

Practical review of diagnosis, treatment, and prognostic indicators of acquired conditions of the penis and prepuce in the bull

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Abstract

This review will discuss the most common acquired conditions of the penis and prepuce in the bull along with diagnosis, treatment, and prognosis for each of those conditions. Conditions discussed will include preputial lacerations, penile hematomas, retropreputial abscesses, phimosis/paraphimosis, and deviations of the penis. It is the intent of this manuscript to arm practitioners with clinically important knowledge regarding medical treatment and prognosis so that they may assist producers in the decision-making process following the identification of a reproductive injury or defect in a bull. This manuscript will not discuss surgical interventions in depth but will discuss when surgical intervention is warranted.

Keywords: Bovine, penis, prepuce, preputial trauma

Introduction

Breeding bulls can present to the veterinarian for a variety of issues and concerns involving the penis and prepuce. However, some conditions of the penis and prepuce may not be readily evident to the owner and may only be noted by the veterinarian during a routine bull breeding soundness exam. Regardless of the presentation this review will highlight the most noted acquired conditions of the penis and prepuce. It is the intent of this review to be helpful to the practitioner in the diagnosis, medical treatment and communicating a future prognosis for breeding bulls that are diagnosed with one of the following acquired conditions.

Anatomy of the sheath, prepuce, and penis

The sheath of the bull is considered a double invagination of skin that contains the nonerect penis.¹ The diameter and length of the prepuce vary from bull-to-bull and more significantly from breed to breed with *Bos indicus* and *Bos indicus*-influenced bulls having significantly more sheath and prepuce length as compared to *Bos taurus* bulls. The average length of the prepuce in bulls is 35–40 cm and ~4 cm in diameter. There is a gradual transition from the haired sheath to the non-haired prepuce. The prepuce terminates at the area of the preputial ring where it joins the glans penis. There are many interdigitating layers of elastic tissue between the tunica albuginea of the penis and the epithelium of the prepuce

which allows the penis to be freely movable within the sheath and go from the retracted state to fully extended and erect.¹

Anatomy and physiology of erection

In the fibroelastic penis of ruminants, erectile tissues of the corpus cavernosum penis (CCP) are contained within a strong, relatively inelastic tunica albuginea. Most of the blood contained within the CCP enters through the crura of the penis and all blood contained within the CCP must exit through the crura. Following sexual stimulation, reflex dilation of arteries supplying the penis increases blood flow through the deep artery of the penis into the crura and subsequently into the CCP. The stimuli which increase blood flow through the crura also relax the retractor penis muscles, thereby removing traction from the sigmoid flexure and allowing the tip of the mildly engorged free portion of the penis to extend from the sheath. With continued sexual stimulation, the paired ischiocavernosus muscles overlying the crura initiate rhythmic contractions, compressing the crura against the ischium to occlude vascular flow into and out of the CCP, thereby creating a closed hydraulic tube. Additional rhythmic contractions of the ischiocavernosus muscles increase the pressure of the blood contained within the crura and CCP to generate the high pressures required for full erection and extension. Following ejaculation, the ischiocavernosus muscles relax and intrapenile pressures return to baseline as blood exits the CCP through the crura.^{2,3}

Preputial trauma

Eversion of the prepuce

In *Bos taurus* bulls carrying the polled gene, some degree of eversion of the prepuce is common when they are relaxed, although it is uncommon in horned bulls. Bulls that are heterozygous or homozygous for the polled gene lack the paired retractor prepuce muscles which normally function to retain the internal lamina of the prepuce within the preputial orifice.⁴⁻⁶

In *Bos indicus* and *Bos indicus*-influenced breeds with a pendulous sheath conformation, the length of the internal lamina of the prepuce and the size of external os of the prepuce predispose bulls to eversion of the prepuce or preputial prolapse.⁷ In some affected bulls, 1.27 to 10.16 cm of preputial skin is commonly everted.⁷ However, the length of everted preputial skin demonstrated by some bulls may exceed what has been previously reported in literature.

Bulls with a high degree of preputial eversion are more subject to preputial lacerations, frostbite, and other trauma to the prepuce.⁸ If the exposed prepuce is free of lesions and the bull can retract the prepuce when stimulated, the everted prepuce should not affect the potential to breed.⁹

Preputial lacerations

Bulls with a pendulous sheath and excessive preputial skin may traumatize preputial tissues separate from the breeding act. Regardless, most preputial lacerations in bulls occur at the time of the ejaculatory lunge. As the free portion of the penis enters the vagina during coitus, preputial skin slides caudally up the shaft of the penis and folds of redundant skin gather at the preputial orifice. This bunching of preputial skin usually occurs without incident, but if the redundant preputial skin is entrapped between the bull's abdomen and the bony pelvis of the female, it can be traumatized by the compressive forces during the ejaculatory lunge. In mild cases, the preputial epithelium remains intact and subsequent edema in the damaged tissues results in an uncomplicated preputial prolapse. However, if compression of the entrapped prepuce results in sufficient pressure, it can cause bursting of the epithelium and damage to underlying elastic tissues.¹⁰ Lacerations of the prepuce with subsequent preputial prolapse are more common in *Bos indicus* breeds and their crosses than in *Bos taurus* bulls, due to the pendulous sheath, excessive length of prepuce, and/or large preputial orifices in those breeds. Even serious preputial injuries in *Bos taurus* bulls often do not result in preputial prolapse.¹¹

Rupture of the epithelium of the prepuce at the time of the ejaculatory lunge predictably occurs longitudinal to the long axis of the ventral aspect of the prepuce, but the wound assumes a transverse orientation as the bull attempts to retract the penis into the preputial cavity. The resulting transverse orientation of the laceration effectively shortens the length of the traumatized tissue.¹¹

Following preputial injury, bulls of *Bos taurus* breeds are usually able to retract the damaged prepuce into the preputial cavity and the injury goes unnoticed until cellulitis, abscessation, or stenosis occurs. In contrast, edema in the traumatized tissue frequently causes preputial prolapse in *Bos indicus* type

bulls. The dependent edema increases the size and weight of the prolapsed tissue, leading to prolapse of an additional portion of the prepuce, thereby worsening the condition.³ Preputial prolapse is often more severe in naturally polled bulls, due to the lack of retractor prepuce muscles, as these muscles serve to elevate the prepuce and this elevation can minimize edema formation in damaged tissues.⁴⁻⁶

Wolfe and Carson constructed a useful 4-point classification scale that incorporates severity of the preputial injury to derive a prognosis for return to function and guide treatment decisions¹¹ (Table 1 and Figure 1).

Goals of medical management of preputial lacerations and subsequent prolapse are to control sepsis, reduce edema, and eventually return damaged tissues to the preputial cavity. Begin therapy by thoroughly cleaning and flushing the wound with dilute antiseptic, combined with gentle debridement of devitalized, necrotic tissue. Following cleansing and debridement, an application of emollients and topical antibiotics can be applied to the preputial tissue. The purpose of this is to prevent further desiccation and reduce infection within tissues. 'Petecillin' also known as 'Petermycin' is a mixture of anhydrous lanolin, oxytetracycline, and scarlet oil and often used as an emollient and topical antibiotic treatment.¹¹ However, scarlet oil is not an U.S. Food and Drug Administration (FDA) approved product and AMDUCA only allows for extra label drug use for FDA approved products. Other topical treatments reported are the use of betadine sugar mixture as well as the use of silver sulfadiazine (SSD) cream. Following application of topical preparation of choice, the injured tissues should be covered with bandaging.

To begin preputial bandage, insert a latex tube into the preputial orifice to allow urine to egress from the prepuce. Once the tube is correctly placed such that the proximal end is proximal to the proposed bandage, place an orthopedic stocking over

Table. Preputial injury classifications by Wolfe and Carson.¹¹

Category	Description
I	Simple preputial prolapse with slight-to-moderate edema without laceration, necrosis, or fibrosis. Respond well to medical or surgical treatment. Good prognosis for return to service.
II	Prolapsed prepuce has moderate-to-severe edema, may have superficial lacerations or slight necrosis, but no evidence of fibrosis. Surgery is usual course of therapy. Good to guarded prognosis.
III	Severe edema of the prolapsed prepuce with deep lacerations, moderate necrosis, and slight fibrosis. Surgery is indicated with guarded prognosis.
IV	Prolapsed prepuce has been exposed for an extended interval and there is severe edema, deep lacerations, deep necrosis, fibrosis, and often abscessation. Culling of bull usual recommendation. Guarded to poor prognosis follows surgery.

the exposed tissue. Then apply a snug elastic tape bandage beginning at the distal end of the prolapsed tissue and working proximally, overlapping the tape as it advances up the prolapsed tissue and preputial orifice to the sheath where it can be adhered to haired skin^{3,11} (Figure 2). Ensure that the bandage applies sufficient compression to reduce edema but does not strangulate tissues.



Figure 1. Grade 3 preputial prolapse.



Figure 2. Bandaging of prepuce: a urine egress tube has been placed within the preputial cavity. The tube and sheath have been covered with an orthopedic stocking and covered in an elastic tape bandage material.

For bulls with a very pendulous prolapse and severe edema, utilization of a sling made of net or burlap allows the prepuce to be held close to the abdomen to encourage lymphatic flow and reduction of edema (Figure 3). Frequent bandage changes are necessary, and when bandages are changed, perform 15–20 minutes of hydrotherapy to the wound to assist in edema reduction and removal of devitalized tissue. Some bulls with minor injuries may return to service without surgery, although recurrent injuries are common.¹¹

Surgical resection and anastomosis of the preputial scar can improve outcomes and are indicated when the bull's value warrants the investment.^{12–14} Surgical outcomes are improved by preoperative wound management, as described above.

Retropreputial abscesses

Retropreputial abscess formation following preputial laceration occurs more commonly in bulls of *Bos taurus* breeds than in *Bos indicus* breeds. Following preputial injury, *Bos taurus* bulls often retract the penis into the sheath so that prolapse of the prepuce does not occur. Consequently, the injury commonly goes unnoticed until the laceration becomes contaminated and cellulitis and abscessation ensue (Figure 4). Needles should never be introduced transdermally into the abscess. Phlegmon may extend from the preputial orifice to the scrotum, or the swelling may be confined to a small, well-defined area along the sheath. Retropreputial abscesses can be differentiated from penile hematomas as retropreputial abscesses are located more distally along the shaft of the penis closer to the preputial orifice and are seldom symmetrical as compared to a penile hematoma. Careful physical examination of the swelling is warranted as abdominal abscesses may occur near the sheath but not directly communicate with the sheath and prepuce giving the bull a much better prognosis for recover. Ultrasound may be useful in these cases to determine extent of damage and associated anatomical landmarks.

Treatment options are limited to systemic antibiotic therapy and local treatment with cold-water hydrotherapy to reduce edema. Occasionally drainage into the preputial cavity can be established at the site of the disruption of the preputial skin.



Figure 3. Burlap cloth is used to elevate the pendulous prepuce. The burlap cloth can be secured with elastic bungee cords.



Figure 4. Retropreputial abscess characterized by the location more distally along the shaft of the penis closer to the preputial orifice and asymmetrical appearance between left and right side of the animal.

Efforts to use endoscopy to induce drainage into the preputial cavity have met limited success (Personal communication, C. Armstrong). Retropreputial abscesses should never be drained through the skin of the sheath as the procedure will likely extend the infection through the peripenile elastic layers and increase subsequent adhesion formation.

Prognosis for return to breeding soundness is always guarded for bulls with a retropreputial abscess, as adhesions within the elastic tissues or between the elastic layers and the skin of the sheath can interfere with penile extension. Only a small percentage of bulls heal sufficiently to allow normal penile extension and return to service.

Penile hematoma

In bulls, the term hematoma of the penis is used to indicate the condition which follows rupture of the tunica albuginea of the penis. This condition is also referred to as a broken or fractured penis. During normal erection, venous outflow to the CCP is obstructed and contraction of the ischiocavernosus muscles increases pressure within the penis to approximately 14,200 mmHg.^{2,15} During the normal coital act, the bull

mounts, makes one or two searching motions with the penis to locate the vulva, and achieves intromission and ejaculation with a single forceful lunge. If the penis is outside the vulva during the ejaculatory lunge and is thrust against the escutcheon of the female or if the female collapses during coitus, severe angulation of the penile shaft drastically increases the intracorporeal pressure to greater than 70,000 mmHg, a level sufficient to rupture the tunica albuginea.¹⁶ The most common site for rupture is on the dorsal surface of the distal sigmoid flexure, just above the point of insertion of the paired retractor muscles, although in rare instances it may occur at other locations.^{17,18}

The erect penis contains less than 250 mL of blood at the time of rupture of the tunica albuginea. This blood is under pressure at the time of rupture and forcefully enters the peripenile elastic tissue, creating a symmetrical swelling in the sheath immediately cranial to the base of the scrotum. The hematoma may grow if repeated sexual stimulation induces additional attempts at erection due to continued leakage of blood through the rent in the tunica albuginea. Occasionally, the swelling may extend caudally along the retractor penis muscles.

Hematoma of the penis is readily diagnosed by physical examination and ultrasound and can be differentiated from a retropreputial abscess by the typical location and symmetry of the swelling. Mild to moderate prolapse of the prepuce, which may have a distinct bluish tint secondary to the subcutaneous blood, is often the first sign of injury that an owner notices, albeit it may not be present in every bull. This prolapse of the prepuce occurs secondary to edema.

Subcutaneous hemorrhage may be evident on the sheath near the scrotum in light-colored bulls. Palpation of the symmetrical swelling on the dorsum of the distal bend of the sigmoid flexure of the penis confirms rupture of the tunica albuginea. The penis will not extend due to swelling within elastic tissues. Do not attempt to manually extend the penis or use an electroejaculator in cases of rupture of the tunica albuginea, as such efforts may exaggerate damage to the already damaged elastic tissues.

Rupture of the tunica albuginea may result in loss of reproductive function. Multiple complications following rupture of the tunica albuginea may occur and include: abscess formation at the site of the hematoma, adhesions between the penis and peri-penile tissues, development of vascular shunts between the CCP and the surrounding vasculature, injury to the prolapsed prepuce, and damaged or destruction of the dorsal nerves of the penis.³

Approximately 50% of bulls with rupture of the tunica albuginea of the penis resume breeding following conservative (non-surgical) therapy consisting of at least 60 days of sexual rest, prophylactic systemic antibiotic therapy to prevent abscess formation following hematoma, hydrotherapy of the sheath to promote circulation multiple times a day, and treatment of the preputial prolapse if warranted.¹¹ Conservative therapy alone may be indicated when diagnosis is delayed, or the economic value of the bull does not justify the expense of surgery. The bull should undergo a complete breeding soundness examination prior to being returned to service and the owner should be advised of all potential complications. Owners should also be advised to monitor the bull during the

breeding season to ensure that intromission is occurring as loss of sensation of the glans penis is a sequela that has been reported following injury and consequent return to service in bulls that suffered a penile hematoma. Adhesions formed following the rupture and consequently the tearing of adhesions during breeding are thought to damage the nerves at the distal bend of the sigmoid flexure. The adhesions are not severe enough to inhibit full extension of the penis.¹⁹

Surgical treatment to remove the blood clot and suture the rent in the tunica albuginea, when performed 3–7 days after the injury, can result in approximately 80% of bulls returning to breeding soundness.¹¹ Owners should be advised that even following successful management and resolution, recurrence is possible during subsequent breeding.

Phimosis and paraphimosis

Phimosis or the inability to extend the penis is most common secondary to preputial stenosis resulting from scar tissue¹¹ (Figure 5). Other causes of phimosis include a short penis that is simply too short to extend beyond the preputial orifice when erect, adhesions within the elastic layers of the prepuce and surrounding epithelium, or large penile fibropapillomas.

Extension of the penis is dependent upon the gliding of the elastic tissues and preputial epithelium to allow the free portion of the penis and internal lamina of the prepuce to exit the preputial orifice. Formation of adhesions between the penis, elastic tissue, and skin following trauma may effectively



Figure 5. Severe preputial stenosis secondary to injury leading to phimosis.

inhibit the movement of the penis, resulting in complete or partial impairment of penile extension. The site of the adhesion may be identified by palpation or visualization of skin gathering or wrinkling over the adhesion during an attempted erection.

Stenosis of the preputial lumen may occur after preputial injury, and subsequent management (either medical or surgical). Contraction of scar tissue that replaces damaged elastic tissue leads to constriction of the preputial lumen and resulting preputial stenosis can prevent extension of the penis. Stenosis may be severe enough to interfere with the evacuation of urine from the preputial cavity. Large penile fibropapillomas may also result in phimosis if the diameter of the fibropapilloma is larger than the preputial orifice.

Paraphimosis, the inability to retract the penis, may occur following preputial laceration or preputial trauma (Figure 6). Preputial contusions or lacerations with subsequent edema prevent retraction of the penis into the sheath. Rarely bulls with balanoposthitis caused by herpes virus infection extend the inflamed penis and prepuce, which then becomes edematous, preventing penile retraction.

Regardless of the reason for the paraphimosis, the exposed skin of the penis and prepuce will desiccate and the superficial layers of the skin become necrotic and slough. To protect the penile skin, apply an emollient ointment containing an antibacterial agent on the exposed penis and prepuce and cover it with orthopedic stockinette then apply a pressure bandage as described above. Daily bandage changes and cold water hydrotherapy may reduce edema. Continue daily bandage changes until the bull can retract the penis then continue to infuse the emollient and antibiotic ointment for 7–10 days in attempt to reduce the risk of preputial stenosis. Paraphimosis secondary to preputial lacerations has only a fair-to-guarded prognosis for return to breeding soundness, depending on the extent of the injury and the timeliness of treatment. Bulls with paraphimosis caused by herpes viral infections have a good prognosis for return to breeding soundness, unless there is deep necrosis of the peripenile elastic tissues. Bulls severely affected with infectious pustular balanoposthitis should be given a minimum of a 30 days sexual rest.¹¹

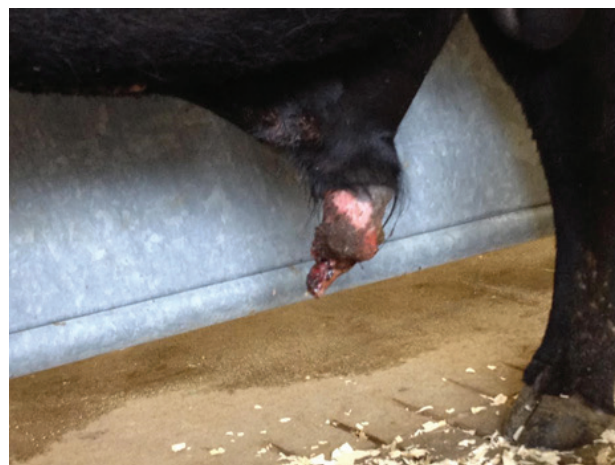


Figure 6. Paraphimosis secondary to preputial trauma. Severe necrosis of the prepuce and penis offer a grave prognosis.

Inability to make intromission

Erection failure

Penile engorgement begins prior to mounting in the normal bull and full erection should occur as the bull mounts to make intromission. Occasionally, painful conditions of the spine, rear limbs, or pelvis prevent the animal from achieving erection and mounting and pathology of the lumbar or sacral nerves may prevent normal function of the muscles of erection.¹¹

Determining the cause of erection failure begins with a thorough history, physical examination, and an observed test mating. An accurate breeding history is important to distinguish between congenital or acquired abnormalities. Erection in the bull depends on the penis being a closed vascular system and in the normal penis there are no venous outlets from the CCP along the body or shaft of the penis. An electroejaculator may be useful as an aid in determining if a bull is able to achieve and/or maintain an erection, but the electroejaculator does not stimulate a physiologic erection and observation of the animal's performance during an observed test mating is more reliable for diagnosis of erection failure than electroejaculation.¹⁸

When erection failure is present, contrast cavernosography is useful to determine if failure is caused by vascular abnormalities such as vascular shunts or to thrombosis of the CCP. Review and diagnosis of cavernosal shunts are discussed in other chapters within this special edition.

Deviations of the penis

Deviation of the normal alignment of the erect penis will inhibit the ability to copulate. Three types of penile deviations are described. In decreasing order of occurrence, they are the spiral or corkscrew deviation, the ventral or rainbow deviation, and S-shaped deviation.

Spiral deviation of the penis

Spiral deviation, the most common of the penile deviations, is the result of deficiencies in function of the dorsal apical ligament of the penis that normally serves to support the erect penis and maintain the normal alignment necessary for intromission. The dorsal apical ligament originates from the tunica albuginea proximal to the base of the free portion of the penis and runs beneath the penile skin, along the dorsum of the free portion. The terminal fibers of the dorsal apical ligament rejoin the tunica albuginea near the distal end of the CCP and insert centrally with a broad set of fibers.

The terminal fibers of the dorsal apical ligament attaching to the left side of the distal penis are heavier and less pliable than those of the center or on the right side.^{20,21} Observations of a bull penis during simulated coitus using a transparent artificial vagina demonstrated that following intromission, the central portion of the dorsal apical ligament often slips to the left side of the glans near the time of the ejaculatory lunge and the penis assumes a corkscrew shape and spirals within the vagina. Most bulls exhibited spiraling within the artificial vagina to some extent, but not at every service.²² Ashdown and Smith speculated that spiraling of the penis within the vagina

following intromission might increase tactile stimulation and promote ejaculation.²³

Pathologic spiral deviation of the penis occurs when the dorsal apical ligament slips to the left side of the free portion of the penis prior to intromission. Affected bulls often have a history of one or more successful breeding seasons before the onset of impotence due to penile deviation, with most cases being diagnosed between 2.5 and 5 years of age.⁸ Histories rarely indicate previous trauma or penile injury. Abnormal spiraling usually occurs after penile protrusion; however, in some bulls, spiraling may occur within the preputial cavity.²⁴ Premature spiraling of the penis can also occur in bulls that have suffered denervation of the glans penis following injury. This phenomenon will be discussed in other chapters within this special edition.

Elements leading to the premature occurrence of this otherwise normal phenomenon are poorly understood.^{20,21,23} Malfunction of the dorsal apical ligament due to shortening of the ligament or lengthening of the penis as the bull ages was once regarded as the etiology, but this remains unproven. It is speculated that since spiraling of the penis within the vagina in normal bulls occurs concurrent with peak intra-penile pressure, pathologic spiraling of the distal penis may be the result of premature achievement of peak erectile pressure prior to intromission.⁸ Irrespective of the cause, bulls with premature spiral deviation of the penis are unable to complete the copulatory act.

Diagnosis is often apparent, but can be difficult if the pathologic deviation does not occur at every breeding attempt, especially early in development of the condition.¹¹ Diagnosis of spiral deviation should only be made after observation of the breeding act or during a test mating. Development of spiraling during electroejaculation is frequently observed and has not been predictive of a tendency to spiral during natural service. Spiraling during attempted electroejaculation should not be the sole diagnostic criterion.

Correction of spiral deviation of the penis requires surgical intervention. Several techniques for placing a fascia lata or synthetic graft between the apical ligament and the tunica albuginea of the penis to reinforce the dorsal apical ligament attachment have been described. These and other techniques are used to strengthen the attachment of the dorsal apical ligament to the dorsum of the penis and prevent premature spiral deviation of the penis.¹¹

Ventral deviation of the penis

Ventral deviation of the penis occurs less commonly than spiral deviation. The exact etiology is unknown; however, there is speculation that the deviation results from a combination of altered architecture of the tunica albuginea of the penis or apical ligament and altered blood flow through the ventral portion of the CCP. Both suspected causes are likely the result of chronic traumatic injury.¹¹ The penile body assumes a long gradual ventral curvature as erection progresses, with the deviation frequently originating proximal to the junction of the sheath and prepuce.

The degree of deviation becomes progressively more evident as erection progresses. This condition is often referred to as a 'rainbow', due to the arc formed by the erect penis. Unlike

spiral deviation, ventral deviation can be suspected based on observation during electroejaculation, but confirmation by an observed test breeding is recommended. Surgical correction of ventral deviation of the penis is less likely to be successful than correction of the spiral deviation and should only be attempted when the ventral deviation is limited to the free portion of the penis.¹¹

S-shaped deviation of the penis

The S-shaped curvature of the penis is the least common of the reported penile deviations. This condition usually occurs in bulls 4 years of age or older and is thought to be caused by inadequate apical ligament length or excessive penile length with a normal apical ligament. The condition may develop following trauma to the apical ligament with subsequent contracture and shortening of the ligament. Some affected bulls may be able to breed successfully.⁸ No successful therapy for correction of it has been described, but in bulls of high genetic merit, semen can be collected with use of an artificial vagina or electroejaculation and used for artificial insemination.

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