How to Diagnose and Treat Hemospermia: A Review and Case Series

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1. Introduction
Disorders of breeding stallions have severe ramifications for not only the economics of the equine industry but also the welfare of affected animals. Hemospermia in particular is challenging to diagnose and manage, as there are many etiologies and treatment options. Importantly, one of the mainstays of treatment for all cases is sexual rest, which has severe economic consequences on the stallion’s reproductive performance. Because hemospermia is associated with heavy breeding or collection schedules, the disease is often diagnosed in the beginning or height of the breeding season. Therefore, timely identification of the disorder, diagnosis of the pathophysiology, and implementation of a treatment protocol will provide the best opportunity to return the stallion to breeding function, albeit most often for the following season. Some causes of hemospermia are life-threatening, such as squamous cell carcinoma, and early diagnosis and treatment may improve survival rates.

Often, the first indication of hemospermia, especially in live-cover breeding operations, is infertility. Presence of erythrocytes within the ejaculate may dramatically reduce pregnancy rates as the result of effects of an unknown factor of the erythrocytes on spermatozoa. Alternatively, blood may be noted at the mare’s vulva or stallion’s penis on dismount. Stallions that are collected by means of an artificial vagina may be identified by blood-contaminated ejaculates. External lesions may be observed during washing before collection. Stallions may demonstrate normal libido but pain on erection, dilation of the glans, or ejaculation. Pain may also be observed in association with masturbation behavior or urination.

The objectives of this paper are 1) to provide an overview of the diagnostic evaluation of stallions that present for hemospermia; 2) to review the major causes of hemospermia and their treatment options; 3) to present a case series of stallions with hemospermia that represent cases that veterinarians commonly see in practice.

2. Diagnostic Protocol

Signalment
Hemospermia has been reported in stallions of variable ages and breeds; however, in one report of 18 cases, 15 were Quarter Horses (83.3%). Of the 18
Horses, the average age at onset of hemospermia was 7.1 years (range, 3–18) and the number of seasons at stud was 3.7 (range, 0–13).

History
Hemorrhage may be noted during washing of the penis, from the penis after breeding or collection, on the phantom after collection, from the mare after live-cover mating, or associated with urination. The horse may have a history of pain during urination, masturbation, erection, or ejaculation. Self-mutilation behavior and colic have been described in a stallion with hemospermia caused by seminal vesiculitis. Important history to acquire from the owner includes the following:

- Any previous episodes of hemospermia
- Any change in stallion body weight or condition
- Any change in stallion collection frequency
- Any recent adjustments to the collection phantom, such as height, type, and so forth (stallion use: collection only, live-cover mating, or both)
- On observation of hemospermia, was the blood expelled as large clots or progressive from blood-tinged to frank blood?
- Any observations of bleeding in the stall, such as associated with urination
- Any observations of bleeding when the penis is washed during erection

Physical Examination
Evaluation of the stallion that presents for hemospermia begins with a thorough physical examination. The horse may require sedation to facilitate examination of the external genitalia. The epithelium of the prepuce and penis should be evaluated for any lesions, including papules, pustules, erosions, ulcers, proliferative lesions, or lacerations. Special attention should be paid to the urethral process and urethral fossa because these are common sites of injury and neoplasia, although some lesions of the glans are not apparent until erection occurs. The epididymis should be palpated and imaged for enlargement or an increase in firmness. Transrectal ultrasonography may demonstrate abnormalities of the ampullae, seminal vesicles, bladder, or inguinal lymph nodes, which would indicate further diagnostic testing.

Semen Collection
The stallion is teased and washed, and semen is collected through the use of an artificial vagina. Some practitioners prefer to use an open-ended Colorado-style artificial vagina to fractionate the ejaculate, although in most cases this is not necessary to obtain a diagnosis. Stallions with painful lesions of the glans penis or urethral process may not ejaculate because of pain associated with the lesion at the time of dilation of the glans. These stallions demonstrate normal libido but become acutely painful and dismount the phantom without ejaculating. Repeated collection attempts may result in frustration of the stallion. Often, examination of the penis after dismount will demonstrate the source of hemorrhage on the glans or urethral process. Stallions that ejaculate grossly hemorrhagic semen but do not display external lesions should be submitted for endoscopy within 20 minutes to identify the origin of hemorrhage. Stallions with a history of hemospermia that have had a period of sexual rest may not hemorrhage during initial collections but may do so after repeated collections over days to weeks.

Collected semen with hemospermia on gross or macroscopic inspection may appear pink to red in color. On gross inspection, semen with microscopic hemospermia may appear to be normal; the use of cytology is imperative to the diagnosis. Cytology that demonstrates the presence of large numbers of leukocytes and erythrocytes should direct the clinician to evaluate the urogenital tract for inflammatory or infectious processes of the bladder, epididymis, seminal vesicles, or urethra.

Endoscopy
In the absence of lesions of the glans penis and urethral process, endoscopy should be performed within 20 minutes of collection to examine the urethra, colliculus seminalis, seminal vesicles, and urinary bladder. The horse is sedated, often with an α-adrenergic agonist such as xylazine or detomidine and butorphanol intravenously. The penis is washed with warm water and non-irritating soap. Any accumulation of smegma in the urethral fossa should be removed. The penis is then dried. Endoscopic examination requires the use of three personnel: one to aseptically insert the endoscope into the urethra and hold the extended penis; one to operate the endoscope; and one to restrain the horse. Most adult light-breed horses can be examined with a sterilized flexible endoscope of 100-cm length and 10-mm diameter. Small ponies and miniature horses require the use of a pediatric gastroscopic of 8- to 9-mm diameter. Large horses may require the use of a longer endoscope. Smaller-diameter endoscopes are easier to introduce into the seminal vesicles.

The endoscope is inserted into the urethra with a small amount of sterile lidocaine-containing lubricant by an operator who maintains one hand around the glans and one hand to advance or retract the depth of the endoscope, while wearing sterile examination gloves. The endoscope is advanced slowly to observe for signs of pathology. Small volumes of air may be applied to facilitate examination. Dilation of the urethra results in hyperemia of the underlying corpus spongiosum vasculature, which should not be confused with urethritis. At the level of the ischial arch, the convex surface of the urethra should be closely examined for hemorrhage caused by idiopathic urethral rent formation.
hypodermic needle may be placed percutaneously to identify the level of an identified rent.4 Openings to the urethral glands and bulbourethral glands are located proximal to the ischial arch. The pelvic urethra should be examined for signs of urethritis. The colliculus seminalis should be examined for discharge from the seminal vesicle or presence of any cystic structures.5 The seminal vesicles can be entered with the use of a sterile stylette and examined for purulent or hemorrhagic exudate. Transrectal massage of the seminal vesicles may elicit elimination of accumulated fluid and may improve diagnosis. Bacteriological samples may be obtained from the seminal vesicles or urethra. The bladder should be examined for cystitis or uroliths.

3. Differential Diagnoses and Treatment Options

Penile Neoplasia

Squamous cell carcinoma (SCC) represents the majority of diagnosed penile neoplasms. Hemorrhage may occur as the result of ulceration of the glans or irritation of neoplastic tissues during erection. In a recent retrospective study of 3351 equine cutaneous neoplasms, 18.9% were SCC, as were 57.8% of penile or preputial tumors. In another study, 74 of 114 (65%) of equine penile or preputial tumors were SCC. The mean age of affected horses ranged from 16.4 to 19.8 years.6,7 SCC is commonly identified in horses with unpigmented genitalia but can occur in any breed or color.7,8 Appaloosa and American Paint horses are significantly more affected than other breeds.7 Stallions appear to be less frequently affected than geldings, which may be a reflection of the respective population sizes.9

The pathogenesis of penile SCC has been hypothesized to result from infection with equine papillomavirus-2 (EcPV-2), which induces neoplastic changes in penile or preputial epithelium or existing papillomas.10,11 In 16 penile SCC, 15 were positive for EcPV-2 DNA as was a metastatic lymph node.12 Interestingly, 10% of healthy males were positive for EcPV-2 DNA in penile tissues, suggesting that some horses may be asymptomatic carriers.12 Other factors relative to SCC formation include irritation of the skin by smegma or by ultraviolet sunlight exposure. The lesions are slow-growing, locally invasive, and metastasize late in disease to the inguinal lymph nodes. SCC which invade the cavernous tissues of the penis may metastasize hematogenously. Lesions are often not identified in non-breeding stallions until gross abnormalities are present, resulting in pain during collection, urination, or masturbation; hemorrhage; or a foul odor. Early lesions may be raised, discolored, or ulcerated; later lesions may become granulomatous or “cauliflower-like” in appearance. Large lesions may interfere with normal extension and retraction of the penis as well as urination.

Treatment options for penile SCC depend on the size and character of the lesion as well as the presence of metastasis. Small lesions may be treated with chemotherapy, cryotherapy, or laser excision. Chemotherapy options include topical 5-fluorouracil (5-FU), intralungal cisplatin, or oral cyclooxygenase inhibitors. Five-fluorouracil, a fluorinated pyrimidine, is an anti-metabolite that blocks the methylation of deoxyuridic acid into thymidylid acid in the formation of DNA.13 Because thymidylid acid is high in SCC, 5-FU is thought to induce thymidylate deficiency in the neoplastic cells, which leads to apoptosis; normal non-cancerous cells are not affected.15 A study of eight horses with penile or preputial SCC monitored the response to topical 5-FU after surgical debulking or as solitary treatment for small lesions.13 The treatment was applied immediately after surgery or the following day, after hemostasis had occurred, and additional treatments were performed at 14-day intervals until regression of the SCC. Thereafter, horses were evaluated and treated every 6 months to prevent remission. The mean number of treatments to achieve remission was five (range, two to seven), and all horses were still in remission 5 to 52 months later.

Cisplatin, cis-diamminedichloroplatinum (II) or CDDP, is a platinum-containing chemotherapy agent that binds and cross-links DNA to induce apoptosis. It has been administered intratumorally to reduce the toxic systemic effects observed in some patients and to maximize tissue concentrations of this chemotherapeutic agent. Cisplatin in sesame oil emulsion was used to treat 151 SCC in 144 horses, either as solitary treatment or 10 to 14 days after surgery.14 Eighteen of these SCC were of male genital origin. Four treatments were administered at 2-week intervals. The cure rate after one course of treatment was 88%.14

The use of cyclooxygenase (COX) inhibitors as chemotherapy agents has been researched in recent years. It has been demonstrated that COX is overexpressed in equine SCC and plays a role in cell growth and differentiation.15 Inhibition of COX-2 induces apoptosis in neoplastic cells by blocking prostaglandin E2 synthesis and therefore angiogenesis and invasiveness.16 Elce et al16 demonstrated the expression of COX-1 and COX-2 proteins in tissue samples of four preputial and five penile SCC in horses. COX-2 expression was significantly increased in neoplastic versus non-neoplastic preputial tissues (P = 0.04).16 This study also suggested that COX expression in horses was not limited to SCC but also occurred in normal tissues, a finding unique to horses. Another study demonstrated expression of COX-2 in 32 of 37 (86.5%) equine SCC, seven of which were preputial or penile in origin.17 The use of piroxicam was extrapolated from use in other species, such as rats, dogs, and humans, to treat SCC.16 Oral piroxicam was used to treat recurrence of non-genital SCC in a 16-year-old Morgan gelding.18 The SCC had initially been treated with intralesional cisplatin; 3 months after initiation of piroxicam therapy, the lesion and enlarged regional...
lymph nodes returned to a normal size. After 5 years, the horse was still receiving oral piroxicam once every 2 to 3 days, and there had been no signs of recurrence. Specific studies examining the COX selectivity and toxicity of piroxicam in horses have not been published, although in other species it is COX–non-selective.

Cryotherapy has been applied as solitary treatment for small lesions or in combination with surgery. In one study, eight horses were treated with liquid nitrogen, which was applied with the use of a cryoprobe for two fast-freeze, slow-thaw treatments, as solitary treatment, or in combination with local excision or partial phallectomy. Of seven horses available for follow-up, SCC recurred in five animals. Epithelialization after cryotherapy may be prolonged compared with surgical excision alone because of thermal damage.

The prognosis for horses that undergo surgical treatment for SCC is variable. One study of en bloc resection with penile retroversion for penile SCC (n = 4) or squamous papilloma (n = 1) demonstrated that three of five ponies were alive at 3 to 20 months of follow-up (mean, 12 months). One stallion with urethral process SCC underwent local excision and returned to breeding function without recurrence at 1 year. Twenty of 31 pony geldings (64.5%) lived at least 18 months without relapse of penile SCC regardless of treatment method (penile amputation, local excision, or preputial ablation). Six of nine (66%) that had penile amputation survived 18 months. A study of 45 horses with genital SCC treated by en bloc penile resection, penile amputation, and/or segmental posthectomy demonstrated that recurrence occurred in 19% (six of 31) of horses for which follow-up was available. Seventy-one percent (22 of 31) of horses were alive at the time of follow-up, which ranged from 1 to 6 years after surgery. Notably, of the 45 cases examined, only 35 had histologic confirmation of SCC. Recurrence rates in a study of 77 equine preputial or penile SCC were 43.5% (17 of 39) for horses that had partial phallectomy with or without cryosurgery or that had incomplete removal of SCC; 12.5% (one of eight) for horses that had en bloc resection; and 25% (one of four) for horses that had confirmed lymph node metastasis. The overall recurrence rate was 29.5%. Successful removal and prevention of recurrence of SCC was 55.7%.

En bloc resection of the penis requires concurrent castration. Breeding stallions that have undergone partial phallectomy may be able to be collected through the use of an artificial vagina or induction of ex copula ejaculation and semen used for artificial insemination or cryopreservation. Other penile neoplasms of horses include sarcoïd and melanoma, which typically do not result in hemospermia.

**Penile Habronemiasis**

Although uncommon in the United States, penile habronemiasis is an important differential diagnosis for penile SCC. Hemospermia results from collection from affected horses, with hemorrhage originating from inflamed or ulcerated areas of the glans penis. Its incidence has been drastically reduced because of the widespread use of avermectin anthelmintics. Stable and house flies, *Musca domestica* and *Stomoxys calcitans*, respectively, serve as intermediate hosts that deposit the larvae of the stomach worms *Habronema* spp. or *Draschia megastoma* on mucocutaneous junctions of the genitalia or in open wounds. Infection of existing SCC or lacerations is possible. Resultant lesions are not the result of tissue damage caused by the larvae but rather by a severe hypersensitivity reaction to their presence, which results in exuberant granulation tissue production, ulceration, and hemorrhagic exudate that may result in hemospermia, hematuria, or dysuria. Diagnosis is confirmed by excisional biopsy that demonstrates small, hard, yellow granules, larvae, and eosinophils and will rule out sarcoïd, SCC, or pythiosis. Complete blood count may demonstrate eosinophilia. Horses with penile habronemiasis should be suspected of having a large adult stomach worm population. Treatment is performed through administration of avermectin anthelmintics followed by corticosteroid treatment to reduce the immune reaction. Development of avermectin resistance may lead to an increase in observed cases. Prednisolone has been used orally, and liquid nitrogen sprays have been used topically to kill larvae in small lesions. Management factors include the deworming schedule of horses, manure management, and fly control.

**Penile Injuries**

Hemospermia caused by penile injuries may be of several etiologies. The urethral process may be easily damaged by the mare’s tail hairs during live-cover breeding. Penile lacerations, swelling, or hematomas may also occur as the result of kicks (either by the mare during breeding or by the stallion’s hind legs during washing) or use of stallion rings. Some lacerations may not be apparent until erection is achieved and the lesion hemorrhages under increased pressure. Injured tissues should be cleaned and a topical antibiotic and/or anti-inflammatory applied. Lacerations into the cavernous tissues may require surgical closure. Rapidly swelling tissue should be treated with a pressure bandage and abdominal support to prevent paraphimosis. Ability to urinate should be verified. Sexual rest is indicated until the lesion is healed because hemorrhage may recur with subsequent mating or artificial vagina use.

**Equine Coital Exanthema (Equine Herpesvirus-3)**

Infection with equine herpesvirus-3 can lead to pustules and ulceration of the penile surface, which can result in hemospermia on erection and service of an artificial vagina or mare. The infection is self-limiting after several weeks. Sexual rest is indi-
Urethritis

In a review of 18 cases of hemospermia, urethritis was identified as the inciting cause in 10 cases. Features of urethritis included pseudomembranous (n = 1), polyloid (n = 1), concurrent urethral stricture (n = 1), and non-specific inflammation (n = 7). Bacterial cultures from 10 of 18 cases demonstrated growth of Escherichia coli, Pseudomonas aeruginosa, α- and β-hemolytic Streptococcus spp., Streptococcus equiseminalis, and Proteus spp. Four cases had histologic evidence of infection. Lesions were identified in the pelvic urethra in 44.4% of cases. Sexual rest was successful in returning two stallions to breeding function. Surgical treatment by subischial urethrostomy was performed in the remaining stallions with urethritis, and suppositories of nitrofurazone and hydrocortisone were administered. Eighty percent of stallions with urethritis treated by urethrostomy and suppositories returned to normal ejaculation.

One case of viral urethritis has been suspected on the basis of identification of inclusion bodies in urethral epithelial cells, but virus isolation was unsuccessful.

Although these and several other cases of bacterial urethritis are frequently cited, very few cases have been described in the scientific literature in the last 25 years. It is possible that the disease is under-reported or that most cases of hemospermia examined clinically or reported on in recent years have been of other etiologies.

Urethral Rent

Urethral rent development is a distinct disorder of the urethra in stallions that results in hemospermia. Urethral rents can occur in any age or breed, but Quarter Horses appear to be over-represented. The disease can also occur in geldings, but results in hematuria, a clinical sign less often observed in stallions. These variable clinical signs are physiologically based in the fact that corpus spongiosum penis pressure during urination in geldings versus stallions is higher (25.5 ± 12.1 versus 15.3 ± 3.3 mm Hg) and that corpus cavernosum penis pressures in stallions during teasing (107 ± 8.4 mm Hg) and breeding (4147 ± 142 mm Hg) are significantly higher than during urination or rest (13 ± 1.5 mm Hg). Therefore, pressures during urination in geldings and erection in stallions are elevated enough to result in hemorrhage from an established rent. The authors have observed hematuria at the end of urination in some stallions with urethral rents, simultaneous with ischial muscle contractions. Therefore, observation of the stall for blood and the horse’s hind limbs for dried blood are important. It should be noted that urethral defects can heal or begin to seal over with sexual rest and that not all ejaculates are contaminated. A stallion that presents for evaluation of a urethral rent may need to have semen collected several times over hours to days to incite hemorrhage, which can then be confirmed through urethroscopy as being caused by urethral rent.

Urethral rents are located on the convex aspect of the urethra at the level of the ischial arch. Although hypotheses have been made that this area of the urethra is inherently weaker, histologic examination of this region in geldings and stallions with normal and affected urethras did not demonstrate any differences in the lamina propria, urethral mucosa, or corpus spongiosum penis thickness. Defects are linear, longitudinal, and range from 3 to 10 mm in length.

Treatment for urethral rent begins with sexual rest. In some stallions, adequate sexual rest results in complete resolution of hemospermia and rent healing. The most commonly used surgical technique to treat urethral rent is that of subischial urethrostomy. Alternatively, through the use of the same surgical approach, the urethra may not be incised. Dissection of these tissues allows for decreased corpus spongiosum penis pressure during erection at the level of the rent, which can facilitate healing. Topical corticosteroids and or nitrofurazone have been placed in the surgery site during healing. The incisions are left to heal by second intention. Postoperative complications include urethral stricture, infection, fistula formation, or recurrence of urethral rent.

Semen may be collected after several months of convalescence. In some cases, the rent may not completely heal until the following breeding season. In a recent report, a buccal mucosal urethroplasty successfully treated a urethral rent in one stallion and returned it to breeding function.

Seminal Vesiculitis

Seminal vesiculitis is an important disease of stallions that is probably under-reported and can be associated with hemospermia. Bacterial vesicular adenitis results in contamination of the ejaculate with mucopurulent debris, which may be apparent as chunks or pus. The ejaculate ranges in color from bloody to brown. Often, the discoloration is observed in the final jets of an ejaculate. On gross inspection, normal-appearing ejaculate may be diagnosed microscopically by the presence of a large number of neutrophils. Palpation per rectum of the glands may demonstrate enlargement of one or both glands, and, in acute cases, may elicit pain. In one case, colic and self-mutilation behavior were described in association with seminal vesiculitis. Diagnosis is performed by endoscopic examination of the seminal vesicles, including collection of samples for bacteriology. Common isolates include Pseudomonas, Klebsiella pneumonia, Streptococcus spp., and Staphylococcus spp., although in some cases no specific pathogens are isolated. The
pathogenesis and risk factors of the disease are not known. Treatment options include systemic antibiotics and anti-inflammatory drugs as well as endoscopic-assisted lavage of the seminal vesicles and infusion of antibiotics. To attain high antibiotic concentration in the seminal fluids, an antibiotic must have a high pKa and lipid solubility; gentamicin has been demonstrated not to penetrate the seminal vesicles.34 There are no large studies that provide epidemiologic data on prognosis for recovery from this disease. In some cases, resolution is possible. In others, the reproductive management of the stallion is altered to reduce risk of transmission of pathogenic bacteria to mares and improve pregnancy rates. One study of fertility that used semen from a P aeruginosa–infected stallion demonstrated pregnancy rates of 78% (seven of nine) when mares were artificially inseminated with semen that had been incubated in a polymixin-B–containing extender for 20 to 30 minutes.37 Pregnancy rates of 50% (two of four) were achieved when mares were infused with the same extender immediately before live-cover mating.37 A recent report described a stallion with Streptococcus spp. seminal vesiculitis that was medically managed to facilitate semen cryopreservation.38

4. Case Series

Materials and Methods

A retrospective study was performed of stallions that had presented to the Washington State University Comparative Theriogenology service between 2003 and 2012. Eight cases met the inclusion criteria of stallions with hemospermia. The mean age at the time of presentation was 10.1 years (range, 6–20 years). Quarter Horses represented 50% of the affected animals; other breeds represented were Appaloosas (25%) and Arabians (25%). Fifty percent of cases were referred from the primary veterinarian for advanced examination.

Case 1

An 11-year-old Appaloosa stallion was referred for evaluation of hemospermia. Blood had been observed during dismount after two live-cover matings. The horse had been placed on a 10-day course of trimethoprim-sulfamethoxazole by the referring veterinarian after urethral cultures were positive for bacteria (results of which were not available). After 1 month of sexual rest, semen was collected again, and hemospermia was noticed. The history also included unilateral testicular degeneration associated with a kick by a mare 5 years previously.

On presentation, the horse demonstrated normal physical examination parameters. The left testis was small and fibrotic, consistent with the history. Semen was collected through the use of an artificial vagina. On gross examination, hemospermia was observed, and blood continued to drip from the penis for several minutes after collection. Urethroscopy demonstrated a rent approximately 4 cm distal to the bulbourethral gland orifices on the convex surface of the urethra (Fig. 1). Induction of ex copula ejaculation was attempted, but ejaculation did not occur. The horse was discharged with instructions for sexual rest. The horse was examined 5 months later. Two ejaculates collected 30 minutes apart were free of erythrocytes. Bacteriological samples of the urethra before and after ejaculation were negative for reproductive tract pathogens. The horse resumed standing at stud for several years thereafter.

Case 2

A 20-year-old Quarter Horse stallion was referred for evaluation of hemospermia. He was used for live-cover breeding. One year previously, he was diagnosed with penile squamous cell carcinoma, which was confirmed by biopsy. Information regarding treatment was not available. The horse covered eight mares in the current season, with occasional hemorrhage noted after erection or mating. Fertility data were not available. The stallion was referred for evaluation after live-cover mating was attempted, but the horse did not ejaculate, and frank blood was noted from the penis.

On presentation, the horse was in good body condition. The physical examination parameters were within normal limits. The horse was teased, and semen collection was attempted by means of an artificial vagina. The horse did not ejaculate, became acutely painful, and dismounted. Frank hemorrhage was noted from the urethral fossa. The horse was sedated for examination. The urethral fossa contained two ulcerated areas approximately 1 cm
in diameter (Fig. 2). The dorsal surface of the glans penis as well as the body had depigmented, firm, raised areas. The lesions were suggestive of recurrence of SCC. Urethroscopy was unremarkable. Transrectal palpation and ultrasonography demonstrated a large, firmly adhered mass associated with the left inguinal ring, which may have represented metastasis to the internal inguinal lymph node (Fig. 3). Induction of ex copula ejaculation was attempted on two occasions, with no resultant ejaculation. Several treatment options were presented including partial phallectomy, en bloc resection of the penis and lymph nodes, radiation, and chemotherapy (oral piroxicam and topical 5-FU), all of which were declined by the owner. Follow-up by telephone revealed that after 6 months, the horse developed preputial and penile swelling, which resulted in penile prolapse. Treatment was unsuccessful, and the horse was euthanized.

Case 3
An 8-year-old Arabian stallion presented for semen collection and cryopreservation. On gross examination, initial semen collection resulted in hemospermia. Examination after collection demonstrated an erosion of the urethral process (Fig. 4). Cytology demonstrated a nondiagnostic cellular atypia. Urethroscopy was unremarkable. The horse was placed on a regular collection schedule for semen collection and cryopreservation. The horse continued to have intermittent hemorrhage from the urethral process, especially if teased or washed vigorously. Induction of ex copula ejaculation was unsuccessful. The horse was managed by increasing the intercollection interval to 4 to 7 days, with minimal handling and teasing time. This management resulted in successful collection of semen without hemospermia and healing of the urethral process. Frozen semen was shipped on several occasions and had acceptable fertility (data not available).

Case 4
An 8-year-old Quarter Horse stallion was referred for evaluation of hemospermia. He had successfully bred seven of eight mares in the previous year. At the time of presentation, he had been live-cover-mated to one mare, and blood was observed on the penis and the mare’s vulva on dismount. On presentation, the horse’s physical examination param-
eters were within normal limits. There was dried blood on the penis. The horse was washed, and two ejaculates were collected at 30-minute intervals. No hemospermia was noted. The ejaculates were pooled and processed for cryopreservation. The horse resumed a successful career at stud.

Case 5
A 7-year-old Quarter Horse stallion presented for evaluation of hemospermia of 2 weeks’ duration. Hemorrhage from the penis had been noted on erection, after breeding, and lasting for up to 30 minutes after breeding. On presentation, the physical exam was unremarkable. Semen was collected; blood was observed from the urethra on erection. On gross inspection, hemospermia was evident. Urethroscopy demonstrated two urethral rents, located 40 and 55 cm from the urethral process, respectively. Induction of ex copula ejaculation was successful, but hemospermia was evident (Fig. 5). After 6 months of sexual rest, no hemospermia was noted on semen collection. The horse was thereafter lost to follow-up.

Case 6
A 6-year-old Arabian stallion was referred for evaluation of hemospermia of 3 years’ duration. After the initial observation, the referring veterinarian diagnosed a urethral process lesion. A biopsy of the urethral process demonstrated inflammation and dystrophic mineralization. The lesion was treated with a topical antimicrobial ointment for 10 days. One month later, granulation tissue was surgically removed from the urethral process. Subsequently, the horse was used as a teaser stallion. Semen was collected 1 month before presentation, and hemospermia was observed (the ejaculate was pink). Examination of the stallion demonstrated several small ulcerations of the urethral process that were not actively bleeding. Urethroscopy was unremarkable. Induction of ex copula ejaculation was unsuccessful. Semen was collected through the use of an artificial vagina. Semen was free of erythrocytes. After collection, the urethral process was erythematous and inflamed. Subsequently, the stallion was no longer needed for teasing, and castration was elected.

Case 7
A 13-year-old Quarter Horse stallion presented for examination of hemospermia of 1 week’s duration. Blood clots had been observed from the horse’s penis after live-cover mating. The horse had been submitted the previous season to our service for collection and cryopreservation of semen. Semen was collected twice, with no evidence of hemospermia; semen was processed for cryopreservation. Urethroscopy demonstrated a healing urethral rent at the level of the ischial arch (Fig. 6). After a period of sexual rest, the horse successfully bred several mares. Five months later, hemospermia was again noted. Semen was collected at the clinic three times within 35 minutes, and no hemospermia was noted; ejaculates were processed for cryopreservation.
After 7 months of sexual rest, semen from this horse was collected at the farm, and hemospermia was again observed. The owner of the horse indicated that the phantom used to collect semen at the farm was of a steeper angle than the phantom at our clinic; the significance of this to the lack of hemospermia observed at our clinic is unknown. Semen from this horse was collected twice at the clinic; the second ejaculate demonstrated overt hemospermia. Urethroscopy demonstrated a second urethral rent, parallel to the one observed the previous season. The rent was associated with an elevated area of tissue suggestive of corpus spongiosum prolapse into the urethra. Several options were presented to the owner, including subischial urethrostomy, which was declined. To manage the stallion medically, sexual rest was implemented for 9 days, after which semen was collected. Overt hemospermia was observed (Fig. 7). The semen was centrifuged with the use of density gradient centrifugation; however, too few spermatozoa for cryopreservation were recovered with the use of this technique. After another week of sexual rest, semen was collected 2 hours after administration of imipramine and minimal teasing to reduce the duration of corpus spongiosum pressure on the rent; hemospermia occurred. The horse had several observations of hematuria and blood dripping from the penis in the stall. Three attempts to induce ex copula ejaculation were unsuccessful. Currently, the horse is still under the care of our clinic and scheduled for examination after 10 months of sexual rest. Hematuria has not been recently observed.

Case 8
An 8-year-old Appaloosa stallion presented for semen collection and cryopreservation. Semen had been previously collected from this horse (4 years old) for cryopreservation at our clinic. The horse had an unremarkable health history and the physical examination was within normal limits. While being washed for semen collection, the horse kicked the penis with his left hind leg. On gross inspection, collected semen had hemospermia. The penis did not demonstrate any swelling or continued hemorrhage. After 2 days of sexual rest, semen was again collected and was not contaminated with erythrocytes. The horse resumed a normal collection schedule, with no further hemospermia.

5. Discussion
A common complaint in breeding stallions, hemospermia is detrimental to fertility and can result in considerable financial losses as well as reduced welfare of affected animals. The ability to diagnose hemospermia in breeding stallions is of significant importance to the equine practitioner.

Several breeds are over-represented in diagnosed hemospermia cases. A report of 18 cases demonstrated 15 Quarter Horses, three Appaloosas, and one Arabian. Three cases of hemospermia caused by urethral rent were found in two Quarter Horses and one Appaloosa. Buccal urethroplasty was performed in a Quarter Horse. The breeds represented in our study were very similar to those previous studies (four Quarter Horses, two Appaloosas, and two Arabians). The mean age at presentation in our study (10.1 years; range, 6–20) was comparable to that in the study by Sullins et al (7.1 years; range, 3–18).

There are many etiologies to hemospermia. Often, the history includes a change in collection phantom height or angle. This may change the pressure on the horse during collection and predispose to hemospermia. One example is the horse in Case 7, which demonstrated hemospermia when collected on the farm but less often when collected at the clinic. This may also be a feature of Case 4 and demonstrates that variation in washing technique, stallion handling, and the phantom may result in intermittent hemospermia that spontaneously resolves. The practitioner must be astute in examination of the horse to identify external lesions, such as urethral process lesions, habronemiasis, equine herpesvirus-3, SCC, or blunt-force trauma. In the absence of external lesions, the practitioner must be educated in the practice of or have means to refer the horse to a specialist for advanced diagnostics, including urethroscopy. In the current case series of eight affected stallions, diagnoses included urethral rents (n = 3), urethral process lesions (n = 2), squamous cell carcinoma (n = 1), kick to the penis (n = 1), and unknown origin (n = 1). Sexual rest returned four horses to breeding; one was castrated; one was not treated; and one is still under manage-
ment by our service. These diagnoses are in contrast to Sullins et al., who diagnosed 18 cases of hemospermia caused by urethral rent (n = 1), urethritis (n = 11), urethral varicosities (n = 4), lymphosarcoma (n = 1), and unknown origin (n = 1). Of those 18 cases, 15 were treated by subischial urethrostomy. Of three treated with sexual rest, one died (lymphosarcoma) and two returned to breeding function. Of three stallions diagnosed with urethral rents, one returned to breeding function after 11 months of sexual rest, one was castrated 6 weeks after urethrostomy when hemospermia recurred, and one resumed breeding function 10 weeks after urethrostomy.29

If surgical options are not elected to manage hemospermia, whether caused by urethral rent or SCC, the practitioner must be prepared to manage affected horses medically. In our clinic, one stallion, for which subischial urethrostomy was repeatedly declined, was treated medically by use of imipramine to lower the ejaculatory threshold before semen collection. In two stallions, semen collection was attempted with minimal washing and teasing time to lower the risk of hemorrhage from erectile tissues. In six of the eight stallions (75%) presented here, semen collection was attempted ex copula. The one successful ejaculate was erythrocyte-contaminated. Ex copula ejaculation allows for collection of concentrated semen without high corpus spongiosum pressures, although stallions with urethral rents may still bleed, as in Case 5. Although the technique was not successful in the majority of our cases, it is a technique that we perform regularly in our clinic on debilitated stallions for genetic preservation.

If hemospermia is unable to be managed medically, ejaculates can be manipulated to increase pregnancy rates. Semen from one stallion in our study was density-gradient centrifuged to obtain un-contaminated semen. It has been demonstrated that placing an extender in the uterus before live-cover mating may counteract some of the negative effects of erythrocytes on spermatozoa. Semen from stallions with seminal vesiculitis can be extended with antibiotic-containing extender or placement of that extender in the mare.37 Collection of semen in fractions may help to improve fertility if only erythrocyte-free jets are processed for artificial insemination.

The effects of hemospermia on fertility have been documented.27 The presence of blood in the ejaculate has not been shown to affect spermatozoa morphology; however, in one study, the progressive motility and plasma membrane integrity were lower in semen with 10% or 20% added whole blood compared with unaffected ejaculates.39 It was noted in that study that spermatozoa appeared to accumulate around the erythrocytes. In another study, semen with 20% added whole blood resulted in a per-cycle pregnancy rate of 7.7%, whereas per-cycle pregnancy rates with the use of unaffected semen or semen with 20% added serum were 28.6% and 50%, respectively.27 These studies demonstrate that the infertility observed in hemospermia cases are the result of the erythrocyte presence in the ejaculate and not the presence of serum, although the mechanism whereby this infertility occurs is still unknown and warrants further investigation.

Despite the medical and surgical techniques available to practitioners to manage stallions with hemospermia, no technique is 100% effective. To ensure acceptable fertility from breeding stallions, practitioners must educate stallion owners that collection and cryopreservation of semen from stallions when the horses are young and healthy is the best guarantee against future financial losses caused by stallion debilitation or death, including hemospermia. In one of our cases, the horse was managed medically for urethral rent during the breeding season, yet mares were still able to be bred through the use of previously frozen semen, preventing the farm from losing a foal crop.

6. Summary
Hemospermia can be devastating to a stallion's fertility and welfare. The prognosis for recovery of breeding function and life are dependent on the diagnosis. Practitioners who work with breeding stallions should educate stallion owners on the importance of routine breeding soundness examinations at the beginning of each breeding season and routine collection and semen cryopreservation of healthy stallions. These practices will help to identify any pathology early, which can result in higher treatment success and survival rates, especially for SCC. Practitioners who diagnose hemospermia in breeding stallions but are unable to manage the horse should actively seek referral to a specialist.

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