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How to Determine Fetal Gender in Early and Advanced Gestation

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1. Introduction
A wealth of information on equine fetal anatomy and physiology has been acquired in recent years. Ultrasonographic fetal monitoring techniques have documented, in great detail, fetal growth and organ development at various stages of gestation. Ultrasonographic anatomy of fetal sex organs, from the genital tubercle to fully developed organs, has been extensively described in its entire progression. Fetal gender determination in the mare provides a useful management tool to breeders by allowing a predelivery estimation of the value of offspring. Knowing fetal gender in advance of delivery allows for commercial strategies to be implemented, as the value of stock at sales time is often determined by the gender of the offspring. Furthermore, it is well established that some stallions have a greater proportion of quality female versus male offspring or just the opposite. Finally, culling of broodmares is easier when fetal gender is known.

2. Diagnostic Windows for Fetal Gender Determination
First Stage Diagnosis: Early Gestation
There are two different stages when the diagnosis of fetal sex can be determined by ultrasonography. The first stage is between 57 and 70 days gestation and involves the identification of the genital tubercle (Fig. 1) by transrectal ultrasonography. The genital tubercle, the precursor of the penis in the male and the clitoris in the female, appears around day 55 of gestation as a hyperechoic equal sign (=), located between the fetal hindlimbs, at an approximately equal distance between the tail and the umbilicus. As gestation progresses, the genital tubercle migrates towards the tail in the female fetus (Fig. 2) and towards the umbilical cord in the male (Fig. 3). The shape of the genital tubercle may change over time, appearing trilobed (Fig. 4) or conical (Fig. 3).

The early stage technique requires good equipment and considerable expertise, allowing consistent fetal sex determination within a small diagnostic window (optimal time days 59–68) and by a single diagnostic parameter. Best imaging will be accomplished when the fetus engages high up into a uterine horn (Fig. 5) and the fetus to transducer distance is greatly reduced. After day 70, the fetus tends to reside more deeply in the mare’s uterus/abdomen and is not consistently accessible for imaging by transrectal ultrasonography due to the disproportionate increase in fetal fluid volume compared to fetal body mass, typical of this stage of gestation. After day 100, the fetus can be reliably found within the mare’s pelvis.
Second Stage Diagnosis: Advanced Gestation
The second stage for fetal sex diagnosis avails of a much wider diagnostic window between 100 and 260 days gestation. Multiple parameters can be used to validate diagnosis (fetal primary sex organs) at this stage, but a combination of transrectal and transabdominal ultrasound scanning may be required.

Fetal presentation plays a substantial role in the diagnostic approach in advanced gestation. Establishing fetal orientation should be readily accomplished in the course of the examination, knowing that in the fetus in posterior presentation the hindquarters will be easily accessible per rectum and expedite transrectal diagnosis. The active nature of the equine fetus determines frequent changes in presentation up to 9 months gestation, making transrectal examination potentially diagnostic even in advanced pregnancy. The ability to change presentation decreases as gestation advances, as fetal size and the encasement of the hindquarters within the fetal horn prevent further rotations along the short axis. After 9 months, fetal sex can still be determined transrectally in grossly undersized fetuses and when a posterior or transverse presentation persists. A transabdominal approach will be required for diagnosis when the fetal hindquarters are out of reach of the operator’s hand per rectum, as it commonly occurs from around 5 months gestation and when the fetus is in anterior presentation (Fig. 6).

Fig. 1. Transrectal, cross-sectional oblique view of a 60 day-old male fetus (8 MHz linear transducer). The genital tubercle (GT) is seen emerging between the hind limbs and caudal to the umbilical cord.

Fig. 2. Cross sectional oblique view of a 60 day-old female fetus, by US per rectum (8 MHz linear transducer). The GT is seen emerging from the buttocks.

Fig. 3. Frontal plane view of a 70 day-old male fetus by US per rectum (7.5 MHz linear transducer); the GT presents with a conical shape. The chest and scapula are identified cranially (to the right of the sonogram), and the outline of the diaphragm can be barely detected between chest and abdomen.

Fig. 4. Cross sectional view of a 62 day-old male fetus with a trilobed GT, US per rectum (7.5 MHz linear transducer).
Finally, fetal gender determination in advanced gestation can be carried out during summer, fall, or early winter, at a more convenient time of the year for the busy equine reproduction clinician.

3. Equipment
B-mode, real-time portable scanners, equipped with 5 to 7.5 MHz linear-array transducers are commonly employed for assessment per rectum. Linear, sector, or convex 3.5 to 6 MHz transducers can be used transabdominally up to day 260, depending on the size of mare and fetus, the thickness of the mare’s ventral abdomen, and the stage of gestation. Occasionally, a 2.5 MHz transducer may be required for adequate visualization of the relevant fetal structures. Doppler technology offers a valuable additional tool in the evaluation of the fetal gonad, both in transrectal and transabdominal scans.8

4. Techniques
Transrectal sonographic viewing of the equine fetus requires standard rectal palpation skills as per routine ultrasound (US) examination of the mare’s reproductive tract. Thorough cleansing of the mare’s abdomen is necessary for diagnostic percutaneous US evaluation. Mares are best examined in stocks and although not usually required, sedation of the mare in advanced gestation reduces fetal activity and lowers the fetus towards the ventral abdomen, enhancing transabdominal imaging. Sedation is contraindicated when a trans-rectal approach is adopted. Clipping, shaving, alcohol, and/or coupling gel application can optimize percutaneous imaging. During the summer months, excellent imaging can be obtained by simply sponging alcohol over the unclipped hair of the ventral abdomen.

Fig. 5. Detailed sonographic image of a 75 day-old fetus engaged within the uterine horn, in close proximity to the transducer (linear 8 MHz).

Fig. 7. Transabdominal scan of the abdominal content of a 7 month-old fetus (4 MHz convex transducer).

Fig. 6. Incidence of fetal presentation throughout gestation; on x-axis month of gestation, and on y-axis percentage of observed fetal presentation.7

Fig. 8. Transrectal view of a 108 day-old female fetus in posterior presentation: right of the sonogram mare’s caudal (8 MHz linear transducer).
Orientation of the sonogram should be initially established in order to identify the scanning direction on the screen of the ultrasound unit. The transducer is then advanced along the sagittal plane within the rectum or over the ventral abdominal wall until fetal parts are recognized. The fetal heart and chest will be located first, as they are easily identified; cranial and caudal orientation of the fetus will be determined next. Fetal head and neck indicate cranial while the bean-shaped, echolucent stomach silhouette is used as a landmark for caudal orientation (Fig. 7). Dorsal and ventral orientation is established by identifying the spinal cord and, opposite to that, the umbilicus. Fetal presentation and position will subsequently be defined. As the equine fetus tends to be a rather dynamic entity, temporary obstruction of the view will intermittently occur due to superimposing umbilical cord loops or fetal bony structures (mostly pelvic limbs) casting acoustic shadows over the areas of interest. Quite often, during early stage diagnosis, the fetus will just disappear from the acoustic field. Considerable time and patience are required during the learning process curve, but an experienced operator will accomplish diagnosis in a short frame of time, ranging between 30 s and 5 min.

Gender determination is made by scanning of the caudal fetal abdomen, hindquarters, and buttocks to identify the position of the genital tubercle or the anatomical structure of primary sex organs. Frontal, cross-sectional and oblique scanning planes may all be required to obtain adequate visualization of...
diagnostic parameters, particularly during early fetal gender determination.

5. Diagnostic Parameters in Advanced Gestation

Fetal gonads are easily identified within the caudal abdomen as two symmetrical oval structures, ventral to the kidneys, with an oblique orientation of their long axis, converging caudally towards the pelvic inlet (Fig. 8). The caudal poles of the gonads are adjacent to the bladder and in close contact with the abdominal tract of the umbilical arteries (Figs. 9 and 10). The fetal gonads represent an excellent landmark within the caudal abdomen and show a distinctive echotexture that differs from male to female, adding great diagnostic value when assessed during the course of a fetal sexing examination. A marked diversity in echotexture can be appreciated in the female gonad between cortex and medulla (Fig. 11), with intense color Doppler signal over the outer band of tissue (Fig. 12), demonstrating high vascularization of the peripheral area. An additional area of intense color Doppler signal can be visualized on the outer lateral portion of the female gonad, corresponding to the ovarian pedicle (Fig. 13). Male gonads appear uniformly echodense, with a small outer dotted area (Fig. 14) and a hyperechoic longitudinal, central line (mediastinum) (Fig. 15). Intense color Doppler signal is detected in these two areas, as they correspond re-
spectively to the pampiniform plexus and the testicular vein (Fig. 16). The pampiniform plexus appears larger than the ovarian pedicle and displays a more intense color Doppler signal.

The fetal primary sex organs may be clearly identified on ultrasound as early as 100 days gestation. In the male fetus, a fully comprehensive gender diagnosis will include the identification of penis and prepuce (Figs. 17–19), scrotum/testicular compartments (Figs. 20 and 21), urethra (Fig. 22), and gonads. The penis is visualized in the ventro-caudal abdomen, just behind the umbilicus. Sometimes the umbilical cord’s strong pulsatile activity causes a passive bouncing motion to the penile shaft that is resting over the umbilical arteries (Fig. 23). The penis may be partially or completely encased within the prepuce but can often appear fully extended and occasionally erect. In the erect penis, the urethra is visualized in cross section as a distinct circular hyperechoic structure (Fig. 24). The urethra can be easily visualized along the ventral shaft of the flaccid or erect penis as a double hyperechoic line. Longitudinal and cross-sectional images of the urethra can be obtained over the male perineum. The fetal scrotum displays a composite echodensity, as the scrotal compartments appear as two symmetrical, oval, less echodense areas (Fig. 20). The hypoechoic appearance of each scrotal compartment relates to the presence of the adjacent gubernaculum testis. The male fetal gonads appear uniformly echodense with a hyperechoic central line.
correspondent to the testicular vein, as described above.

In the female fetus, the primary sex organs to be visualized to reach diagnosis include mammary gland, nipples, vulva/clitoris, and gonads. The fetal mammary gland can be visualized in the pubic region and appears triangular (Figs. 25 and 26) or trapezoidal (Fig. 27) in shape and uniformly echodense. The nipples emerge from the ventral border of the mammary gland as relatively large hyper-echodense areas (Fig. 28). No relevant structures can be visualized over the ventral perineum (Fig. 26), as opposed to the male fetus, where the urethra runs the entire length up to the anus (Fig. 22). The fetal clitoris is a hyperechoic structure that bulges out of the buttocks (Fig. 29).

It is positioned high up in the perineum but should not be confused with the anus, adjacent to the tailhead. The vulvar commissure can be seen coursing between the anus and the clitoris in a cross-oblique section of the fetal buttocks (Fig. 30).

6. Diagnosis

Diagnosis by a single exam per rectum is rapidly attained when the fetus is in posterior presentation, even up to 8 months gestation. The rate of positive diagnosis per rectum reaches 100% between 110 and 130 days gestation, with an estimated time of less than 150 s.9 In transverse presentation, gender determination per rectum is easily accomplished.
when the fetus assumes a ventrocaudal position within the mare's pelvis. In anterior presentation, the fetal hindquarters can be visualized transrectally up to 5 months gestation according to fetal size and location within the uterus. Rotation of the fetus over the long and short axis is commonly observed up to 8 months of pregnancy, and frequent changes of presentation occur around 5 to 6 months. At this time, repeating the exam 5 to 10 min later may find the fetus in a more advantageous position for diagnosis. A transabdominal approach is usually necessary for gender determination over 5 months of gestation, when the fetus lies in anterior presentation.

Good knowledge of fetal anatomy and rapid identification of fetal parts are essential for ease of diagnosis. Diagnosis in advanced gestation should be based on at least three identified parameters. The time required to conduct a diagnostic examination is 1 to 5 min for the experienced examiner. Variability depends on the difficulty encountered in visualizing the area of diagnostic interest, and a very active fetus generally makes a poor candidate for a rapid diagnosis. Video recording of scans provides opportunities for further studies and detailed evaluations.

Finally, proper identification of the mare at the time of examination and the provision of a signed certificate of fetal gender diagnosis should be an integral part of the service offered.
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Conflict of Interest

The Author declares no conflicts of interest.

References

How to Assess the Equine Pregnancy by Ultrasonography

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1. 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 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\textsuperscript{11,13,15,16} (Fig. 1), aortic diameter\textsuperscript{11,13} (Fig. 2), bi-parietal diameter (Fig. 3), and to a lesser extent fetal chest and femur length\textsuperscript{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 anatomic 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 months 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.\textsuperscript{1}

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 successful 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. Rhythmical breathing movements may be observed in all fetuses in advanced gestation (from 7 months), 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 or a large range of FHRs may indicate fetal distress but could be brought on by painful maternal systemic problems or excitement. Sustained bradycardia, 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 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.

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

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

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

Fig. 7. Transabdominal scan of a 7 month-old fetus, displaying the anatomical features of the ventrocaudal abdomen.
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 month rotation along the short axis is restricted by fetal body size and the encasing of the fetal hindlimbs within the gravid uterine horn. Detection of an abnormal presentation after 9 months 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 and amniotic fluid depth values are reported in the literature. 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 hippocrane is de-

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

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

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

Fig. 11. Transabdominal sonogram of a 6 month-old fetus, showing measurement of fetal fluid depths.
fined as an allantoic calculus and can often be 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). Markedly reduced volumes of amniotic fluid (oligohydroallantois) may be observed in mares suffering from severe systemic illness. An association of the condition with a poor fetal outcome has been reported. Objective assessment of fetal fluid depth requires extensive scanning of the mare’s abdomen and is best carried out during phases of fetal quiescence.

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 (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).
Cervical Parameters
Recent data on cervical size and echotexture in the pregnant mare suggest a high degree of cervical tone maintained up to 9 months 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).

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 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.

Acknowledgments

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The Author declares no conflicts of interest.

References


How to Perform Hysteroscopy in the Mare

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1. Introduction

Hysteroscopy is not a common procedure in broodmare practice. A thorough breeding soundness examination that includes transrectal palpation and ultrasonography, endometrial cytology, endometrial biopsy, endometrial culture, and vaginal/cervical speculum examination will detect many reproductive maladies frequently encountered in the mare. However, in some circumstances, these more commonly employed techniques are insufficient to clearly identify or ameliorate the problem, and hysteroscopy has been used to achieve this end. In an early study, 17 of 40 mares admitted to a veterinary teaching hospital with a history of infertility had reproductive tracts that were considered normal on palpation, yet hysteroscopy revealed abnormalities in 26 of these 40 mares.1 Since that time, abnormalities observed through the use of transrectal ultrasonography have either obviated the need for or alternatively prompted the use of hysteroscopy to render a more definitive diagnosis or treatment.

The use of hysteroscopy in the mare was described as early as the 1960s.2 Subsequently, many authors have published articles on the use of hysteroscopy in the mare for a variety of purposes.1,3–9 While the term hysteroscopy will be used throughout this manuscript, it is also called uteroscopy and has been referred to as examination of the uterus via fibroscopy, endoscopy, and videoendoscopy in other publications.

2. The Equipment

A flexible videoendoscope, 100 cm in length and 1 to 1.4 cm in diameter, is commonly used for hysteroscopy. The unit should have sufficient light intensity and image quality to optimize visualization of the uterine lumen. Most modern units are equipped with a video monitor, which enhances the examination. The use of recording equipment to capture still and video images is highly recommended to enable review of the procedure and to provide a record of the examination. Ideally, the insertion tube should have a working channel that accommodates ancillary equipment such as catheters, grasping forceps, biopsy forceps, electrocautery loops, and laser fibers.

Since endoscopy equipment is used for examination of a variety of body cavities, it is important that it be thoroughly cleaned and sterilized according to the manufacturer’s instructions between uses. Particular attention should be paid to areas where moisture may accumulate, as these sites provide an environment that facilitates the growth of Pseudomonas aeruginosa. Persistent endometritis with Pseudomonas as well as growth of other organisms has been reported following hysteroscopic proce-
HOW-TO SESSION: REPRODUCTION—IMAGING

3. Preparation of the Mare
The mare should be placed in stocks with the tail wrapped and deviated away from the perineal area. Feces should be evacuated from the rectum and the perineum of the mare should be cleansed in an aseptic manner. Sedation and analgesia should be administered. Most practitioners have a favorite sedation protocol, and the following is the author’s preferred method. Depending on the size and temperament of the mare, she is administered detomidine HCL (0.006–0.01 mg/kg, IV), and a catheter is placed in the jugular vein. Depending on the anticipated length of the procedure, 5 or 10 mg of detomidine HCL is added to a 500 or 1000 mL bag of saline, respectively, which is then connected to the catheter in a routine manner. The detomidine/saline mixture is then administered by slow drip until the desired level of sedation is achieved. If necessary, more can be administered during the procedure as needed. The author prefers this method because it maintains a more even level of sedation and avoids the wide fluctuations in sedation that can occur over time with repeated larger boluses of sedative. After the mare is sedated and just prior to the start of the procedure, butorphanol tartrate (0.01–0.02 mg/kg) is administered intravenously thought the catheter.

4. Basic Procedure
Under ideal circumstances, at least three people should be present to perform the hysteroscopic procedure; one person remains at the head of the mare for restraint as well as monitoring and administering sedation, one person inserts and maintains the position of the insertion tube through the cervix, and one person operates the steering controls of the insertion tube and directs the overall procedure.

After the insertion tube has been rinsed thoroughly, the image should be “white balanced” to optimize visualization. It is easy to become disoriented once the insertion tube enters the uterus, especially if rotation of the tube has occurred. Therefore it is helpful, prior to inserting the instrument into the mare, for the operator to select a point of reference and become familiar with the directional controls of the steering tube.

A small amount of sterile lubricant is applied to the end of the insertion tube, avoiding contact with the lens, and the assistant wearing a sterile glove and sleeve carries the insertion tube through the vulva and vestibule into the vagina so that the cervix can be visualized (Fig. 1). The cervix is then penetrated and slightly dilated with the index finger, and the insertion tube is passed through the cervix into the uterus. Once inside the uterus, the lumen needs to be distended to allow visualization. While the hysteroscopic procedure can be performed at any time in the mare’s cycle, diestrus is preferable because, at that time, the cervix is of sufficient length to be grasped around the insertion tube and maintain uterine distention. Administering progesterone to estrous or anestrous mares for 5 to 7 days prior to the procedure can also accomplish this. In peri-ovulatory mares, the cervix may be sufficiently relaxed that the entire hand carrying the insertion tube can be placed though the cervix into the uterine body and then the hand pulled back against the internal cervical os to act as a plug to maintain distention.

Distention of the uterine lumen can be accomplished by insufflation with filtered air administered via the endoscopic equipment or by a sterile, isotonic fluid such as saline or lactated Ringer’s solution (LRS). Note that insufflation with air can cause endometrial hyperemia, which should not be misinterpreted as inflammation. The method of distention depends on clinician preference and the purpose of the procedure. Regardless of which method is chosen, over distention of the uterus should be avoided so as not to cause significant discomfort to the patient or damage to the uterus. One study determined that a hysteroscopy can be performed safely and efficiently within a pressure range of 12.8 to 28.6 mm Hg and that clinical or cardiac signs of discomfort or effects on the circulatory system were only registered after pressures significantly exceeded 100 mm Hg. Precise monitoring of intraluminal pressures is not practical in most clinical environments, so it is recommended to use only the amount of distention necessary to optimize visualization and to continuously monitor the mare for signs of discomfort.

Insufflation allows visualization of normal structures as well as the relative amount and location of
foreign materials such as purulent exudate or blood, etc. Samples of exudate, foreign material, or other abnormalities can be obtained via instruments introduced through the working channel. However, when using insufflation, the lens of the insertion tube may require repeated rinsing to remove mucus or other debris during the procedure. Distention with fluid tends to keep the insertion tube lens free of direct contaminants, but visualization can be compromised if significant amounts of exudate, blood, or other materials become suspended in the distention fluid. If this occurs, drainage or aspiration of the cloudy fluid followed by redistention is recommended prior to proceeding with the procedure. Fluid distention of the uterine lumen can be accomplished using the fluid reservoir or the working channel of the endoscope, but this can take an inordinate amount of time. The author prefers to attach a stallion catheter to the insertion tube with waterproof tape so that the two can be passed through the cervix simultaneously and maintained in proximity. The distal end of a typical IV extension set is then inserted into the belled end of the stallion catheter, and this system is connected to a 5 L bag of LRS or other sterile, isotonic fluid. If drainage of the distention fluid becomes necessary, the extension set can be disconnected and the fluid allowed to escape via gravity flow, or a suction device can be attached to the stallion catheter to facilitate drainage.

Once the uterine lumen is sufficiently dilated, the uterine body and bifurcation of the uterine horns should be visualized (Fig. 2). The insertion tube is directed toward the uterine horn of choice and slowly advanced proximally through the entire length of the horn until the uterotubal papilla at the uterotubal junction (UTJ) is observed. This structure can vary somewhat in appearance being relatively flat and somewhat difficult to visualize in some mares to very prominent in others (Fig. 3). The instrument is then slowly withdrawn to the level of the bifurcation and then the opposite uterine horn is similarly examined. The character and color of the endometrium is observed throughout the examination; it should be relatively uniform in its entirety. The color is typically a pale pink, but the extent of endometrial folds observed can vary with the degree of luminal distention. If the examination is performed during estrus, the surface of the endometrium will typically glisten with mucus, and the endometrial folds will be visibly edematous (Fig. 4). Any abnormalities such as discoloration, ulceration, plaque-like lesions, biofilm, cystic structures, luminal protuberances, adhesions, foreign bodies, or accumulations of blood or exudate should be digitally recorded and sampled as necessary. When the examination is completed and the insertion tube is being removed, the majority of air or fluid used for luminal distention should be removed either passively or by gentle suction. If the fluid distention

Fig. 2. Bifurcation of the uterine horns viewed after insufflation.

Fig. 3. Uterotubal papilla at the uterotubal junction.

Fig. 4. Endometrial folds of the uterus prior to optimal distension.
technique was employed, fluid remaining in the bag can then be used to further lavage the uterus.

5. Common Applications
The most common use of hysteroscopy in our practice is for laser ablation of endometrial lymphatic cysts using an Nd:YAG or diode laser. Various methods of cyst ablation using hysteroscopy have been previously described in more detail and improvements in pregnancy rates have been reported following these procedures. The cysts are first identified using transrectal ultrasonography, and their size and location are recorded in the mare's record. The mare is prepared as described above, and the entire uterus is examined noting the location of any visible cysts prior to initiating cyst ablation. Either air insufflation or fluid distention can be used. The author prefers to use fluid when possible because, in addition to keeping the lens clean, no smoke is produced while ablating the cyst in the fluid environment as can occur with insufflation, which results in temporary obscurement of the visual field. Another advantage of fluid distention is the beneficial effect of concurrent uterine lavage. Laser ablation can also be used for removal of small transluminal adhesions (Fig. 5). Note, however, that when fluid is used for luminal distention, more wattage will be necessary to achieve the same degree of cauterization as would occur if air insufflation were used.

Hysteroscopy has also been used for direct examination of the endometrium when suspicious, nondefinitive findings are observed via transrectal ultrasonography. Examples include foreign bodies appearing as hyperechoic structures, differentiating of large multiloculated structures as cysts or transluminal adhesions (Figs. 6–8), or suspected uterine tumors. Retrieval of foreign bodies and endometrial biopsy procurement via hysteroscopy has recently been described. Attempts to suppress estrus with marbles has been attempted by

Fig. 5. Laser fiber approaching a thin transluminal adhesion prior to photoablation.

Fig. 6. Ultrasonographic image of the uterus of a mare with large multilocular fluid filled structures.

Fig. 7. Multiple transluminal adhesions viewed by hysteroscopy after multilocular fluid filled structures were detected via transrectal ultrasound.

Fig. 8. Purulent fluid being released during laser photoablation of a large transluminal adhesion.
a number of practitioners, sometimes with disastrous results, when multicolored marbles are used and they disintegrate within the uterine lumen causing significant damage. Although large fragments could be retrieved via hysteroscopy, the disintegration often results in numerous minute glass fragments that become embedded in the endometrium and are virtually impossible to remove. While biopsies can be obtained via flexible instruments passed through the working channel, samples obtained are typically small and shallow whereas using a standard biopsy instrument passed along the side of the insertion tube will provide superior samples.28

Two manuscripts describing direct hysteroscopic insemination of the UTJ with low numbers of sperm were presented at the AAEP meeting in 1998.22,23 However, achieving direct cannulation of the UTJ is too difficult for routine use and, subsequently, deposition of semen on or near the UTJ was shown to be an effective method of low dose, deep horn insemination.24 Comprehensive summaries of hysteroscopic insemination studies have been published.25–27 While hysteroscopy insemination allows direct visualization of the UTJ, semen deposition at the tip of the uterine horn using a manual, transrectally guided technique has been shown to be equally effective and is more economical and efficient for most practitioners.28

Recently, Inoue described direct cannulation of the UTJ and deposition of dye into the oviduct as a method of determining tubal patency.29 He proposed that the difficulty others have experienced in cannulating the UTJ was a result of over insufflation of the uterus, which makes it difficult to center the UTJ in the center of the endoscopic image. Therefore, it was recommended that the endoscope be passed up the uterine horn to the level of the UTJ with minimal insufflation of the uterus.

References and Footnotes


How to Perform an Examination of the Internal Reproductive Tract of the Stallion

Regina M. Turner, VMD, PhD, DACT

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1. Introduction
Palpation and ultrasonographic examination of the internal genital tract of the stallion can be included as part of the routine breeding soundness examination. Kenney et al. described palpation of the internal inguinal rings and accessory sex glands per rectum as a routine part of the breeding soundness examination.1 Examination of the terminal aorta/proximal iliac arteries is a simple addition to this transrectal examination and can provide valuable additional information on the reproductive soundness of a stallion. In stallions with reproductive abnormalities such as azoospermia, oligospermia, pyospermia, hemospermia, suspected cryptorchidism, weakness of the hindlimbs during mounting, enlargement of the scrotum, and even hematuria, examination of the internal inguinal rings, accessory sex glands, and terminal aorta/proximal iliac arteries can be a critical part of a complete examination that allows the clinician to determine a definitive cause for the pathology.

2. Methods and Results

Anatomy
The internal inguinal rings are located at approximately 5 and 7 o’clock on the ventral floor of the caudal abdomen, approximately 10 cm cranial to the pelvic floor. Although referred to as ‘rings,’ these structures are more like ‘slits’ that are delineated cranially by the fibers of the internal abdominal oblique muscle and caudally by the inguinal ligament. In the normal stallion, the only structure that should descend from the abdomen through this slit is the spermatic cord. Transrectally, the spermatic cord can be palpated as a thin string with a palpable pulse originating from the testicular artery. The spermatic cords extend from the cranial end of each ampulla towards the ipsilateral inguinal ring.

The paired ampullae are the most cranial of the accessory sex glands. The ampullae are glandular thickenings of the ducti deferentia and consist of numerous branching crypts in which sperm can be stored prior to ejaculation. Immediately caudal and lateral to the ampullae are the paired seminal vesicles. The seminal vesicles extend outward from the midline at an approximate 40° angle to the urethra. When empty, the seminal vesicles become flattened and when distended with fluid they become roughly oval.2 The ampullae and seminal vesicles narrow caudally and extend under the isthmus of the prostate to open through a common excurrent duct into the urethra at the seminal colliculus. The isthmus of the prostate is located on the ventral
midline caudal to the bulk of the seminal vesicles and dorsal to the trigone region of the bladder. The right and left lobes of the prostate are roughly wing-shaped and extend laterally from the isthmus. The prostate gland empties into the dorsal urethra through numerous prostatic ducts. The paired bulbourethral glands are roughly spherical and are located on either side of the urethra just cranial to the anal sphincter at the ischial arch. The function of the accessory sex glands is to add fluid volume, enzymes, amino acids, and buffers to the ejaculate.3,4

The caudal aorta terminates just under the sacrum along the dorsal midline. It is readily palpable due to its large size and strong pulse. The proximal internal and external iliac arteries are also readily palpable as they branch from the terminal aorta.

Examination Technique

Examination of the internal reproductive tract of the stallion is performed per rectum. Stallions can be restrained and prepared for this examination similarly to mares. Stocks are preferable, since most stallions are not accustomed to this procedure. However, tractable animals can also be safely examined without stocks, using the same routine safety precautions that one would use with a mare (e.g., examination around a stall door). Sedation is usually not needed, but can be used for nervous or difficult animals. Internal structures should be identified by palpation (when possible) prior to ultrasonographic examination.

Once palpation is completed, ultrasonography can be performed. Due to the superficial location of the accessory glands, a 7.5 MHz or higher frequency linear array transducer is preferred. If a 7.5 MHz transducer is not available, a 5 MHz transducer can be used, although some detail will be lost. The transducer is held, introduced, and advanced in the rectum as it is for ultrasonography of the mare. If a linear array transducer is not available, a microconvex transducer or a sector scanner with an off-line beam may suffice. The larger size of the sector scanner can make examination per rectum difficult and may preclude transrectal ultrasonographic examination in ponies or miniature horse stallions.

Internal Inguinal Rings

The internal inguinal rings can be palpated by sweeping one’s hand along the caudoventral abdominal floor just cranial to the pelvic until the ‘slit’ of each internal ring is encountered. The ring can more readily be identified as described by Kenney et al, “...by folding one’s fingers against the palm of the hand and then unfolding the fingers while pushing the finger tips against the abdominal wall.” In a normal animal, it should be possible to follow the entire caudoventral body wall in an uninterrupted fashion from left to right and across the midline. If the veterinarian is unfamiliar with the normal feel of the inguinal rings, tractable stallions may allow palpation of the internal inguinal ring with a hand inserted in the rectum while simultaneously following the spermatic cord up to the external inguinal ring with the contralateral hand by reaching forward and upward around the stallion’s hindlimb. For example, to identify the right inguinal ring and canal, insert the left hand into the rectum while reaching forward with the right hand around the stallion’s right hindlimb. Identify the spermatic cord and follow it dorsally. By attempting to touch the fingers of your left hand to the fingers of your right hand through the body wall, you will familiar-

<table>
<thead>
<tr>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquired inguinal/scrotal hernia</td>
<td>- Enlarged scrotum</td>
<td>- Enlarged scrotum</td>
<td>- Bowel loops descending through affected ring</td>
<td>- Absence of blood flow in cord distal to torsion (Doppler ultrasonography)</td>
</tr>
<tr>
<td></td>
<td>- Colic</td>
<td>- Distended small intestine</td>
<td>- Transcutaneous ultrasonographic examination of scrotal contents is typically performed</td>
<td>- Ultrasound examination typically performed</td>
</tr>
</tbody>
</table>
ize yourself with the location and feel of the right inguinal ring and canal. After identifying the internal inguinal rings, each spermatic cord can be palpated as it enters the internal inguinal ring and then the cord can be traced caudally to the ipsilateral ampulla (Table 1).

Ampullae

The ampullae palpate as paired soft tissue tubular structures running on top of the pelvic floor and converging at their caudal ends towards the midline. The ampullae can be imaged ultrasonographically in sagittal sections with the linear array transducer placed directly over and parallel to the long axis of each gland (Figs. 1 and 2). With the transducer in this position, the ampullae are imaged as soft tissue bands that extend from left to right across the upper edge of the ultrasound screen (Fig. 3). The lumen of each ampulla may be visible as a black (fluid) or white (no fluid present) line through the approximate center of the gland. In normal stallions, the lumen and total diameter of the ampulla will increase after sexual stimulation and decrease following ejaculation. The mean total diameter of the ampullae in light horse stallions is 11 mm with a range of 4 to 18 mm.

The ampullae can also be visualized in short axis cross section by turning the linear array transducer at a 90° angle to the long axis of the glands (Fig. 1). This view can be difficult or impossible to obtain with larger transducers or in smaller stallions as the pelvic diameter may limit proper positioning of the probe. In short-axis cross section, both ampullae appear as circular soft tissue structures that can be followed caudally as they converge upon the midline (Fig. 4). Higher frequency transducers will provide sufficient image quality to image the seminal colliculus. The pelvic urethra becomes visible in short axis cross section ventral and medial to the ampullae as the glands are followed caudally and approach the midline.

When a higher resolution transducer is employed, it may also be possible to image the uterus masculinus in some animals. This structure is a remnant of the embryologic paramesonephric (Mullerian) ducts and, when present, is found medial to the ampullae just cranial to the prostatic isthmus. The size of the uterus masculinus varies, but it typically appears as a thin-walled oblong structure filled with anechoic fluid. It is common to find this embryologic remnant in stallions and it is not typically associated with clinical pathology (Table 2).
Seminal Vesicles

The seminal vesicles may be palpable just lateral to the caudal half of the ampullae, but only if they are well-distended with fluid. When empty, the seminal vesicles typically are difficult to palpate. To image the seminal vesicles ultrasonographically in sagittal sections, the transducer is moved slightly laterally and caudally with respect to each ampulla and positioned so that the long axis of the transducer parallels the long axis of each seminal vesicle (Fig. 5). By rotating the transducer 90°, the seminal vesicles can also be imaged in short axis cross section dorsal and slightly lateral to the ampullae (Fig. 4). When the glands are empty, they can be difficult to identify. The empty seminal vesicles appear as elongated, flattened, and somewhat irregular soft tissue structures. Varying amounts of fluid may be present within the glandular lumen. The ultrasonographic character of the fluid in normal glands varies from anechoic to that of mixed echogenicity, sometimes with echogenic flecks throughout. With sexual stimulation, the amount of fluid within each gland will increase and the gland will become easier to identify and more bladder-like in shape. With prolonged sexual stimulation, the volume of intralumenal fluid can become quite large and the glands will appear more thin-walled. This fluid is usually, but not always, expressed as gel during ejaculation.5 The mean total diameter of the seminal vesicles in light horse stallions is 12 mm with a range of 4 to 20 mm (Table 3).6

Prostatic Isthmus and Prostatic Lobes

The prostatic isthmus is located on the ventral midline of the pelvis, just caudal to the bulk of the ampullae and seminal vesicles. The lobes of the prostate are aliform and extend outward to the right and left of the isthmus. The prostatic isthmus may be palpable as a ridge on the midline, caudal to the trigone of the bladder, and is imaged on the animal’s midline by moving the transducer caudally from the seminal vesicles, parallel to the long axis of the stallion’s body. The prostatic lobes are viewed by moving the transducer laterally to the left and right of the midline (Fig. 6). In the absence of sexual stimulation, the prostatic parenchyma appears gray-white and heterogeneous, containing numerous small anechoic fluid spaces. The overall size of the prostate and size and number of the fluid-filled spaces increase following sexual stimulation.5 In a highly teased animal, the appearance of the gland can be quite dramatic with large radiating anechoic fluid spokes extending throughout the parenchyma. The mean thickness of the lobe of the prostate in light horse stallions is 25 mm with a range of 10 to 40 mm. The mean isthmus thickness is 10 mm with a range of 4 to 25 mm.6

Prostatic neoplasia has rarely been reported in geldings as a cause of hematuria8 and it therefore can be helpful to familiarize oneself with the characteristics of the gelding prostate. Because the
prostate is an androgen-sensitive organ, the gelding prostate is smaller and less well-defined than that of the stallion. Unlike the distinct prostate of the stallion, in the normal gelding the prostate can be difficult to discern ultrasonographically (Table 4).9

Bulbourethral Glands

The bulbourethral glands are not palpable due to their location beneath the urethralis and bulboglandularis muscles. However, the glands can be imaged caudal to the prostate to the right and left of the ventral midline just inside the anus (Fig. 1). Because of their caudal location, to properly place the transducer over these glands, the wrist and palm of the veterinarian’s hand must be withdrawn from the rectum leaving only the fingers holding the ultrasound transducer just within the anal sphincter (Fig. 2). The bulbourethral glands are circular to oval soft tissue structures (Fig. 7). After sexual stimulation, the glands enlarge and small anechoic fluid-filled spaces may be visible within the parenchyma.5 The mean length of the bulbourethral glands in light horse stallions is 38 mm with a range of 17 to 59 mm. The mean height is 24 mm with a range of 12 to 39 mm (Table 5).6

Terminal Aorta and Iliac Arteries

By advancing your arm typically past the elbow and turning the palm dorsally, you will be able to palpate the terminal aorta on the dorsal midline and follow it caudally to the branching of the iliac arteries. The terminal aorta is visualized ultrasonographically by advancing the transducer cranially until it is positioned approximately under the sacrum. The linear array transducer is held so that the long axis of the transducer parallels the horse’s spinal column and the beam of the transducer is directly dorsally. The aorta appears as a large vessel in sagittal section. Normally, the walls of the artery are smooth and blood flows steadily and smoothly within the lumen. As the aorta is followed caudally, one can identify the internal and external iliac arteries branching at the termination of the aorta. The iliac vessels are followed dorso-laterally along the body wall until they are lost in the hindlimb musculature (Table 6).

3. Miscellaneous Abnormalities

Midline Cysts of the Seminal Colliculus

Midline cysts of the seminal colliculus have been implicated as a cause of ejaculatory dysfunction and

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</tr>
</thead>
<tbody>
<tr>
<td>Sperm accumulation</td>
<td>Poor sperm motility, Highly variable numbers of sperm, High percentage of detached heads</td>
<td>None</td>
<td>Heterogeneous, “moth eaten” appearance of the glandular tissue</td>
<td>U/S abnormalities not consistently found and not pathognomonic</td>
</tr>
<tr>
<td>Blocked ampullae</td>
<td>Oligo- or azoospermia initially. Supra physiologic sperm numbers with poor sperm motility and detached heads after relief of blockage. Low seminal plasma alkaline phosphatase if blockage is bilateral</td>
<td>Ampullae may be palpably enlarged and feel tense</td>
<td>Dilated ampullary lumen distal to blockage. Hyperechoic debris within ampullary lumen and crypts. Heterogeneous glandular parenchyma.</td>
<td>U/S abnormalities not found in all cases but can be diagnostic when present</td>
</tr>
</tbody>
</table>

Fig. 5. Normal seminal vesicle in sagittal section. This gland is moderately filled with fluid that is typically expressed during ejaculation as gel. The downward facing arrow points to the thinned dorsal wall of the gland. The upward arrow points to the fluid in the lumen of the gland. Note that the seminal vesicles can vary greatly in size and shape depending on the amount of fluid within the lumen.
variable semen quality in stallions. It has been suggested that, to be clinically significant, the cysts must be of an appropriate size and located immediately adjacent to the excurrent ducts of the ampullae and seminal vesicles, very close to the opening of the ducts at the seminal colliculus (caudal to the prostate). Ultrasonographically, these cysts are oval, teardrop-shaped, rectangular- or spindle-shaped, and contain anechoic to slightly echogenic material.

Cryptorchidism

A cryptorchid horse is one in which one or both testicles have not descended into the scrotum. Retained testicles can be accurately identified, located, and measured ultrasonographically using either a 5 or 7.5 MHz linear array transducer transrectally or a lower frequency (e.g., 3.5 MHz) sector scanner transducer transabdominally for abdominal testicles or by scanning externally over the external inguinal ring for inguinal testicles. Scanning over the external inguinal ring is easiest to accomplish using either a sector scanner or a microconvex transducer, due to their smaller footprints. If these are not available, a linear array transducer will suffice.

If a suspected cryptorchid testis is not identified near the external inguinal ring or within the inguinal canal, then transrectal examination of the caudal abdomen can be performed to determine if the testicle is within the abdomen. Transcutaneous ultrasonographic examination of the caudal abdomen can also be used to identify retained testes. Abdominal testicles can be located anywhere from the caudal pole of the kidney to within the internal

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<td>Seminal vesiculitis</td>
<td>- Hemospermia</td>
<td>· Affected gland may be enlarged, painful and fluid-filled</td>
<td>· Echogenic/ flocculent fluid in lumen, sometimes with visible fibrin tags</td>
<td>· Seminal vesicles of normal stallions can become dramatically enlarged with fluid during sexual stimulation. Don’t confuse this with pathology. When necessary, the glands also can be examined and even cannulated and treated using urethroscopy.</td>
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<tr>
<td></td>
<td>- Pyospermia</td>
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<tr>
<td></td>
<td>- Debris in ejaculate</td>
<td></td>
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<td></td>
<td>- Poor sperm motility and/or longevity of motility</td>
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<td></td>
<td>- Pain during ejaculation</td>
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<td>- Colic/Pain?</td>
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<td></td>
<td>- Subfertility</td>
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<td>- Subfertility</td>
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Fig. 6. Wing of the prostate gland. Note the aliform shape. Black arrows point to the lateral edge of the gland. This gland is moderately stimulated, as shown by the distinct anechoic fluid pockets scattered throughout the parenchyma. Highly stimulated stallions will have even more dramatic fluid accumulation.

Table 4. Abnormalities of the Prostate

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<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Prostatic masses/ neoplasia</td>
<td>- Dysuria</td>
<td>· Enlarged, asymmetric prostate gland</td>
<td>· Loss of normal architecture of prostate</td>
<td>· Rare</td>
</tr>
<tr>
<td></td>
<td>- Hematuria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Stranguria</td>
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AAEP PROCEEDINGS / Vol. 60 / 2014
Proceedings of the AAEP Annual Convention, Salt Lake City, UT, USA - December 6-10, 2014
inguinal ring (i.e., anywhere along the path that the testis should follow during its normal descent into the scrotum). However, the majority of retained testes migrate to the internal ring, but fail to enter the ring (the point of greatest resistant to the descent of the testis). Therefore, most cryptorchid testes are found immediately adjacent to the internal inguinal ring or within the inguinal canal. As a result, when searching for a retained testicle by palpation or ultrasonography, it is usually most efficient to first examine the inguinal ring and the areas immediately adjacent to it. If the testicle is not identified, then the search can be widened to include the larger area between the inguinal ring and the caudal pole of the kidney (the site of its embryonic origin). Starting at the inguinal ring, palpate and then sweep the transducer back and forth slowly, gradually advancing towards the caudal pole of the kidney.

An abdominal testis sometimes can be identified by palpation without the aid of ultrasonography. However, the small size of the retained testis, together with its softer texture, can make the tissue difficult to identify. Ultrasonographic examination often improves one’s ability to identify the presence of an abdominal testis. The parenchyma of a cryptorchid testicle is generally hypoechoic relative to that of a descended testicle, but nonetheless remains distinctive. In some cases, the spermatic cord may be identified and, in fact, the cord may be more readily identifiable than the testicular parenchyma itself. With some practice, this technique can be highly sensitive for the identification of abdominal testes.11

4. Discussion
The ability to evaluate the internal reproductive tract of the stallion is a skill that is important to any veterinarian performing breeding soundness evaluations or even semen evaluations on stallions.13 However, because pathology of the internal reproductive of the stallion is relatively uncommon, examination of these structures is something with which most veterinarians are unfamiliar. Familiarity with the normal palpable and ultrasonographic features of the structures of the caudal abdomen of the

Table 5. Abnormalities of the Bulbourethral Glands

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<thead>
<tr>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cysts</td>
<td>None</td>
<td>None</td>
<td>Anechoic, circular, well-delineated, single or multiple intraglandular cysts</td>
<td>Clinically insignificant</td>
</tr>
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Table 6. Abnormalities of the Terminal Aorta/Iliac Arteries

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<tr>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic-iliac thrombosis</td>
<td>Ejaculatory failure, Hindlimb weakness in association with exercise/exertion, Disturbances of hindlimb innervation, Hindlimb pain, Affected limb is palpably cooler than contralateral limb</td>
<td>Reduced or absent pulses</td>
<td>Soft tissue thrombus visualized extending into lumen from vessel wall, Blood flow disturbed by presence of thrombus</td>
<td>US diagnostic</td>
</tr>
</tbody>
</table>
stallion can allow the clinician to readily identify pathology when it is present. Even if you do not work with many breeding stallions in your practice, this skill can be acutely and critically important when presented, for example, with a stallion with an enlarged scrotum for which spermatic cord torsion and inguinal herniation are high on the differential list. The ability to identify an abdominal testicle can also provide an invaluable service to a client, while also providing the surgeon information on the exact location of the testis prior to entering the abdomen, thus allowing the surgeon to select the most appropriate surgical approach. For these reasons, practitioners are encouraged to take the opportunity to examine normal stallions and geldings whenever the opportunity arises.

Acknowledgments

Conflict of Interest
The Author declares no conflicts of interest.

References

How to Measure Testes Size and Evaluate Scrotal Contents in the Stallion

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1. Introduction
Ultrasonographic (US) evaluation of the scrotal contents is used to evaluate the normalcy of the spermatic cord, testes, and scrotum. In addition, it is the most accurate and simple method for measuring testes size (i.e., volume), which is used to determine the efficiency of sperm production in the testes. Historically, stallion testes are measured using calipers. Calipers have the disadvantage of requiring the testis to be positioned so as to completely fill the scrotum. Often this requires manipulation of the testis by grabbing the scrotal neck to force the testis into a scrotal position. This type of manipulation can aggravate the stallion (i.e., kick). In contrast, the ultrasound can image and measure the testis in situ thereby minimizing excessive scrotal manipulation. Ultrasonographic testis measures are also more accurate since the parenchyma can be directly visualized and specific landmarks for measurement can be identified. Finally, US can be simpler and faster than the caliper method.

2. Materials and Methods
Ultrasonographic evaluation of the scrotal contents in the stallion includes the spermatic cord (the spermatic artery, ductus deferens, and spermatic venous network (pampiniform plexus)), the epididymis (head, body, and tail), the testis, vaginal cavity, and tunics and scrotum (skin, dermis). The clinician should be able to identify position, location, and the normal echoic pattern of these structures. The examination of the scrotal contents, in addition to determining normalcy, should also include measurement of the length, width, and height of each testis. These measures are then used to calculate testis volume and determine the efficiency of sperm production.

Equipment
In general, linear array scanners with a 5.0-MHz probe can be used for evaluation of the scrotal contents and provide greater depth when measuring the length. Higher frequency probes provide greater detail but can be limited by the depth of penetration. Ideally, small sector scanner probes (Fig. 1) provide better access due to their smaller size and more specific identification of scrotal structures. The length measure of large testis may be greater than the limit of the US (e.g., 10–12 cm), and therefore that measure may have to be estimated. The T-type linear probe allows ease of handling and placement in the scrotal area.
Evaluation of the Testes and Scrotal Contents: Stallion Position and Location

1. Examine the stallion in a stall or quiet breeding shed area. Most stallions can be restrained in stocks if there are no other distractions to excite them. Administration of a light dose of detomidine hydrochloride® (e.g., 0.007 mg/kg IV) may facilitate the evaluation.

2. An experienced stallion handler should be at the head of the stallion during the whole evaluation (Fig. 2).

3. Examine the stallion from the left flank area with the ultrasound positioned (Fig. 2) close to the evaluator but a safe distance from the stallion.

4. An initial cursory manual evaluation of the testes and scrotum should be performed to determine the degree of tractability and resistance that the stallion might exhibit (Fig. 3). The intent of this evaluation is to briefly evaluate size, position, and location of the testes and scrotal contents but not perform deep palpation since this may aggravate the stallion.

Deep palpation should be performed as the final step in the evaluation.

5. Cover hands with disposable latex examination glove.

6. Apply a small amount (i.e., enough to allow probe-skin contact) of lubricant to the US probe surface. Gel can also be applied directly to the scrotal skin.

7. Once the clinician is comfortable with the stallion’s temperament towards the procedure, a position closer to the flank and scrotum can be taken.

8. Individual testis measures in centimeters (length, width, and height) can now be taken. Since the width and height are usually of similar size and easiest to measure, it is convenient to take these first. It is recommended to evaluate the near testis (left) first and take duplicate values for each measure.

a. Height: The height is measured by placing the probe ventrally and directing the beam dorsally so that the central vein (Figs. 4 and 5) is approximately two-thirds of the distance from the surface and the spermatic artery can be visualized dorsally. There is no need to grasp or manipulate the testis for this measure. Note that the testis does not lie in a horizontal position but rather is tipped so that the cranial testis is higher than the caudal testis. This will require...
the clinician to angle the probe caudally so that the cross-section of the testis appears round rather than elliptical.

b. Width: The opposite testis should be pushed dorsally so that the testis of interest is allowed to occupy the scrotum without being compressed or distorted, which will alter (i.e., reduce) the width measure (Figs. 6 and 7). Avoid grabbing the neck of the scrotum to force the testis into the scrotum similar to the technique recommended for measuring the circumference of the bull testes. This can cause strong contractions of the cremaster muscle making the testis even harder to manipulate. The probe should be positioned laterally on the scrotum, approximately one-third of the distance from the cranial scrotum. This is usually the widest portion of the testis. The shape of the testis should be approximately round and oblique sections should be avoided.

c. Length: Similar to the height measure the testis should hang in situ without being manipulated. The US probe is placed on the most caudal aspect of the scrotum and directed cranially to include the greatest caudal-cranial distance. If the tail of the epididymis is included in the image (Fig. 4) it should not be included as part of the measure (Figs. 4 and 8). To avoid “off center” images, the probe should be rotated vertically approximately 30° to visualize the greatest length.

d. A minimum of two measurements/dimension are taken and repeated until they are within 3 to 5 mm of each other.

9. After both testes have been measured, the clinician should do a thorough manual as well as
ultrasonic evaluation of the scrotal contents. The manual examination should start at the neck of the scrotum and evaluate each testis structure (head, body, and tail of the epididymis) individually as well as determine that the testes are able to move freely within the vaginal cavity.

Qualitative Evaluation of the Scrotal Contents: The Ultrasound Examination

Following the evaluation of testes size, the scrotal contents should be evaluated qualitatively (i.e., circulation, echotexture, shape, and anatomic orientation).

1. Orienting the US horizontally, evaluate the neck of the scrotum, which should visualize the cross-section of the spermatic artery. Blood flow should be confirmed either through grey-scale movement of the blood or more accurately through color Doppler imaging.

2. As you proceed, ventrally from the scrotal neck to the craniodorsal area of the testis, the probe will be rotated to a vertical position similar to the position for the width measure. This will allow visualization of the termination of the central vein, as it empties into the pampiniform plexus. The probe is passed caudally allowing visualization of the whole testis in cross-section. At the caudal end of the testis, the tail of the epididymis is visualized. Fluid accumulation (hydrocele), if present, will vary in the volume present. Small amounts will accumulate in the area around the tail of the epididymis resulting in easy identification of the tail. As the hydrocele increases, fluid will expand ventrally and eventually surround the whole testis.

The clinician is required to perform the examination in the vicinity of the flank area of the stallion. For obvious reasons, this is a risky position for the clinician. If semen collection is performed in conjunction with the evaluation, stallions tend to be more tractable following semen collection. Regardless, it is recommended to sedate the stallion to facilitate a thorough and complete evaluation. The ultrasound evaluation of the scrotal contents should be considered a stand-alone primary procedure, and therefore sufficient time and patience should be al-
lotted to allow for a thorough examination of the scrotal contents as well as accurate measurement of the testes dimensions. An inadequate examination can result in erroneous testis measures leading to an incorrect clinical interpretation.

Structures to Evaluate

1. Spermatic cord: The primary structure visualized is the tortuous spermatic artery as it winds to the testis (Fig. 3). Pathologic changes in spermatic cord torsion, varicocele (dilation of the pampiniform plexus), generalized edema resulting from inflammation (orchitis or epididymitis).

2. Testis: Examination of the testis parenchyma, which should be homogenous in echotexture. Pathology: Neoplasia (seminoma is the most common tumor of the descended adult testis). Benign cysts on the periphery of the testis. Hematomas from trauma.

3. Epididymis: The head, body, and tail regions are located craniolateral, dorsolateral, and caudal, respectively, on the horizontally oriented testis. Pathology: Displacement due to spermatic cord torsion. Small or absent in hypoplasia or dysplasia. Prominent/enlarged due to sperm accumulation or inflammation (Fig. 9).

4. Vaginal cavity: The vaginal cavity is a potential space that communicates with the peritoneal cavity through the inguinal canal. Pathology: Peritoneal content leakage (e.g., peritoneal fluid, hydrocele, intestines). Circulatory (artery, vein, lymphatic) compromise to the spermatic cord can result in free fluid accumulation; trauma/hematcele; infection/pyocele.

5. Scrotum: Consists of the skin, dermis, and parietal vaginal tunic. Pathology: Edema or hyperplasia due to trauma or hypoproteinemia.

3. Discussion

Interpretation of Testes Volume

Measurement of testes size is an important part of the stallion breeding soundness evaluation since testes size is associated with sperm production. The number of sperm produced by the stallion may impact fertility and, thus, the number of mares that a stallion can breed. Historically, testes size was determined using the linear measure, total scrotal width, in which calipers were used to measure the combined testes width, the mediastinum testes, and the scrotum. This technique, however, does not determine the three-dimensional shape (i.e., volume) of each testis. While the relationship of length, width, and height tends to be proportional, there are instances where they are not, and the determination of each dimension will more accurately determine volume.

Subsequently, ultrasonography has been introduced as a technique to measure and evaluate the testes. This technique has the advantage of being specific and accurate since the clinician can visualize the testis parenchyma and identify landmarks that assure measurement of the length, width, and height.

Measurements (length, width, and height) from each testis are performed as described above. The measures from each testis are then inserted in a formula that approximates the volume of an ellipsoid

\[
\frac{4}{3}\pi (\text{length-cm})(\text{width-cm})(\text{height-cm})
\]

\[= \text{volume of the testis in cm}^3\]

or

\[
0.5233 (\text{length-cm})(\text{width-cm})(\text{height-cm})
\]

\[= \text{volume of the testis in cm}^3\]

The volumes from each testis are combined to give the total testicular volume (TTV).

The TTV is then inserted into the regression formula to calculate the expected daily sperm output (DSO) (Fig. 10). There are two formulas that have been previously published.\(^2,3\) It is recommended to use both formulas to obtain a range of values.
Predicted DSO (billions)

\[
\text{Predicted DSO} = 0.024 \times (\text{TTV}) - 1.26^2
\]

An example of how to use the formula is given below. Measures for each testis dimension are taken, and the volume is calculated for each testis and then summed to determine the TTV. In this case, the TTV is 191 cm³. This value would then be inserted in the two formulas above to give a range of expected DSO from 3.3 to 3.8 billion sperm.

Example:

<table>
<thead>
<tr>
<th>Testis</th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Height (cm)</th>
<th>Volume (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>7.8</td>
<td>4.0</td>
<td>5.0</td>
<td>82</td>
</tr>
<tr>
<td>Right</td>
<td>8.0</td>
<td>4.9</td>
<td>5.3</td>
<td>109</td>
</tr>
</tbody>
</table>

Interpretation: The intent of measuring the TTV is to:

1. Determine the absolute volume measure. The average total testes volume for the population of stallions measured in the two studies was approximately 250 cm³. Based on this TTV the average stallion should produce approximately 4.74 to 5.24 billion sperm when at DSO. This translates to a spermatogenic efficiency of approximately 18 million sperm/cc testis parenchyma/day. The absolute value becomes particularly important when measuring sexually immature stallions retired to stud following performance careers. The clinician is often asked to render an opinion on a stallion’s testes size in relation to his potential as a breeding stallion. Recognizing that a 2 to 4 year stallion has a TTV similar to the average sexually mature stallion is useful when rendering an opinion. The clinician must also recognize that TTV alone does not “qualify” a stallion as fertile, but a “normal” testes size does reduce the risk of “subfertility.”

2. Spermatogenic efficiency is the number of sperm produced per gram of testis parenchyma. This value can be determined by dividing the DSO value by the TTV. Efficiency of sperm production in the stallion ranges from 16 to 19 × 10⁶ sperm/gram of testis parenchyma. While the TTV is an important measure, it does not describe testis function (i.e., efficiency). Therefore, it is possible to have “normal” size testes that are not producing a “normal” amount of sperm (i.e., inefficient). Inefficiency will also be noticed when the actual DSO value is less than the expected DSO value.

3. Compare the expected DSO value to the actual number of sperm collected from the stallion. Ideally the clinician would like to collect a stallion once daily for 5 to 7 days to determine DSO. Oftentimes, this is impractical due to time and monetary constraints and a lesser collection frequency is more practical. Stich et al reported that testes volume will affect the number of days required to reach DSO with a smaller TTV (148–245 mL) reaching DSO sooner (day 5) than medium (253–274 mL; day 6) or large testes (292–466 mL; day 6–7). In lieu of collecting a stallion for 5 to 7 days, collecting two ejaculates 1 hour apart and using the second ejaculate as an approximation of DSO, is a useful compromise. In most cases, the clinician is not interested in whether the stallion is producing too much sperm but rather whether he is producing too little when compared to the expected DSO value.

Acknowledgments

Conflict of Interest
The Author declares no conflicts of interest.

References and Footnote

*Dormosedan, Pfizer Animal Health, New York, NY 10017.
How to Perform Urethral Endoscopy in the Stallion for Diagnostic Purposes

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1. Initial Considerations

While the procedure of urethral endoscopy might appear to be relatively unobtrusive, the operator should be aware that the examination can lead to complications. As such, precautions should be taken to avoid such unintended consequences. A key safeguard is to ensure that instrumentation and associated fluid that gain entry into the urethra are free of microbial contaminants or chemical irritants. It is important that the operator specifically follow the prescribed sterilization protocol(s) recommended by the manufacturer of the equipment, as deviations in cleaning may damage the equipment. If the protocol dictates that the instrument be submerged for disinfection, it is of paramount importance to perform a leak test on the endoscope prior to submersion in a solution, as accidental fluid invasion into some compartments of the endoscope can result in damage to sensitive internal components, resulting in costly repairs. A leak testing instrument, which may come as an accessory for the endoscope or be purchased separately, creates positive pressure (e.g., 150 mm Hg) within the endoscope such that bubbles will be detected at the site(s) of leakage upon submersion in the water bath. Semi-automated cleaning kits are available to aide in properly disinfecting endoscopes.

As endoscope insertion tubes are generally passed into a variety of body cavities and used by an assortment of personnel, it is critical that all operators are trained in endoscope care, including initial cleaning techniques for the endoscope immediately after each use so that organic matter is not permitted to dry upon extended storage. The suction/biopsy channel of the instrument is most prone to accumulation of debris when a patient is examined. Cleaning the endoscope with an enzyme-detergent solution prior to a disinfectant solution may be indicated. The water reservoir is a likely site for growth for the opportunist bacteria, Pseudomonas aeruginosa, as standing water is particularly supportive of growth of this microorganism. As such, one must not disregard disinfection of the water reservoir and the associated channel to the light-guide lens.

While one requires assurance that the instrument is sterile prior to use, it is equally important that disinfectants are properly rinsed from the endoscope; otherwise, the disinfectant(s) can be profound contact irritants that lead to destruction of mucosal surfaces. Of particular note, one must be assured that disinfectant solution is removed from the water.
reservoir and associated channel for rinsing the lens.

2. Reasons for Performing a Diagnostic Urethral Endoscopy in the Stallion

Endoscopic examination of the stallion urethra can be a valuable diagnostic approach for stallions with specific clinical manifestations. The most common ailments which justify urethral endoscopy as a diagnostic tool are seminal vesiculitis and rents in the penile urethra. These conditions generally present with pyospermia or hemospermia/hematuria, respectively. Occasionally, seminal vesiculitis can lead to visually apparent red blood cells, as well as excessive neutrophils, in ejaculated semen. These disorders are generally not associated with outward signs of pain at the time of ejaculation or urination. If no lesions are observed on the penile integument or urethral process, than an internal source of bleeding or infection is to be suspected. Urinary incontinence, stranguria, or urine discoloration may lead one to suspect bladder lesions such as cystitis, uroliths, or bladder tumors. Uncommonly, stranguria may be associated with lesions of the pelvic or penile urethra, such as urethral calculi or transluminal adhesions. Hematuria may also be indicative of kidney disease, such as might occur with renal carcinoma or pyelonephritis. With the exception of the seminal vesicles, primary infections of the remaining accessory genital glands are quite rare or unreported. While this communication is technique-based rather than disease-based, the essence of this section is to demonstrate that numerous different disorders might exist that justify use of endoscopy as a diagnostic tool. In cases of idiopathic hemospermia, pyospermia, urine discoloration, urinary incontinence, or stranguria, urethral endoscopy/cystoscopy is likely indicated for direct viewing of these sites.

3. The Equipment

A flexible endoscope is required for urethral endoscopy. While fiberoptic endoscopes can be used for this purpose, video endoscopes generally provide superior image quality. It is preferable to have a video monitor for easy visualization of the field of view by both operators and other attendees for the procedure. Recording devices for video and still captures are also recommended. The working length of the insertion tube should be a minimum of 100 cm, and the diameter should be a maximum of 1 cm. A smaller tube diameter may be necessary for smaller or younger stallions or for navigation through the openings of the seminal colliculus into the seminal vesicle (vesicular gland) luminae. Accessory instruments that may be valuable during the procedure are aspiration catheters, culture swabs, grasping forceps, and biopsy forceps. While this communication is directed toward use of the endoscope as a diagnostic instrument, if one envisions using the instrument for laser, electrocautery, or cryosurgical applications, it is advisable to discuss with the manufacturer(s) appropriately designed endoscopes for such purposes.

4. Anatomical Considerations

An illustration of an endoscopic view of the stallion urethra reveals the openings to an assortment of glands as well as the ejaculatory ducts and the bladder orifice (Fig. 1). The insertion tube bends approximately 180° when passing over the pelvic brim so all of the structures in the pelvic urethra are “upside down” when viewed through the endoscope. The openings to the bulbourethral glands are located posteriorly in the pelvic urethra in two linearly-arranged rows, as viewed endoscopically. The openings to the urethral glands are located slightly more proximally and laterally in single rows. The seminal colliculus (colliculus seminalis) is a small protuberance on the ventral midline (as viewed endoscopically) immediately posterior to the bladder orifice. The seminal colliculus contains two ejaculatory duct openings. Each opening is typically a common exit point for secretions of the corresponding ductus deferens and ampulla, as well as the
ipsilateral seminal vesicle (vesicular gland). Infrequently, the ducts of the seminal vesicles have openings separate of the ejaculatory ducts on the seminal colliculus. The seminal colliculus is enveloped laterally by small tissue mounds, which contain numerous slit-like openings of the prostate gland. The accessory genital glands are illustrated in Fig. 2 and are generally discernible transrectally by palpation and/or ultrasound.

The Examination

Sedation of the stallion with detomidine hydrochloride (6–10 µg/kg, intravenously) aids in exteriorization of the penis and provides limited analgesia during the procedure (Fig. 3). The examination can be initiated 3 to 5 minutes following drug administration and should be performed with the patient restrained in a set of stocks to minimize movement. Use of acepromazine maleate (or other derivatives of phenothiazine) for tranquilization is contraindicated in stallions because of the propensity for drug-induced paralysis of the retractor penis muscle, which can lead to irreversible penile prolapse.

Once the penis is exteriorized by sedation of the stallion, the penis should be subjected to gentle traction and surgical scrubbing, using povidone iodine-based or chlorhexidine-based soap products. As the point of entry of the endoscope insertion tube is the urethral sinus of the fossa glandis.

Fig. 2. Illustration of the accessory genital glands of the stallion (dorsal view): (a) genital fold, (b) bladder, (c) ampulla, (d) seminal vesicle (vesicular gland), (e) lobe of prostate gland, (f) isthmus of the prostate gland, (g) pelvic urethra (enclosed by urethralis muscle), (h) bulbourethral gland, and (i) retractor penis muscle.

Fig. 3. Partially exteriorized penis at three minutes following intravenous administration of detomidine hydrochloride (6 µg/kg). The prepuce can be reflected at this time to grasp the free portion of the penis for cleaning. Additional sedation will allow more lengthening of the penis but the additional length of the penis can result in inadequate exposure of the proximal urethra and bladder with a 100-cm insertion tube in larger stallions.

Fig. 4. A sterile scrubbing technique should be applied to the distal penis prior to insertion of the endoscope. Care should be taken to include adequate cleansing of the fossa glandis and glans penis. It is important to remove all soap residue from the penis, and this can be particularly difficult to complete with the urethral sinuses of the fossa glandis.
thral orifice, cleansing should focus on the distal penis (Fig. 4), being careful not to allow contamination of the site by microbes of the proximal penile and preputial integuments. It is important to thoroughly rinse all residual soap from the penis, as it can result in contact dermatitis. The recesses of the fossa glandis are the most vulnerable sites for accumulation of soap residue, so this area should be flushed with sterile saline after the surgical scrub is completed (Fig. 5). Following sterile preparation of the site, sterile gauze can be used to encircle the distal penis with overlying digital pressure to stabilize the penis for the procedure (Fig. 6).

The procedure is most easily performed with two operators: one to hold the penis and guide the insertion tube and one to manipulate the control knobs. Sterile lubricant should be applied to the tip of the insertion tube prior to entering the urethra (Fig. 7). Care should be taken to avoid lubricant contact with the endoscope lens, such that visualization is not hampered. The instrument should also be “white-balanced” to enhance color optics if that feature is offered with the endoscope (Fig. 8). Once inserted into the urethra, the insertion tube should be slowly advanced with intermittent air insufflation so that the field of view is easily discernible (Fig. 9). The lens may need to be rinsed occasionally if the image becomes blurred. As the endo-
scope is advanced toward the proximal penile urethra, the vascular pattern becomes quite prominent (Fig. 10). This is a normal finding and should not be confused with inflammatory changes. As one courses over the pelvic ischium, the openings of the bulbourethral glands can be found on the ventral midline of the pelvic urethra (when viewed endoscopically) whereas the openings of the scattered urethral glands are located more laterally (Fig. 11). More proximally, the seminal colliculus is a distinct protuberance located on the floor of the proximal urethra (recall that structures in this area are typically upside down when viewed endoscopically). It typically contains two prominent openings to the ejaculatory ducts (Fig. 12); however, the opening can be more slit-like and may require dilation with an atraumatic probe to become distinct (Fig. 13). Gentle forward pressure on the insertion tube while it is overlying the orifice of the ejaculatory ducts will generally allow admittance into the duct leading to the seminal vesicles. The procedure can be augmented by insufflation of air at the level of the opening or prior to insertion of an atraumatic probe (via the biopsy channel) into the opening to facilitate entry of the insertion tube. Numerous slit-openings to the prostatic ducts are detected on either side of the seminal colliculus (Fig. 12). The opening to the bladder, located at the most proximal point of the urethra, is oftentimes closed during the endoscopic procedure (Fig. 14), but access to the bladder lumen can be gained with slight forward pressure on
the insertion tube. The urine in the bladder can be partially, or completely, evacuated with controlled aspiration so that the luminal contents and mucosal surface, and the ureteral openings can be identified (Fig. 15).

Disorders of the urethral and bulbourethral glands are essentially unreported, and prostatic lesions are rare. Although the most common disorder of the accessory genital glands is occluded ampullae, this condition cannot be confirmed via urethral endoscopy. Two disorders of the stallion that are most commonly confirmed by urethral endoscopy are seminal vesiculitis and rents in the pelvic urethra.

For confirmation of seminal vesiculitis, the insertion tube of the endoscope can be inserted directly into the seminal vesicles, whereby the interior of the gland(s) can be examined, samples obtained for cytology and culture, and gland lavage and infusion of medications can be conducted (Fig. 16). Alternatively, a sterile aspiration catheter or culture instrument can be advanced into the lumen of a seminal vesicle via an ejaculatory duct for procurement of samples (Fig. 17). This is also a good method for lavage of the seminal vesicles and for instillation of medications.
Rents in the urethra are the most common disorder associated with hematuria/hemospermia in stallions where external lesions of the penis are absent. Profuse arterial hemorrhage in ejaculates usually results from an idiopathic defect in the urethra that communicates with the surrounding corpus spongiosum penis. Diagnosis of the urethral defect requires urethral endoscopy (Fig. 18). The defect can be small and difficult to identify. Endoscopy immediately following ejaculation may aid the examiner in locating the defect because blood can often be detected within the defect at this time. The rent occurs largely in a similar location in all affected patients, being located on the ventrum of the urethra (as viewed endoscopically) distal to the duct openings of the bulbourethral glands.

6. Precautionary Measures

Care must be used when performing a urethral endoscopy, as untended injury to the patient can occur. A primary precaution is to ensure that the endoscope and entry fluids are sterile prior to use, so as to prevent development of cystitis or seminal vesiculitis. Undue force on tissues can also induce injury as can aspiration of air from compartments when the endoscope tip is close to a wall, leading to traumatization of mucosa and underlying structures.

As a general rule, aspiration should not be attempted when a visible lumen is not detectable. One should also guard against over-inflation of the urogenital tract with air when performing an endoscopic examination, as rupture of the bladder has occurred in such instances. It is wise to deflate the bladder and urethra when the examination is completed.

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Conflict of Interest
The Author declares no conflicts of interest.

Footnotes

*Dormosedan*, Orion Corporation, Espoo, Finland.

*Betadine* Surgical Scrub, Purdue Pharma, Stamford, CT 06901.

*Nolvasan* Surgical Scrub, Zoetis Inc., Florham Park, NJ 07932.
Incidence of Complications Associated With Use of the Henderson Equine Castrating Instrument

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Use of the Henderson equine castrating instrument is becoming more widely accepted in equine ambulatory practice. Its use is associated with a low rate of complication in young horses (<2 years of age) and a rate of serious complications in all ages of horses similar to other published techniques. Authors’ address: University of Pennsylvania, 382 West Street Road, Kennett Square, PA 19348 (Levine, Aceto); 20612 276th Avenue SE, Maple Valley, WA 93038 (Schroeder); and 25 Webster Lane, Oxford, PA 19363 (Berkowitz); e-mail: dglevine@vet.upenn.edu. *Corresponding and presenting author. © 2014 AAEP.

1. Introduction
Castration is one of the most common surgical procedures performed in equine practice and complications of these surgical procedures are the most common cause for malpractice claims against equine practitioners. The Henderson equine castrating instrument is reported to result in a reduction of intraoperative and postoperative complications due to its technique of spinning and “tying” the vessels of the spermatic cord together with the vaginal tunic.

2. Materials and Methods
One hundred and eighty horses were included in this study and their medical records evaluated for the occurrence of complications. Castrations were performed in dorsal recumbency using injectable anesthesia. Two incisions were made and the testicles were removed using the Henderson equine castrating instrument. The incisions were left open to heal by second intention.

3. Results
The total complication rate was 10% (18/180). Of these complications, 16 were non-life-threatening (swelling, seroma). One horse bilaterally eviscerated upon recovery and was euthanized and another horse developed wound botulism postcastration. Horses three years of age and older were five times more likely to develop a postcastration complication than horses two years of age and younger.

4. Discussion
Use of the Henderson equine castrating instrument resulted in a low complication rate, especially among younger horses. This rate is similar to castrations performed with other published techniques and validates this technique’s use in horses.

Acknowledgments

Conflict of Interest
The Authors declare no conflict of interest.
Complications Related to the Use of Intrauterine Glass Marbles in Mares

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Use of toy intrauterine glass marbles may lead to chronic endometritis, pyometra, and fragments of glass becoming embedded in the endometrium. Authors’ addresses: Western College of Veterinary Medicine, Clinical Sciences, Department of Large Animal, Saskatoon, SK, S7N 5B4, Canada (Diel de Amorim, Nairn, Manning, Card); Ontario Veterinary College, Department of Population Medicine, Guelph, ON, N1G 2W1, Canada (Chenier); and 3661 15th Avenue, Prince George, BC, V2N 1A3, Canada (Green); e-mail: amorimm@uoguelph.ca. *Corresponding and presenting author. © 2014 AAEP.

1. Introduction
The effectiveness of intrauterine glass marbles for estrus suppression in mares varies in studies from 11-41.3%, but their use is still common practice. The purpose of this study was to describe a case series of five mares that developed complications related to intrauterine marble(s).

2. Materials and Methods
The history, reproductive examinations, cytologic, and microbial information from 6 mares with intrauterine glass marbles were reviewed. Intrauterine marbles were retrieved manually or under hysteroscopic guidance.

3. Results and Discussion
Three mares had 1 and 2 mares had 2 intrauterine glass marble(s), 5/5 mares had marbles for > 1 year, 2/5 had chronic endometritis, and 3/5 had pyometra. A marble or glass shards were adhered to the endometrium in 3/5 mares. This report demonstrates that the long term use of toy intrauterine glass marbles may have severe deleterious effects on reproductive health.

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Conflict of Interest
The Authors declare no conflicts of interest.