Diagnostic techniques for assessing bull infertility  
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Abstract
Investigating causes for bull infertility requires thorough understanding of the anatomy and physiology of erection, coitus and ejaculation. This presentation will review techniques not commonly used during a routine breeding soundness examination for exploring reproductive failure in bulls. Additionally limited therapeutic options will be discussed for management of chronic seminal vesiculitis as well as use of the pudendal nerve block to assist with extension of the penis of the bull.

Keywords: bull, breeding, erection, infertility, cavernosography

Introduction
Erection in the bull occurs when blood flow increases in the deep artery of the penis and into the crus penis and subsequently into the corpus cavernosum penis (CCP) following olfactory or visual sexual stimulation. The CCP in the bull is a closed system in that erectile blood flows into the penis from the crus and leaves this same area during detumescence following erection. The stimulation that causes this reflex dilation of the deep artery of the penis also causes relaxation of the retractor penis muscles which hold the penis in the preputial cavity. As the retractor penis muscles relax, the sigmoid flexure relaxes and the mildly engorged penis protrudes from the sheath. With continued sexual stimulation the ischiocavernosus muscles (ICM) begin rhythmic contraction which raises blood pressure from the normal resting state of 15 mmHg within the CCP. Peak pressure within the CCP may be greater than 14,000 mm Hg. This rapid increase in blood pressure within the CCP causes complete penile extension and erection. Following ejaculation the ICM relax, detumescence occurs as blood pressure within the CCP decreases and the penis is withdrawn back into the preputial cavity.1-6

Erection may be induced in the bull with an ejaculator although the optimal method for evaluating erection is with observed test mating. Normal function of the penile nerves is essential for coitus and is most accurately assessed by observed test mating or by semen collection by artificial vagina.7

Test mating
Bulls with erectile dysfunction do not achieve sufficient erection pressure to complete coitus.6,8 Bulls with nerve dysfunction mount the cow but there are no penile searching motions near the vulva and the bull fails to make intromission.9,10 Usually the penis is placed along the cow’s hip or below the vulva in the escutcheon area above the cow’s udder.

Semen collection with an artificial vagina
Semen collection with a properly prepared artificial vagina (AV) can confirm that a bull has the sufficient erection and sensation to ejaculate. The temperature within the AV should be 45 to 50°C and sufficiently filled to provide mild pressure on the erect penis. Most reasonably docile beef bulls can safely be collected with an AV as they mount a female in estrus.9 Failure to ejaculate into the AV could result from in sufficient pressure within the AV or in appropriate liner temperature for that particular bull. More likely failure to ejaculate would be due to a painful condition of the back or hind limbs or to lack of nerve sensitivity of the dorsal nerves of the penis.

Contrast cavernosography for evaluation of the erection failure or penile deviation
Contrast radiography of the corpus cavernosum penis may confirm vascular defects in the penis.10-12 The procedure is most easily accomplished with the bull restrained on a table in lateral recumbency. Manually extend the penis and place a towel clamp under the dorsal apical ligament
approximately 6-10 cm from the distal end of the penis to aid in manipulation of the penis. Percutaneously place a double strand of heavy suture (0.6 mm) between the retractor penis muscles and the penis to retract the penis away from the abdominal wall in order to enhance visualization of the sigmoid flexure of the penis. The radiographic series will consist of two or three film exposures taken as quickly as practicable progressing from the free portion to the distal bend of the sigmoid flexure.

On the dorsum of the penis near the towel clamp insert a 16-gauge x 3.8 cm needle at a 45° angle proximally through the tunica albuginea and into the CCP. After attaching a sterile extension set to the needle for ease of injection and to position the hands away from the radiographic field inject 10 ml sterile saline which should flow into the CCP with ease. Place a radiographic cassette under the penis then rapidly inject 15 ml of water-soluble radiographic contrast medium (Renograffin 76, Squibb Diagnostic, New Brunswick, NJ) and expose the film. Slowly inject an additional 15 to 30 ml of medium as the radiographic series is performed. Remove the cassette and quickly place another cassette more proximal under the penis. By using 43 cm-long cassettes the entire penis up to the sigmoid flexure may be radiographed with two or three exposures. Ideally all radiographic exposures should be completed within 60 seconds.

The normal bovine penis has no vascular communications from the CCP to peripenile vasculature. Presence of contrast medium outside the CCP is evidence of a vascular shunt as a potential cause for erection failure. Alternatively, failure of complete filling of the vascular spaces within the CCP may indicate fibrosis or failure of proper development of the internal architecture of the penis. These conditions usually result in partial erection failure or deviation of the erect penis.

**Erection failure due to corpus cavernosal shunts**

**Congenital vascular shunts**

Occasionally young bulls fail to achieve intromission due to congenital corpus cavernosal vascular shunts. These bulls usually are normal on physical examination but fail to achieve adequate intracorporeal pressure for erection. When observed during erection, either by test mating or with electroejaculation the free portion of the penis becomes noticeably bluish during attempted erection. The bluish discoloration is due to blood from a relatively porous tunica albuginea of the penis exiting the corpus cavernosum penis and being removed by subcutaneous capillaries and veins. These shunts may be confirmed by cavernosography. Typically the shunts are multiple and not considered repairable.

**Acquired vascular shunts**

The most common cause of acquired corpus cavernosal shunts is penile hematoma due to rupture of the tunica albuginea of the penis on the dorsum of the distal bend of the sigmoid flexure. Shunts in this area of the penis may be surgically repaired thereby restoring a bull’s ability to achieve erection.

**Electro diagnostics for evaluation of penile nerves**

Determination of sensory nerve conduction velocity is a well-established modality for evaluating peripheral neuropathy. Injury of the dorsal nerves of the penis may occur during or after rupture of the tunica albuginea of the penis at the distal bend of the sigmoid flexure or due to trauma elsewhere along the course of these nerves along the penis. The procedure is most easily accomplished with the bull restrained in lateral recumbency. Sedation or anesthesia is not required and most bulls tolerate the procedure very well. Manually extend the penis and place a gauze loop around the glans penis to hold the penis in extension for approximately 15 minutes while the procedure is conducted. Place two spring-type ring electrodes 2.0 cm apart around the middle third of the glans penis. The proximal electrode is the cathode and the distal electrode the anode. Place a 1cm disk electrode as a ground 2.0 cm proximal to the stimulating electrodes. Electrode conductivity gel is applied under each electrode.

Recording electrodes are paired needle electrodes placed 1 cm apart at three sites along the penis. Insert the needle electrodes through the skin to the dorsum of the tunica albuginea ensuring that the tip is
near the dorsal nerves of the penis. The distal pair of needles is inserted one half the distance between the urethral orifice and the attachment of the prepuce to the free portion of the penis, the middle site is one half the distance between the attachment of the prepuce to the insertion of the retractor penis muscles at the distal bend of the sigmoid flexure, and the proximal site is just proximal to the distal bend of the sigmoid flexure.

Mean conduction velocity is 55.1 ± 5.1 m/s for normal bulls. This procedure can confirm loss of innervation of the dorsal penile nerves and also may localize the lesion on the nerves. If the denervation involves the glans or distal few centimeters of the penis the bull will be incapable of intromission. However, if innervation is intact to distal end of the prepuce and proximal few centimeters of the penis the bull should be able to ejaculate into an artificial vagina for semen collection for cryopreservation.

Pudendal nerve block to assist penile extension

The internal pudendal nerve is made up of fibers originating from the ventral branches of the third and fourth sacral and the pelvic splanchnic nerves. Achieve caudal epidural anesthesia then introduce the hand into the rectum to the depth of the wrist and direct the fingers laterally and ventrally to locate the lesser sacrosciatic notch and foramen by rectal palpation. Locate the internal pudendal artery by its pulsations at the cranial angle of the notch and palpate the pudendal nerve approximately 1 cm caudodorsal to the artery. Insert an 18-gauge, 10 cm spinal needle through the skin in the ischiorectal fossa beside the tail and direct the needle forward and slightly ventrally to a depth of 5 to 7 cm. Palpate the tip of the needle through the rectal wall and direct the needle in the direction of the nerve in the foramen. Inject approximately 10 ml of 2% lidocaine hydrochloride along the nerve then withdraw the needle 2 to 3 cm and inject an additional 10 to 15 cm at the cranial border of the foramen to desensitize the muscle branches of the rectal nerve. Repeat the procedure on the opposite side of the pelvis.

The advantage of the technique is that the penis and prepuce are easily extended by this procedure and the animal can remain standing. A disadvantage of the technique is that a bull will not be able to retract the penis and prepuce for approximately 30 minutes following the procedure.

Infrared thermography

Infrared thermography provides a non-invasive measure and map of skin surface temperatures. Skin surface temperatures vary according to blood flow regulation to the skin surface and are affected by both internal and external factors. The cutaneous circulation is under sympathetic vasomotor control and peripheral nerve injuries and nerve compression can result in skin surface vascular changes that can be detected by infrared imaging. Inflammation and nerve irritation may result in vasoconstriction, causing cooler thermograms in the afflicted areas. Transection of a nerve and/or nerve damage to the extent that there is a loss of nerve conduction results in a loss in sympathetic tone causing vasodilatation indicated by an increase in the thermogram temperature.

This technology is useful for localizing neuromuscular or vascular pathology and may be particularly helpful when examining a bull for pain in the back or hind limb area. This technology is also useful for graphically depicting issues with scrotal or testicular thermoregulation which may lead to impaired spermatogenesis.

Treatment of chronic seminal vesiculitis

The paired seminal vesicles of bulls are 2 to 4 cm wide and 10 to 15 cm long and are located on the pelvic floor lateral to the ampullae and dorsal to the neck of the bladder. The glands are lobulated and secrete a clear fluid, containing nutrients and buffers, which is discharged immediately before and during ejaculation through ducts that open into the urethra adjacent to the colliculus seminalis.

Inflammation or infection of the vesicular glands is fairly common in young bulls housed together on and high energy diets. These peripubertal bulls may spontaneously recover from this condition or respond well to antimicrobial treatment. However, aged or chronically infected bulls rarely recover from seminal vesiculitis. Based on clinical and abattoir evaluation of reproductive tracts of bulls the prevalence
of infection of the seminal vesicles is reported to range from less than 1 percent to greater than 9 percent. Peripubertal bulls may spontaneously recover from septic seminal vesiculitis, but aged or chronically infected bulls rarely recover.21-23

Bulls with septic seminal vesiculitis are often classified as unsatisfactory potential breeders as their semen may be grossly contaminated with exudate and blood, but often, red blood cells and white blood cells can be detected only microscopically.2 Abnormal concentrations of polymorphonuclear cells (PMNs), poor sperm motility, low fructose concentrations, and an elevated seminal pH are characteristics of semen of bulls affected with vesiculitis. Semen of bulls with septic seminal vesiculitis freezes poorly, and antibiotics used in extenders often do not significantly diminish the large number of bacteria in the ejaculate. Although chronic, unresponsive, septic seminal vesiculitis does not occur commonly in breeding bulls, the economic impact of this disease is considerable. The greatest economic loss associated with septic seminal vesiculitis occurs in bulls whose genetic value qualifies them for inclusion in an artificial insemination program.

The prognosis for bulls with chronic septic seminal vesiculitis is guarded at best. Prolonged antimicrobial therapy is often unsuccessful and complete surgical removal of affected glands is technically difficult.

The author has successfully treated bulls with chronic seminal vesiculitis by chemical ablation of the glands with 4% formaldehyde.24 Restrain the bull in a chute and achieve caudal epidural anesthesia and introduce the hand into the rectum and identify the vesicular gland. Approximately 4 to 6 cm ventrolateral to the anus on the side adjacent to the infected vesicular gland introduce an 18 gauge x 30 cm stainless steel needle through the skin parallel to the rectum to a depth of 10 to 12 cm. With the aid of the hand in the rectum advance the needle and guide the tip into the vesicular gland. Inject 10 to 15 ml of sterile saline into the gland and palpate for gland enlargement to verify needle placement. Inject 4% formaldehyde into the gland until swells and its surface is quite firm. Withdraw the needle and repeat the procedure on the opposite vesicular gland if indicated. Immediately administer flunixin meglumine as bulls so treated frequently display signs of abdominal pain following the procedure. Allow sexual rest for 45 to 60 days before examining the ejaculate for evidence of seminal vesiculitis.

References