Management of the high risk mare

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Context

For many mare owners late pregnancy is a time of nervous anticipation and expectation. While greater than 90% pregnancies are healthy and result in uncomplicated deliveries, there are however mares whose pregnancy poses a health risk to them.[1,2] There are also mares that develop life-threatening medical and surgical problems during their pregnancy, and problems that put the mare's pregnancy at risk.[2] Mares that are presented with a history of pregnancy or fetal loss, or that have serious medical conditions, which may compromise the desired outcomes of pregnancy, such as: birth of a healthy, term foal, and a healthy postpartum mare are considered 'High Risk'.[3] Commonly 5% of pregnancies are lost after 100 days of gestation.[3] The foals arising from troubled pregnancies may result in the birth of foals that are non-viable, or that require intensive care.[3,4] Life threatening complications may also arise as a consequence of a mare's foaling, and these injuries may endanger a mare in future pregnancies.[5] The developmental consequences of high risk pregnancy for the fetal foal are often severe.[4,6] The recognition, intervention, and prevention strategies for High Risk pregnancies in mares will be discussed.

Conditions associated with 'High Risk' mares or pregnancies

'High Risk' mares include those with a previous and often repeat history of delivering a compromised foal. Compromised foals include: stillborn foals, premature/dysmature/prolonged gestation foals, septic foals, foals with neonatal isoerythrolysis, ischemic encephalopathy, twin foals, and neonatal maladjustment foals.[3,4] The 'High Risk' category also includes mares that have birth related problems such as: premature placental separation (red bag), dystocia, placentitis, protracted labor, and uterine artery hemorrhage/hematoma.[4] Some mares may develop physical abnormalities during pregnancy including: laminitis, hydrops, abdominal wall disease, or have a narrow or fractured pelvis.[1,2] Mares carrying foals with genetic problems (example hydrocephalus) are also at risk. Mares with advanced age (>20 years) during pregnancy are also at higher risk of complications.

Placentitis is one of the main causes of 'High Risk' pregnancy in mares.[4,6] Other 'High Risk' mares include those that may develop complicated medical or surgical problems. Mares may become 'High Risk' from environmental exposures such as: grazing pastures or forages containing fungal endophytes, such as fescue infected with *Neotyphodium coenophialum*; consumption of toxic plants (locoweed *Astragalus spp*), goitrogenic plant species (*Brassica species* i.e mustard foals), or other toxins (for example, heavy metals).

History

The mare's health history and past problems during pregnancy should be discussed. It is important to determine the mare's breeding date(s) or exposure to a stallion. It is important to establish if the mare was evaluated for a twin pregnancy, and when this examination(s) occurred in the pregnancy. Determine how long the clinical signs, such as colic-like signs, or precocious udder development have been present, and what other clinical signs have been seen, such as vaginal discharge. Determine if the mare been dripping or streaming milk, or has material on her legs compatible with leaking mammary secretion. Take note of the tilt, shape, and size of vulva and integrity of the vulvar seal and if the mare has had Caslick's surgery. Mares that have a history of problems during pregnancy or that are at risk of problems should be monitored carefully, generally with serial ultrasound examination of the reproductive tract, fetus, blood work, and milk electrolytes.

For mares that are High Risk a practitioner should consider a referral to a practice or location with facilities readily and able to: manage obstetrical emergencies, perform cesarian sections, or that provide neonatal intensive care services. The birth of a foal at a location where there is an intensive care unit facilitates rapid intervention during and after birth. Careful monitoring of the 'High Risk' mare and

the pregnancy using serial ultrasonographic examinations, and milk electrolytes, is useful. Having knowledgeable foaling attendants present at parturition also may help to optimize the outcome.

High risk mares-examination

Assessment of a 'High Risk' mare should be systematic and thorough. A complete physical examination should be performed, including examination of the mare's digital pulses and mucus membrane color. The tools used to recognize a 'High Risk' mare include: history, vaginal examination, transrectal palpation and ultrasound, abdominal wall examination, transabdominal placental and fetal monitoring, serial examination of mammary secretion electrolytes, serum chemistry/CBC and biomarker analysis.[3]

Vaginal examination

A vaginal examination is used to evaluate the status of the cervix and to investigate mares with vaginal discharge. A healthy pregnant mare with good perineal conformation should have a pale, dry vagina, and a tight cervix with no discharge until near term. The mucus plug of the cervix is tacky and light tan in color. This plug generally is passed within 12 hours of parturition at term. The vaginal examination of a mare must be performed using strict aseptic technique. The mare's perineum is prepared as for artificial insemination. A sterile speculum may be used, and/or a careful manual, quick, vaginal examination performed. A careful, efficient, gentle examination may be performed with a surgically gloved hand of the external portion of the cervix to determine if it is softened, open or closed. Avoid excessive handling of the cervix.

If there is a vaginal discharge a few slides should be prepared using a Wright Giema stain to examine the cells present (there should be no neutrophils or red blood cells and no bacteria/fungi). To differentiate the cytology of a liquefying cervical plug from a purulent discharge, the plug cytology will have very few cells in it. If inflammatory cells are present on the sample it should be submitted for culture and sensitivity. The presence of red blood cells or neutrophils in a vaginal discharge is abnormal. If neutrophils are present examine them for intracellular bacteria (determine if cocci or rods) and Gram stain a slide to determine the class of bacteria. If bacteria are present the determine of the bacterial morphology and Gram classification should inform the choice of an antibiotic. It also serves as a starting point if the foal is born septic and needs treatment. The most common bacterial agents involved in ascending placentitis include β- hemolytic *Streptococcus* such as *Streptococcus equi zooepidemicus*, and *E. coli*. In spite of having bacterial placentitis, infected mares seldom develop fevers, but when infection occurs through the ascending route they may have vaginal discharge. Vaginal discharge is not always however a constant finding.[4]

Transrectal palpation and ultrasonographic examination

Rectal examination is used to determine: cervical tone, the fill of the uterus, fetal orientation and assessment of the fetal compartment (combined thickness of the uterus and placenta [CTUP], fetal fluid depth and character).[7] The fetal parts that are commonly assessed include the fetal cranium, orbit and limbs (carpi). The goal is to measure the orbital diameter (length and width in mm) the sum of which is correlated with gestational age (to a month). Location of the cranium of the fetus informs the examiner that the fetus is in anterior presentation. The foal may be assessed in terms of the skeletal development by evaluating the shape of the growth plates. The uteroplacental unit is a fluid filled organ, and the ventral surface of the uteroplacental unit is evaluated, and the location where the combined thickness of the uterus and placenta (CTUP) is measured is usually adjacent to the vaginal branch of the uterine artery (Figure 1). The areas adjacent to the cervix is examined for the presence of an exudate, placental separation and edema (Figure 2). Rough guidelines for CTUP are: <8 mm 271-300 days, <10mm 301-330, <12 mm after 330 days. Thumb rule is that after the eighth month of pregnancy the CTUP should match the month of gestation.[7] Thicker CTUP measurements may signal trouble, such as ascending placentitis. It has been our experience that once a placenta has an increased CTUP in a case of placentitis it may or may not completely return to within normal limits after therapy.[3]

Abdominal wall examination

In healthy pregnant mares, typical measurements of the thickness of the muscles in millimeters of the ventral abdomen include (mean ± standard deviation; SD): rectus abdominus 16.5±6, mm pectoralis ascendens 10.5±3 mm, and cutaneous trunci 9±1.5 mm and only slight edema is usually present in pregnant mares. Older mares are predisposed to ventral abdominal wall disease because studies show that the abdominal wall muscles weaken with age.[8] An examiner needs to be aware that there may be fat interspersed between the muscle layers. There was little variation from left to right side of the abdomen in muscle measurements and surprisingly similar results with large breed and light horse mares, and before and after parturition. When abdominal wall disease is suspected an examination should be concerned about underlying causes such as: placentitis, dropsical conditions, and twins.

Excessive edema, thickening and muscle fiber separation are all signs of abdominal wall muscle compromise. The excessive weight of the fetus and fetal fluid poses a risk of ventrolateral abdominal wall disease.[9] Ventrolateral abdominal wall disease may also arise idiopathologically. Clinical signs include reluctance to move or a change in gait. Mares will develop hot painful ventral edema, and as the condition deteriorates, discoloration of the abdominal wall, and serum weeping through the skin. This is evidence of severe myonecrosis. In advanced cases the abdominal wall may fail at the aponeurosis of the internal oblique muscle in the lower flank area(s), which leads to a unilateral and bilateral lower flank hernia. The myonecrosis may dissect across the ventral abdomen involving the prepubic tendon, or arise on either side of the pelvis. There usually is bloody mammary secretion, which is pathognomonic for abdominal wall disease. The prepubic tendon is complicated mixture of insertion fibers. When the prepubic tendon area ruptures the mare's pelvis tilts, the abdomen drops, and the result is displacement of the udder cranially, ahead of the stifle (Figure 3). They may develop a fatal ileus as the bowel may be located adjacent to the skin. In very serve cases the skin may also rupture leading to eventration. The problem may be unilateral or bilateral.[9]

Transabdominal ultrasonographic examination

Transabdominal ultrasonographic examination is performed by systematically evaluating the abdominal wall integrity and the quadrants of the abdomen. A 3.5 or 5 mHz probe is used. The abdomen is scanned from the udder to the sternum to locate the uterus. The examination is accomplished by wetting the hair of the mare's abdomen using alcohol and mineral oil or ultrasongraphic couplant. The fetal allantoic and amniotic fluid compartments may be visualized and the fetal fluids evaluated in terms of quantity and character. Some floating particulate material is considered normal (vernix, protein), excessive matter usually indicates fetal asphyxia/fetal diarrhea, or bacterial growth in the fetal fluids. Hippomanes may be identified in the allantoic fluid. The ultrasonographic scan is usually most productive in the caudal quadrant of the abdomen near the udder. The ventral abdomen of the mare from the xiphoid to the udder on both sides should be examined. The orientation of the foal can be confirmed. The CTUP is measured in a number of locations (normal <2.2cm). The fetal orientation is ascertained, (in anterior presentation the fetal heart is located in the anterior of its thorax close to the mare's pelvis) and then the thorax is located in order to observe the fetal heart rate. The fetal and non-fetal uterine horns are identified (or not if there are twins).[7,11,12] The fetal aorta, and distance between the ribs may be measured to assist in determining fetal age, and growth over time.[7]

Fetal assessment

A fetal assessment, also called a biophysical profile, should include an evaluation of the CTUP of the placenta in various locations. A determination of fetal fluid depth/character, fetal tone, aortic diameter, and fetal heart rate. Fetal body parts may be measured to confirm fetal age fetal ribs shadows are used to help locate the fetal heart. Fetal heart rate and character may be evaluated (Figure 4). A fetal and maternal EKG may be obtained. Cardiac function in regards to fetal movement should be determined, as fetal movement in the absence of heart rate accelerations indicates fetal hypoxia. The mean fetal heart rated (FHR) varies from 75-85 bpm in a non-stressed fetus. Prolonged FHR <40 or >110 bpm indicates

significant distress. Note that the FHR normally should vary and fetal activity is normally associated with transient increases in FHR. If the FHR does not increase with fetal movement this is also a sign of hypoxia or distress.[12]

Clinical chemistry and CBC

The mare's CBC and chemistry do not change significantly during a healthy pregnancy.[7] In abdominal wall disease the mare's creatine phosphokinase (CK), alkaline phosphatase, aspartate amino transferase enzymes (AST) and gamma glutamyl transferase (GGT) will be elevated, however these changes may not reflect the severity of the abdominal wall compromise.

A CBC is useful to determine if there is elevated fibrinogen suggesting long standing chronic inflammation. A stress leukogram may be noted. Only in the rare really ill systemically sick mares that are endotoxemic will there be a left shift with toxic change noted.[11]

Biomarkers

Biomarkers of placentitis include steroids, elevations in acute phase protein serum amyloid A, relaxin, alpha fetoprotein (which may not be consistently elevated) and microRNA's. In placentitis serial progestogen levels may be increased or decreased, serum amyloid A may be increased (>7 mg/L), and serum fibrinogen may be elevated. [3,13,14] Fetal adrenal activation may result in rising progesterone, while placental failure may be associated with falling progesterone.[6]

Mammary secretion testing

Prefoaling mammary secretion should be evaluated in mares with premature lactation. In mares approaching their due date the use of pH strips to determine milk pH, and water hardness test strips may be used to measure changes in calcium and magnesium that are indicate of readiness to foal. The pH of the mammary secretion typically decreases to pH<6.5 near delivery, and the calcium and magnesium levels (measured as water hardness or calcium carbonate equivalents) in samples diluted 1 part milk to 5 parts water (1:6 dilution), to measure changes in calcium magnesium levels (>200 mmol calcium carbonate equivalents, or 40 mg/dL indicates readiness to foal), or a calcium titration method to determine calcium levels may be used (>200 mmol, 200 ppm).[15]

Hormonal analysis

Serial hormonal analysis of serum progestagen and estrogen values may help predict if the placenta is healthy and is maintaining endocrine functions. Progestagens are monitored as an indicator of placental function and fetal stress. During pregnancy excessively high or low progestagen levels indicate a problem. In the experimental infection models of *Streptococcus equi zooepeidemicus* placentitis, mares that had acute reactions and aborted early had high levels of progestagens while more chronically infected mares had lower levels of progestogen.[4,6] Fetal stress may cause premature adrenal activation and the production of increased amounts of precursors for the progestagens. Progestagen values measured as progesterone in the Coat-A-Count® RIA typically range from 2-6 ng/ml from 180-310 days of gestation and may increase or decrease $\pm$ 2 ng/ml on a daily basis, hence the recommendation to monitor the levels changing over time. Progestagen levels (cross reactive in progesterone assays) over 10 ng/ml are considered elevated.[4,6] A sudden drop in progestagen is often associated with impending abortion. Synthetic progestagens such as altrenogest (Regumate®) do not interfere or cross-react in the progesterone RIA. Fetal death is associated with a decrease in maternal estrogen levels. A sudden drop in progesterone is often associated with impending abortion.

Interventions for specific conditions of 'High Risk' mares

The specific therapy for a number of conditions is discussed below.

Therapy for placentitis

If a cause can be determined the therapy is aimed at minimizing inflammation, improving fetal viability using medications such as antibiotics, tocolytics, steroids, anti-endotoxin or anti-inflammatory

agents, and hormones. For twin pregnancy prevention is the key! In mares with placentitis mares need to be monitored for preterm delivery and managers need to be prepared for birth of a neonate that may need intensive care. Neonatal intensive care tools (heat lamps, plasma transfusion, antibiotics, 24 hour supportive care) need to be readily available.[4,6]

The goals of therapy are to fight or eliminate infection, decrease inflammation and cytokine formation, and decrease myometrial activity. Therapy will often delay preterm delivery due to placentitis, but seldom is sufficient to allow a term delivery.[4]

The initial choice of antibiotic should be based on cytology, Gram stain, and culture. A culture and sensitivity are used to confirm the organism and to choose the appropriate antibiotic. The most commonly used antibiotic is trimethoprim sulfa. Studies using ceftiofur showed that this antibiotic does not readily cross the equine placenta.

To decrease inflammation anti-inflammatories such as flunixin meglumine (utilized when endotoxemia is present) or phenylbutazone are often administered. Inflammatory products may lead to increased uterine contractions. Pentoxyphylline is used to decrease cytokine production. The direct evidence of the benefit of pentoxyphylline still requires further investigation. Dexamethasone may be used to suppress the proinflammatory cytokines, and has been used sparingly in dosages from 25-50 mg SID once or for a few days. Altrenogest (double dose 0.088 mg/kg PO) has been shown to be effective in stopping cloprostenol induced abortion experimentally.[4] In one report mares with *Streptococcus* induced placentitis had gestational lengths that were longer than untreated mares. Recently the use of estradiol cypionate has been examined as a means of improving fetal outcomes.[16]

To decrease myometrial contractility tocolytics such as clenbuterol (beta agonists) need to be given 2-3 times a day to decrease uterine contractions.[17] Generally clenbuterol administration is associated with uterine relaxation and improved fetal perfusion. Clenbuterol is no longer available in injectable form, but only as a syrup. This medication will not stop abortion or parturition, but may modulate uterine contractions.[18] Altrenogest may also decrease uterine contractions and may improve fetal outcomes. The COX-1 COX-2 inhibitors such as firocoxib may decrease endometrial prostaglandin section, however there is little information on their use during pregnancy. The non-steroidal anti-inflammatory (NSAID) medications, such as flunixin meglumine, are commonly administered to mares with placentitis because of their anti-endotoxic effects.

The minimum duration of treatment for mares is usually 2 weeks after which a mare should be reassessed. In some cases mares may need to be maintained on antibiotic and NSAID therapy until delivery. The Table lists common medications utilized to treat placentitis.

Consequences of placentitis. Veterinary bills are large. The foal is often born septic or endotoxemic. The foal may have neonatal maladjustment syndrome (NMS). Foals may never reach their full size, they may develop debilitating developmental orthopedic disease. Neonatal intensive care unit graduates often are suboptimal athletic performers. Preterm delivery is also associated with full or partial retention of the placenta, which may trigger its own set of problems in the mare. The mare has impaired reproductive performance including: uterine sub-involution and difficulty conceiving that breeding season.

Laminitis

Many cases of laminitis during pregnancy are idiopathic, but others may be related to excessive body condition. Ideal weight during pregnancy should result in a body condition score of 6/9. Mares that gain weight easily which can lead to mechanical overloading of the hooves and laminitis. In one study 42% of draft horses had a BCS of >7.[19] Mares may be grazing on pasture where they may spend 90% of the time consuming grass. The highly digestible carbohydrates in the grass may be a problem. Draft mares and ponies may have experienced previous episodes of laminitis, which puts them at risk of a reoccurrence. Their hoof care may also be neglected which may make the mechanical forces on their hooves worse.[14]

Owners may report a reluctance to move, laying down alot, or are stiff in the shoulders. A physical examination should include evaluation of the mare's stance. A typical laminitic mare will have a

'sawhorse' stance if the forefeet are involved and a shifting leg stance if all 4 hooves are involved. Reluctance to lift the feet is present. The hooves may be warm. Palpation of the digital pulses shows prominent, bounding pulses. Positive hoof testing is usually present along the toe. In severe cases sinking may be noted near the coronet band. Walking and turning the mare may also reveal the gait problem. The heart rate usually rises dramatically when a mare with laminitis is walked. The heel of the hoof usually strikes the ground first in laminitis. Palmer digital nerve blocks will improve the lameness. Lateral radiographs of the coffin bone (P3) assist in determining if rotation or sinking of the hooves is present. Treatment includes removal of any source of endotoxins, oral phenylbutazone, icing the hooves, trimming the hooves if needed, and application of a support device such as "Soft-Rides" or homemade versions of these on the bottom of the hoof. Don't forget to get them off the grass! Limiting the hours grazing or grazing muzzles may be needed to keep mares from getting too fat.

Hydropic conditions

Mares with excessive girth may have hydropic conditions, may be found to be carrying twins or are excessively conditioned. (body condition score of $\geq$8/9). Hydrops is a rare medical problem in mares that arises from a placental or occasionally fetal dysfunction. Most cases are however idiopathic and result in a progressive and life threatening accumulation of fetal fluid. The excess fetal fluid accumulation may result in the mare's abdominal circumference increasing at a rate of more than 4 cm per day. [9] There may be colic signs, respiratory distress and inappetence in mares that relates to their hemodynamic compromise. Most commonly the fluid accumulates in the allantoic cavity, causing hydrallantois, but occasionally the amniotic fluid is involved and causes hydramnios, or when both compartments are involved, it is called polyhydramnios. The excess weight of the fetal fluid leads to cardiovascular compromise of the mare, and abdominal wall stress. In hydrallantois the fetus may not be palpated per rectum, and in hydramnios there is excessive amniotic fluid. These mares may experience abdominal wall rupture.[7,11] Termination of the pregnancy is almost always needed. Currently preloading the mare with intravenous fluid, then slow drainage of the fetal fluid (over 2-4 hours) with concurrent aggressive fluid replacement, is recommended to save the life of the mare.[11]

Twins

Genetically Thoroughbred, Warmblood and draft mares are more likely to have twins. Prevention and early intervention are the key. Extensive management of some mares is also a factor where mares may not be evaluated during early pregnancy using ultrasonography. Statistics show in general very poor survival of twins, with only 1 in 300,000 having both twins survive the neonatal period. Twins are usually aborted or born about a month premature. They may not reach their full mature size and are prone to developmental orthopaedic disease.[3]

Ventrolateral abdominal wall disease

History includes a large amount of ventral edema, a reluctance to walk, development of an abnormal gait, or a history of "falling." This is a disease that accompanies obesity, age, and may arise as a complication associated with hydrops or twins. In most cases it is idiopathic. Excessive weight on the mare's abdomen results in a pathologic hot, painful, pitting, ventro-lateral edema that indicates underlying muscle damage. The ventral flank is often afflicted first (at the aponeurosis of the internal abdominal oblique) followed by extension to the ventral abdomen and rectus abdominus. In most advanced cases the internal abdominal oblique muscle and rectus abdominus muscle ruptures (aka prepubic tendon rupture), and the pelvis tips. The udder develops a bloody secretion and becomes displaced so the teat is visible ahead of the stifle. The mare may develop a fatal ileus, or eventration.[7]

Fetal abnormalities

Many breeds are known for specific heritable conditions and have genetic tests available for them. A breed with a long list of fetal abnormalities is the Friesian. This breed has a high inbreeding coefficient. There is genetic testing available for "water head", (hydrocephalus) from a defect in the

B3GALNT2 gene, and dwarfism caused by a mutation in the B4GALT7 gene (Fenway Foundation http://fenwayfoundation.com/forms/). Both have a simple recessive mode of inheritance so there is a 1:4 chance if two carriers are mated of having a foal with the abnormality. Junctional epidermolysis bullosa testing is also available for Belgians, but this disease does not cause antepartum problems. Testing is available at the University of Kentucky (http://getgluck.ca.uky.edu/content/submission-forms).[20]

Decision to terminate a pregnancy and/or induce parturition

It is difficult to determine if the medical problems of the mare are severe enough to warrant the termination of pregnancy. Under most circumstances elective induction of parturition should only be performed in mares when medically necessary. The mare should be greater than 330 days of gestation, have colostrum in her udder, a drop in mammary secretion pH below 6.5 and an elevation in milk calcium/magnesium (>200 mmol / L). Her cervix should be relaxed. It is best to seek advice in these cases as many of these mares may require intensive care or hospitalization. The most common method to induce parturition is the use of oxytocin. Although prostaglandin F2-alpha has been used. Fetal maturation may be hastened by the administration of dexamethasone at 100mg/day. Induction of parturition in mares at around 320 days of pregnancy with dexamethasone involves 4 consecutive days of administration at this dose with parturition occurring approximately four days later. There are a variety of doses utilized to induce parturition including a low dose method of 3.5-5 IU of oxytocin (given once daily until parturition occurs) and 20 IU may be utilized to induce foaling within one hour.[21] The low dose method appears to work more reliably if the mare in not moved from her home farm to a new location. If the cervix is very tight a pretreatment with prostaglandin E1 may be utilized intra-cervically 4 hours before oxytocin induction.[22] Attendants should be prepared to open a prematurely separated chorioallantoic membrane (redbag) and assist delivery of a foal and potentially using the EXIT procedure developed by at the University of Pennsylvania.

Prevention strategies

In advance of breeding have genetic testing performed of mares and stallions. Ensure the mares have regular hoof care, vaccination and deworming. Have an ultrasonographic examination for pregnancy status performed are least twice during early pregnancy from 15-35 days to detect twins. Perform a Caslick's vulvoplasty on mares that have sloping or tipped in perineal conformation to help prevent ascending bacterial infections. Retire mares >20 years of age from breeding, or perform embryo transfer. Avoid excessive weight gain during pregnancy. Provide a balanced diet to pregnant mares with adequate amounts of mineral. If pregnancies are lost perform necropsies to determine the cause.[23] Monitor mares closely during pregnancy and keep them in stable isolated groups, preferably with mares close to the same age, and away from other horses.

References

1. Tibary A, Pearson LK: Mare problems in the last month of pregnancy. Proc Am Assoc Equine Pract 2012;58:350-358.
2. Frazer GS, Embertson R, Perkins NR: Complications of late gestation in the mare. Equine Vet Educ 1997;9:306-311.
3. Bucca S: Diagnosis of the compromised equine pregnancy. Vet Clin North Am Equine Pract 2006;22:749-761.
4. Lyle S, Paccamonti D: High risk pregnancy in the mare-practical implications for the practitioner. Pferdeheilkunde 2010;26:29-35.
5. Frazer GS: Postpartum complications in the mare. Part 2: Fetal membrane retention and conditions of the gastrointestinal tract, bladder and vagina. Equine Vet Educ 2003;15:91-100.
6. LeBlanc M, McPherson M, Sherrin P: Ascending placentitis what we know about pathophysiology, diagnosis and treatment. Proc Am Assoc Equine Pract 2004;50:127-143.
7. Bucca S: Assessment of feto-placental well-being in the mare from mid-gestation to term: transrectal and transabdominal ultrasonographic features. Theriogenology 2005;64:542-557.
8. Anderson S, Bracamonte J, Carmalt J, et al: *Ex vivo* comparison of bursting strength of ventral median and right ventral paramedian celiotomies in horses. Vet Surg 2013;42:468-472.
9. Wolfsdorf, K: Ventral abdominal hernia and prepubic tendon rupture. In Robinson NE, editor. Current therapy in equine medicine. Philadelphia: Saunders; 2003. p. 310-311.
10. Hanson R, Todhunter R: Herniation of the abdominal wall in pregnant mares. J Am Vet Med Assoc 1986;189:790-793.

11. Diel de Amorim M, Chenier T, Card C et al: Treatment of hydropsical conditions using transcervical gradual fetal fluid drainage in mares with or without concurrent abdominal wall disease. J Equine Vet Sci 2018;64:81-88.
12. Reef V, Vaala WE, Worth LT et al: Ultrasonographic evaluation of the fetus and intrauterine environment in healthy mares during late gestation. Vet Radiol Ultrasound 1995;36:533-541.
13. Troedsson MHT, Miller L: Equine placentitis. Pferdeheilkunde 2016;32: 49-53.
14. Canisso I, Ball B, Scoggin K et al: alpha-fetoprotein is present in the fetal fluids and is increased in plasma or mares with experimentally induced ascending placentitis. Anim Reprod Sci 2015;154:48-55.
15. Korosue K: Testing mammary gland secretions to help predict when a mare will foal. Vet Rec 2013;173:216-217.
16. Curcio B, Canisso I, Pazinato F et al: Estradiol cypionate aided treatment for experimentally induced ascending placentitis in mares. Therio 2017; 102:98-107
17. Robinson NE: Clenbuterol and the horse. Proc Am Assoc Equine Pract 2000;46:229-233.
18. Palmer E, Chavatte-Palmer P, Duchamp G et al: Lack of effect of clenbuterol for delaying parturition in late pregnant mares. Theriogenology 2002;58:797-799.
19. Kosolofski H, Gow C, Robinson K: Prevalence of obesity in equine population of Saskatoon and surrounding area. Can Vet J 2017;58:968-970.
20. Sabbagh M: Genetic and environmental analysis of dystocia and stillbirths in draft horses. Animal 2014;8:184-191.
21. Witkowski M, Pawlowski K: Clinical observations of the course of oxytocin- or prostaglandin E2/oxytocin-induced parturition in mares. Polish J Vet Sci 2014;17:347-351.
22. Villani M, Romano G: Induction or parturition with daily low-dose oxytocin injections in pregnant mares at term: clinical applications and limitations. Reprod Domest Anim 2008;43:481-483.
23. Schlafer D: Postmortem examination of the equine placenta, fetus, and neonate: methods and interpretation of findings. Proc Am Assoc Equine Pract 2004;50:144-157.

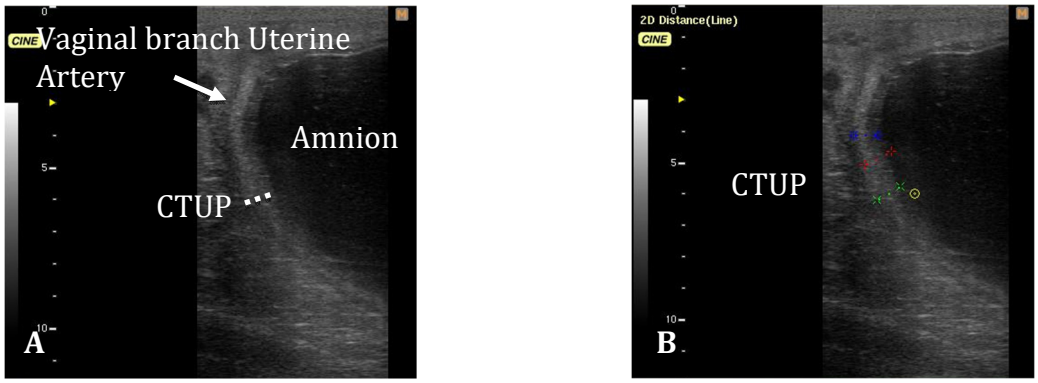

Figure 1: A. Transrectal image of the uterus and placenta. B. The combined thickness of the uterus and placenta (CTUP) is shown by the connected markers.

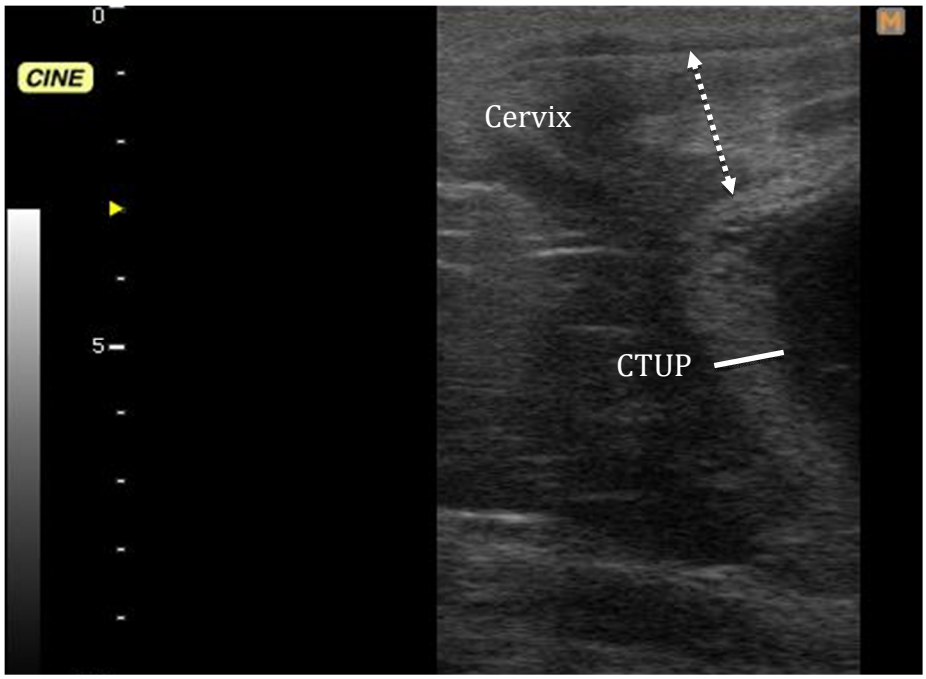

Figure 2: Transrectal ultrasonographic image of the pericervical area including the cervix (dashed arrow) and uteroplacental tissue (solid line) in a pregnant mare.

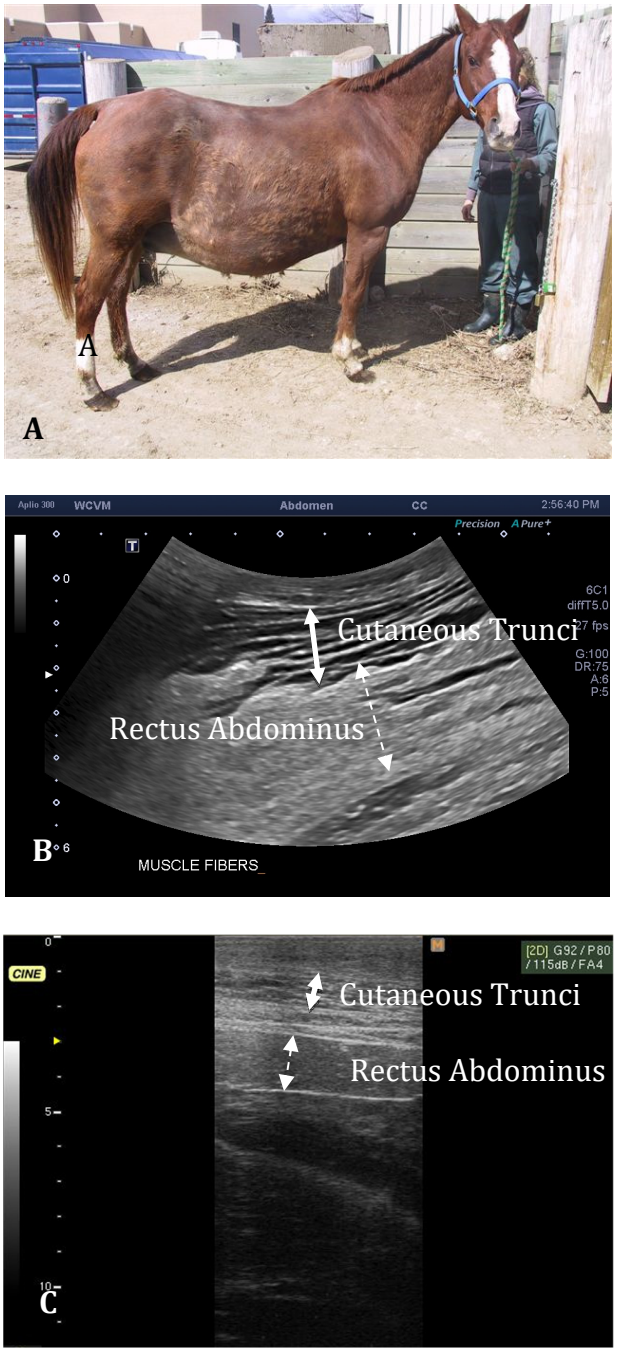

Figure 3: A. Mare in late pregnancy with a ruptured prepubic tendon. B. Transabdominal image of the abdominal muscles showing excess edema in the cutaneous trunci (solid arrow), disorganized muscle fibers and hemorrhage of the rectus abdominus (dashed line arrows). C. Transabdominal image of the abdominal muscles of a periparturient mare showing mild edema of the cutaneous trunci (solid arrow), and intact rectus abdominus (dashed line arrows).

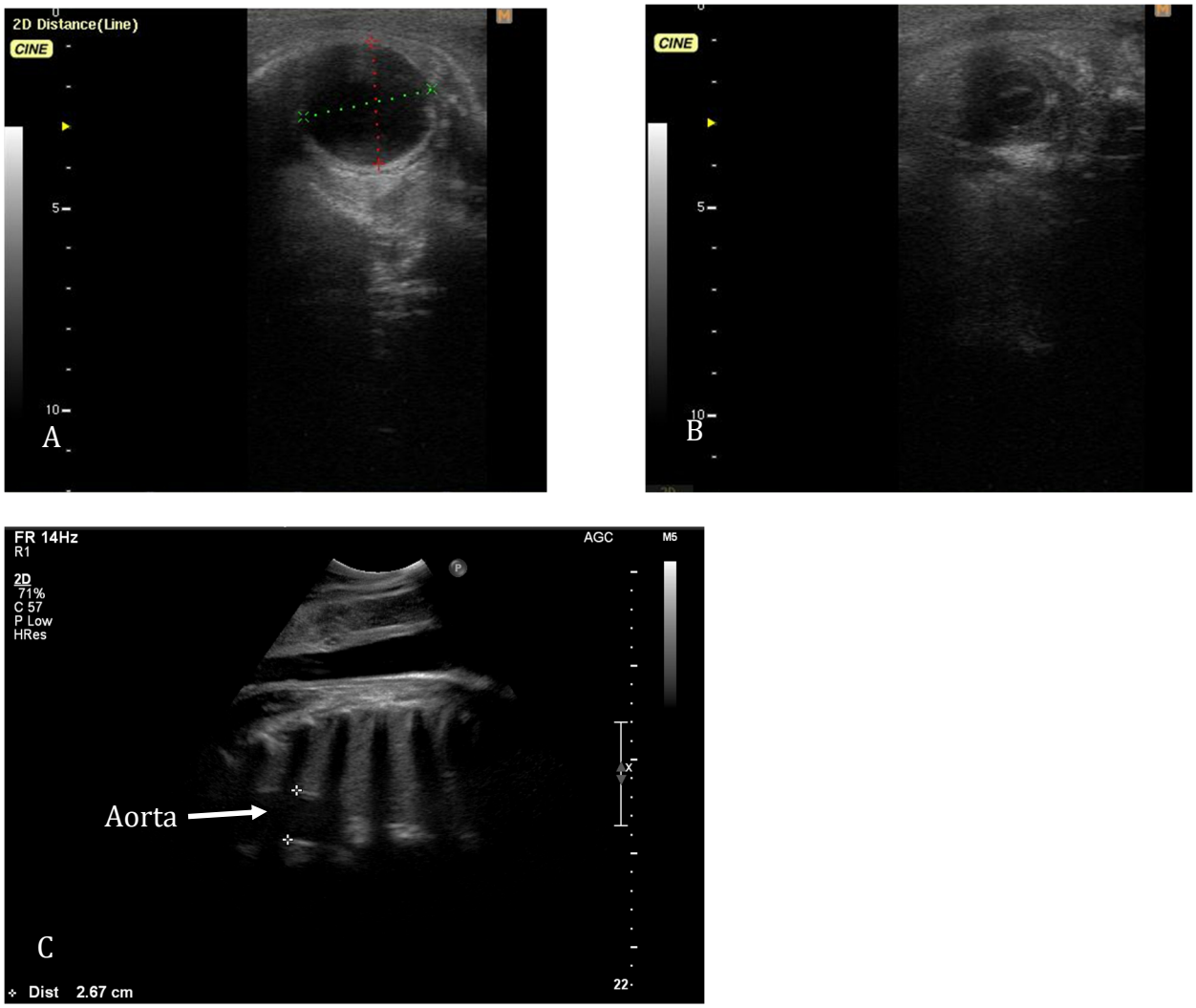

Figure 4: Transrectal ultrasonographic image of the A. fetal orbit, B fetal lens, and C. transabdominal image of the fetal thorax and aorta.

(Editor's Note: Photographs in this manuscript are available in color in the online edition of Clinical Theriogenology.)

Table: Medications administered to High Risk Mares with placentitis

Antimicrobials
Trimethoprim sulpha 30 mg/kg BID PO
Gentamicin 6.6 mg/kg SID IV or IM
Potassium penicillin G 22,000 IU / kg IV QID
Procaine Penicillin G 22,000 IU/kg BID

Anti-inflammatories
Pentoxyfylline 8.5 mg/kg PO BID
Flunixin meglumine 1.1 mg/kg BID IV
Phenylbutazone 4 mg/kg BID PO
Meclofenamic acid 2.2 mg/kg SID PO

Tocolytics
Clenbuterol 0.6 μg/kg IV drip then TID PO
Progesterone 0.6 mg mg/SID IM

Hormones
Estradiol cypionate 10 mg IM / mare / every 3 days
Altrenogest 0.088 mg/kg SID PO (double dose)