Evaluation of the Placenta**

**Transabdominal Ultrasonography** - Ultrasonographic examinations of the placenta in mares that are considered to be at risk for abortion during late gestation, are routinely performed by a transabdominal approach [8,10,11]. Normal values for the combined thickness of the uterus and the placenta (CTUP) has been established based upon examination with a 5 or a 7.5 MHz transducer (Fig. 4) [8,10].

![Figure 4. Transabdominal ultrasound image of the uteroplacental unit in a normal mare at 320 days of gestation. The image was obtained with a 7.5 MHz curvilinear array transducer. The X marks the thickness of the uteroplacental unit. - To view this image in full size go to the IVIS website at www.ivis.org . -](image)

Reef et al. [6], recommended examination of four quadrants of the placenta; right cranial, right caudal, left cranial, and left caudal. Using this technique, they suggested that mares with normal pregnancies should have a minimal CTUP of 7.1 " 1.6 mm, and a maximum CTUP of 11.5 " 2.4 mm. In a subsequent study, it was observed that mares with an increased CTUP often delivered abnormal foals [8]. A CTUP of >17.5 mm has been suggested to be consistent with placentitis [12]. Renaudin et al.[9], examined the monthly variations of the CTUP in mares with normal pregnancies. Their study confirmed previous studies, but showed a significant difference in the CTUP between pregnancy months. However, the CTUP did not increase consistently, and the reliability of measuring CTUP by a transabdominal approach was questioned. Nevertheless, placental thickening and partial separation of the allantochorion from the endometrium may be observed by the use of transabdominal ultrasonography in mares with placentitis originating from hematogenous infection (Fig. 5). In addition, a pocket of hyperechoic fluid can be seen at the base of the lowest area of the uterus in mares with the Nocardia form of placentitis.

![Figure 5. Transabdominal and transrectal ultrasonography of the placenta in a mare during 9th month of gestation. The arrow points to the area of placental separation. - To view this image in full size go to the IVIS website at www.ivis.org . -](image)

Mares grazing endophyte-infected fescue often experience premature separation of the allantochorion, increased allantochorion weight and thickness, and retained placenta. A significant increase in uteroplacental thickness and premature separation of the allantochorion has been demonstrated on transabdominal ultrasonographic examination of endophyte-infected mares. However, the thickness was not observed until an average of 8 hours before the onset of labor [13].

**Transrectal Ultrasonography** - Although a transabdominal approach provides excellent image of the fetus and most of the uterus and placenta, the caudal portion of the allantochorion cannot be imaged by this approach, resulting in difficulties to diagnose early stages of ascending placentitis. However, transrectal ultrasonography of the caudal allantochorion in late gestational mares provides an excellent image of the placenta close to the cervical star (Fig. 6). Renaudin et al. [9], examined normal pregnant mares monthly during gestation, starting at 4 months of pregnancy until parturition.

![Figure 6. Transrectal ultrasonography of a late gestational mare. A = amniotic membrane; B = the middle branch of the uterine artery; x---x = combined thickness of the uterus and the placenta (CTUP). - To view this image in full size go to the IVIS website at www.ivis.org . -](image)
The normal range for the CTUP was established. A 5 MHz linear transducer was positioned 1 - 2 inches cranial of the cervical-placental junction, and then moved laterally until the middle branch of the uterine artery was visible at the ventral aspect of the uterine body. The CTUP should be measured between the middle branch of the uterine artery and the allantoic fluid (Fig. 6, Fig. 7).

Figure 7. Transrectal ultrasonography of a late gestational mare. A = amniotic membrane; x---x = combined thickness of the uterus and the placenta (CTUP). The CTUP is measured between the middle branch of the uterine artery and the allantois. - To view this image in full size go to the IVIS website at www.ivis.org . -

The examiner has to ensure that the amniotic membrane is not adjacent to the allantochorion, since this may result in a falsely increased CTUP (Fig. 8). The CTUP should be measured in the ventral part of the uterine body. The CTUP in the dorsal part of the uterus is often thicker than in the ventral part of the uterus. In addition, placental parts of the dorsal uterus were often found to be edematous in normal pregnant mares during the last month of gestation.

Figure 8. Transabdominal and transrectal ultrasonography of the placenta in a mare during 9th month of gestation. The arrow points to the area of placental separation. - To view this image in full size go to the IVIS website at www.ivis.org . -

An abnormal thickness and partial separation of the allantochorion from the endometrium has been observed in mares with clinical signs of ascending placentitis based upon transrectal ultrasonography (Fig. 9). In advanced stages, the space between the uterus and the placenta is filled with hyperechoic fluid. In a field study on Thoroughbred mares at commercial stud farms, it was concluded that an increased CTUP during mid- and late gestation, indicates placental failure and pending abortion [14]. None of the mares with normal thickness of the placenta lost their pregnancies, and all mares that aborted had a marked increase of the CTUP or placental detachment. Under practical conditions it was suggested that a CTUP >8 mm between day 271 and 300, >10 mm between day 301 and 330, and >12 mm after day 330 suggests placental failure and pending abortion.

Figure 9. Transabdominal and transrectal ultrasonography of the placenta in a mare during 9th month of gestation. The combined thickness of the uterus and placenta (A) is abnormal (11 mm), and the placenta is separated close to the cervix. The external border of the uterus is outlined by black spots, and the allantoic fluid (B) marks the internal border of the placenta. - To view this image in full size go to the IVIS website at www.ivis.org . -

While transrectal and transabdominal ultrasonographic examination of the placenta is useful to detect early signs of some placental pathology, it is important to keep in mind that placental changes resulting in periparturient problems can be subtle and may not readily be detected on ultrasonographic examination. For example, a correlation between both endometrial fibrosis and angiosis, and poor chorionic villous development has been reported [15,16]. These changes can of course not be evaluated by the use of ultrasonography, but would require other techniques.

Endocrine Monitoring of the Placenta

Progesterone - Increased plasma concentrations of progesterone have been observed in mares with advanced stages of
placentitis. Although, increased concentrations of plasma progesterone during mid- and late gestation are suggestive of placentitis, therapeutic decisions should not be made on the basis of one sample. Serial blood samples need to be obtained from an individual mare in order to detect a clinically useful trend in progesterone concentrations. Monthly blood sampling of mares at risk of abortion showed no differences in plasma progesterone concentrations in mares with impending abortion and mares with normal pregnancies [14].

**Estrogen** - Estrone sulfate in maternal serum has been used to monitor fetal well-being [17]. However, this test has not been useful to detect early signs of placentitis [18].

**Relaxin** - Relaxin is produced by the equine placenta, and can be detected in peripheral blood plasma from day 80 of gestation and throughout the pregnancy [19]. The role of relaxin during pregnancy is not fully understood, but there is some evidence that placental relaxin production is compromised in mares at risk of aborting their fetuses [20]. Ryan et al. [21], observed subnormal plasma relaxin concentrations in mares with abnormal pregnancies. Mares with clinical signs of placentitis and mares exhibiting signs of fescue toxicosis had suppressed plasma relaxin concentrations. There is currently no commercial test available for equine relaxin, and more research needs to be performed to evaluate the usefulness of plasma relaxin as a clinical tool to diagnose placentitis and to monitor the efficacy of treatment strategies.

**References**


All rights reserved. This document is available on-line at www.ivis.org. Document No. A0203.0501.