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Surgery of the Scrotum

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Scrotal surgery is common in routine veterinary practice. Many techniques are available for commonly performed surgeries, and most can easily be accomplished in private practice and in the field. Procedures are described for surgical and nonsurgical castration, unilateral castration, inguinal herniorrhaphy, cryptorchidectomy, caudal epididymectomy, and vasectomy. Changes in current thinking about the timing of castration and about pain control in cattle surgery will likely alter the way veterinarians perform scrotal surgery in the years to come.

Castration (orchiectomy)

Castration is the most common scrotal surgery, performed thousands of times each month. Castration of male calves is often performed at birth, at branding in the west, or at weaning. Late castration may also be performed, but is considered to be more stressful to the bull because of scrotal and testicular size. Postsurgical complications are also more common at later ages. Males are castrated to reduce sexual activity in the feedlot stage, and to prevent reproduction of inferior animals.

There are a number of methods to castrate calves. Surgical castration is preferred because one can be ensured that both testicles have been removed. Castration is most commonly performed in lateral recumbency in small calves, or in a squeeze chute in larger calves and bulls. Traditionally, castration has been performed without the use of analgesia, although current thinking on this as a welfare issue is bringing about change in this arena. When castrating a large number of calves, the provision of analgesia is often inconvenient and expensive, but the benefit to calves during and after surgery may be important in promoting continued feed consumption and rate of gain.

To perform castration, the testicles must first be exposed. If two testicles are not palpable in the scrotum, the animal must be considered a cryptorchid

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and the cryptorchid testicle should be removed first (see later discussion on cryptorchidism). Two methods have been commonly used. In the first, used most commonly in small calves, the bottom one third to one half of the scrotum is amputated using a scalpel. The testicles then drop into view. This method provides excellent postcastration drainage. In the second method, separate incisions are made over each testicle, either laterally, or caudally. This is most easily accomplished by use of a Newberry knife, which is inserted from side to side across the scrotum after pushing the testicles proximally with the other hand. The Newberry knife can also be used in a cranial-to-caudal fashion, opening each side of the scrotum separately. The side-to-side incision allows for significantly more drainage postsurgery, which prevents postoperative swelling and establishment of infection.

The simplest method of castration is performed in very small calves, where slow traction is placed on the testicle until spontaneous rupture of the cord occurs. This closes the spermatic vessels and prevents bleeding. It can, however, lead to the occurrence of ''gut-tie'' and intestinal obstruction later in life as the retracting ends of the spermatic cords snap back into the abdomen and may adhere to anything in the abdomen, including the intestine [1]. As a result, sharp transection of the spermatic cords is always preferred.

Even when sharp transection of the cords is performed, castration in cattle is normally performed as a closed castration, without opening the tunica vaginalis. Following exposure of the testicles, the adherent adipose tissue and connective tissue is ''stripped'' proximally to allow for good exposure of the cords. An emasculator (White, Serra, Frank, Reimer, or Hausmann) is placed around the cord as proximally as possible, and closed tightly. Tension should be released on the cords when the emasculator is applied [2]. Maintaining pressure for approximately 30 to 45 seconds is usually sufficient to promote hemostasis in the transected vessels. In very small calves, both cords can be emasculated at the same time. In large bulls, it may be desirable to open the tunica vaginalis and emasculate the retractor muscle and the vascular cord separately. Sufficient tunica should still be removed to prevent hydrocoele formation if this technique is used. Following castration, any tissue hanging from the scrotum should be removed by traction or with emasculator or scalpel.

If desired, the spermatic cord can be ligated with monofilament absorbable suture rather than leaving the cord open. A ligature is applied around the cord as proximally as possible and as tightly as possible. The cord can then be cut sharply or emasculated distal to the ligature. This reduces the amount of postoperative hemorrhage, but may increase the chances of postoperative infection because a foreign object is present, which may harbor bacteria. If ligatures are required or desired, close attention must be paid to aseptic technique. Ligatures can also be applied to large bull cords where hemorrhage is more likely or to cords that continue to hemorrhage excessively following castration by any other means.

A fairly recent addition to the veterinarian's toolbox popular in some parts of the country is the Henderson castration tool, developed by Lance Henderson and manufactured by Stone Manufacturing and Supply Company (Kansas City, Missouri). This specialized clamp is inserted into a variable-speed battery-powered drill, and is used to castrate calves with a significantly reduced risk of hemorrhage. Following exposure and stripping of the cords, the clamp is placed proximal to the testicle, and the drill is activated, producing a slow twisting action, which eventually causes the tunica vaginalis to twist closed and separate in the region of the inguinal ring. This removes the testicle, and provides hemostasis at the same time. The author has used this tool on animals up to 1200 pounds, but it is easiest to use on smaller calves. If rotation is performed too quickly, it is possible for the testicle to be removed before hemostasis is achieved. In theory, "guttie" could occur with this technique also, because the exposed end of the cord may be within the abdomen. Those interested in the tool are encouraged to purchase the newer version, which has teeth in the clamp to provide better grip on larger spermatic cords.

The Burdizzo emasculatome provides bloodless castration by means of crushing the spermatic cord through the scrotal skin. The spermatic cord is pushed to the lateral aspect of the scrotal neck, and the emasculatome is applied across the cord. Some sources suggest crushing each cord twice to ensure complete disruption of the blood supply [3]. Others suggest manipulating the cord while clamped, to separate it from the other half of the cord [4]. The testicles are then left in situ to atrophy. It is important not to disrupt the blood supply to the scrotum itself by applying the emasculatome across the median raphe of the scrotum.

Nonsurgical castration can be performed with the use of rubber rings or bands and an elastrator tool. These may be applied at any time during the life of the animal from birth. Application of these bands causes ischemic necrosis of the scrotum and testicles, eventually resulting in sloughing of the scrotum and contents. Elastrator bands are not as popular in cattle as they are in sheep, but are preferred by some producers. The new Callicrate bander system (No Bull Enterprises, St. Francis, Kansas) uses rubber strips that are applied around the scrotum and crimped with a special banding tool. This system claims to be useful in all ages of bulls. Proponents of the Callicrate system claim growth benefits from retention of the endogenous testosterone, and no daily gain loss at the time of castration compared with surgical castration. Recent reports, however, showed significant loss of gain following banding with this tool [5,6]. The use of elastrator bands in calves can result in tetanus because of the presence of necrotic tissue, and precautions must be taken to avoid problems. There is also some question as to the pain involved in the use of these bands, because necrosis takes several weeks to occur [5,6]. The most critical problem with the use of elastrator bands and rings is their correct application. The applicator must ensure that both testicles are within the scrotum at the time of application,

and that no other organs (eg, intestine) are present in the scrotum. Incorrect application of the bands may result in partial castration, or intestinal obstruction.

Complications may occur following castration by any means. Calves should be observed for excessive hemorrhage, which may require attention in the form of ligatures, clamps, or packing. Fatal hemorrhage is rare, but can occur with significant hemorrhage from the testicular artery. Postcastration swelling is reduced by encouraging free exercise and drainage. If swelling is severe, antibiotics and anti-inflammatory drugs should be administered, and drainage established if possible. Infection at the castration site may necessitate resection of infected tissues, and certainly requires the use of antibiotics to prevent toxemia. Clostridial vaccination should be performed at the time of castration, if not already administered, and many veterinarians also give prophylactic procaine penicillin G at the time of castration. Close attention should be paid to calves with elastrator bands, to ensure that the necrotic scrotum falls off quickly, and that the calves are showing no signs of tetanus or local infection. Elastrator bands have the additional risk of incorrect application, as mentioned previously.

Although rare, evisceration can occur following any open castration procedure. It may be more common in bulls with large inguinal rings, in older bulls, and in bulls with inguinal hernia. Evisceration is often a fatal complication, but immediate detection and rapid surgical correction can result in good outcomes. Also considered a complication is failure to recognize cryptorchidism, and subsequent removal of only one testicle. Inguinal hernias can be mistaken as a scrotal testicle, and opening of these may cause inadvertent incision of the intestine. It is also possible to mistake the penis for the testicle and incise it, causing penile amputation or urethral fistula. The penis can be incorrectly included in the emasculatome, which causes urethral obstruction and penile necrosis.

Management of pain in calves undergoing castration is becoming more and more of a welfare issue for veterinarians. Recent research has examined pain responses of calves following castration by various methods, and following various local and systemic analgesics. It is hoped that an effective and economic method of providing pain control for calves will be determined from this research. Using serum cortisol as a measurement of stress, Stafford and colleagues [7] showed that local anesthesia alone did not prevent cortisol increase, but the addition of an nonsteroidal anti-inflammatory drugs did reduce cortisol release following castration by various techniques. Ketoprofen administration also reduced plasma cortisol response in calves following surgical castration [8]. Local anesthesia reduced the cortisol response following castration, but this response was only present as long as there was local anesthetic present. Following metabolism of the local anesthetic, cortisol increased and pain activities increased [9]. The administration of sodium salicylate before castration in calves reduced the cortisol response; however, cortisol concentrations rose rapidly following reduction

in the serum salicylate level [10]. Plasma cortisol levels were increased in both calves castrated surgically and with a Burdizzo emasculatome, but the administration of local anesthetic attenuated the cortisol increase [11]. Castration by rubber ring (elastrator band) produced prolonged pain responses in calves [12]. From this research, it seems that all methods of castration induce a stress response and pain response, and that nonsteroidal anti-inflammatory drugs are effective in controlling this response over long-term, whereas local anesthesia is effective only temporarily.

The timing of castration of bulls varies with location, production system, and individual. Although the cattle industry in general has considered early castration to be easier on calves than late castration, there are little data to prove these theories. Some recent research has provided hard data regarding timing of castration and effects on average daily gain and pain responses. With regards to age at castration, castration-associated weight loss increases quadratically with age, and castration performed after puberty had significant negative effect on average daily gain [13]. Stress response also seemed to be lower in cattle castrated at less than 6 months of age, as measured by cortisol response [13]. It seems that early castration is indeed better for the calves than late castration. With regards to the method of castration, the data are less clear. Stafford and colleagues [7] and Thüer and colleagues [12] showed that the initial stress response is less with banding techniques, but that chronic pain responses may be present following banding. Bulls banded at weaning with the Callicrate bander gained less that bulls banded or surgically castrated at 2 to 3 months of age [14]. Use of the Callicrate bander at weaning actually reduced postcastration average daily gain compared with surgically castrated bulls in a study by Knight and colleagues [5]. Banded bulls also grew more slowly in a second study by Fisher and colleagues [6], and animals suffered from chronic scrotal wounds.

Unilateral castration

Unilateral castration (orchiectomy) is the removal of one testicle while leaving the opposite testicle in place. It can be performed for many reasons, including testicular injury, hydrocoele, testicular abscess, inguinal hernia, testicular neoplasia, incomplete prior castration, orchitis, or other testicular or epididymal abnormalities (Figs. 1–4) [15–17]. Medical treatment is often first attempted, including hydrotherapy, antibiotics, and anti-inflammatory drugs. Delay in surgical removal of a diseased testicle may result in damage to the contralateral testicle, however, by the heat and swelling associated with scrotal disease [16]. Prior to attempting this surgery, it is essential that the contralateral testicle be evaluated thoroughly with palpation, ultrasound, or other diagnostic modalities to detect any concurrent abnormalities. If the contralateral testicle is not functional, unilateral orchiectomy is pointless.

Unilateral castration can be performed in lateral recumbency under general anesthesia or heavy sedation, or may be performed as a standing procedure in

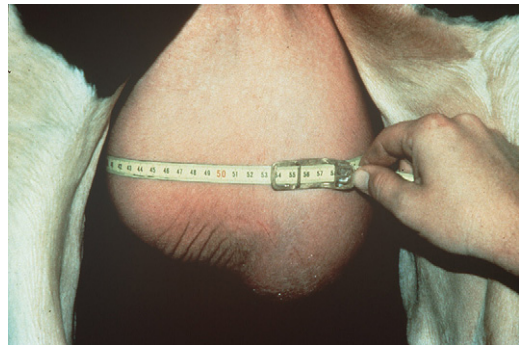

Fig. 1. Unilateral hydrocoele in a bull demonstrating the asymmetric enlargement of scrotum.

squeeze chute with epidural and local anesthesia [15,17,18]. The procedure is similar to routine castration of an older bull. A vertical incision is made at the proximal-lateral aspect of the scrotum over the abnormal testicle and spermatic cord. The spermatic cord and testicle (within the tunica vaginalis) are freed from any underlying tissue. At this time, the surgeon must decide whether to ligate the entire spermatic cord (closed castration), or to open the tunica vaginalis and ligate vascular and muscular components separately. In general, open ligation is suggested to reduce any possibility of hemorrhage. Double ligation is suggested to prevent postoperative hemorrhage. The testicle, tunica, and spermatic cord are removed distal to the ligature using an emasculator. Closure of the tunica over the vascular stump has been described, but is not possible in all cases [16,18,19]. If unilateral castration is being

Fig. 2. Asymmetric enlargement of scrotum in a bull with unilateral scrotal abscess.

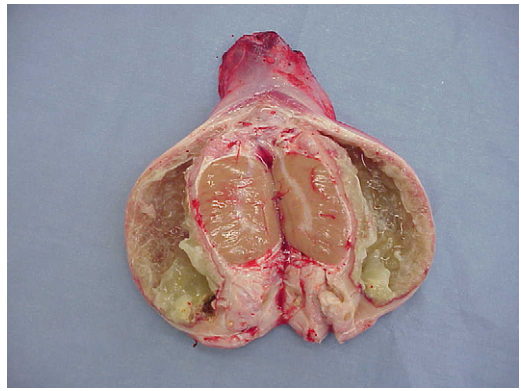

Fig. 3. Periorchitis in a testicle resulting in fibrin and fluid accumulation around the testicle.

performed because of inguinal herniation, the inguinal ring must be closed to prevent further herniation of abdominal contents. The skin and subcutaneous tissues (tunica dartos) are closed in two layers, unless there is infection requiring open drainage. The empty scrotum can be packed with roll gauze and the end of gauze left protruding through an open ventral aspect of the incision. The packing is removed at a later time. If complete closure of the incision is performed, place two to three interrupted sutures at the distal aspect of the incision should drainage be desired postoperatively. In most cases, it is necessary to remove some of the lateral scrotal skin to reduce dead space, or to remove pathology. Postoperatively scrotal swelling is common, occurring in approximately 70% of bulls, but can be managed with hydrotherapy and anti-inflammatory drugs [15].

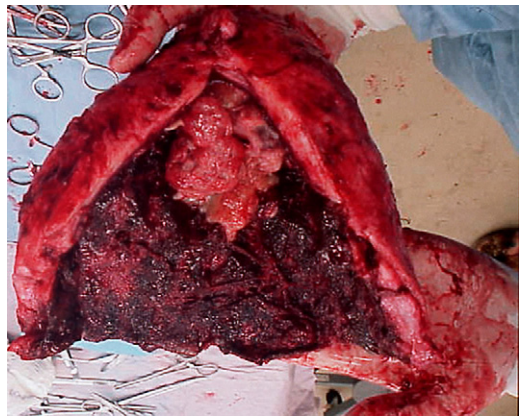

Fig. 4. Testicular rupture resulting in hemorrhage into the scrotum.

Unilateral orchiectomy can preserve the breeding function of bulls [15–18]. Thirteen of 15 bulls became productive and fertile within 6 months of unilateral orchiectomy [15], and five of eight bulls became fertile within 12 months of surgery [17]. Wolfe and coworkers [18] reported that normal bulls produced normal semen within 3 weeks of unilateral castration, but suggested that the heat and swelling associated with conditions necessitating unilateral castration may prolong this period in affected animals. It is commonly reported that the remaining testicle may hypertrophy and produce approximately 75% of the normal semen volume [16,17].

Cryptorchidism

Cryptorchidism occurs when one or both testicles fail to descend into the scrotal sac from their abdominal origin. The testicle may be located within the abdomen; within the inguinal canal; or subcutaneously outside the scrotum (called ectopic testicle). Cryptorchidism is uncommon in cattle, with most cryptorchid testicles actually being ectopic (located in the subcutaneous tissues in the inguinal or preputial area). Cattle are most likely to have unilateral cryptorchidism (usually the left), and usually inguinal rather than abdominal [3,19].

Removal of a cryptorchid testicle depends on its location. Ectopic testicles can be removed with the animal restrained in dorsal or lateral recumbency, with sedation or general anesthesia. Ligation of the cord with monofilament absorbable suture is recommended, and the incision may be closed if performed aseptically, or left open for drainage if performed in the field. Inguinal testicles are best removed with the animal in dorsal recumbency under general anesthesia, and prepared for aseptic surgery. The incision is made over the palpable testicle, or near the inguinal ring. Once the testicle or spermatic cord is identified, the cord is ligated with absorbable monofilament and the testicle removed with scalpel or emasculators distal to the ligature. The incision is closed routinely in two layers.

Abdominal testicles are removed under general anesthesia by flank incision with the animal in lateral recumbency, or by parainguinal incision with the animal in dorsal recumbency (as for a tube cystostomy). The incision is made on the side with the retained testicle. Locating the intra-abdominal testicle can be difficult, and the entire abdomen must be explored from inguinal ring to kidney. Exteriorization of abdominal testicles can also be difficult (Fig. 5). Once located, the spermatic cord is ligated as previously described, and the testicle removed. Use of an emasculator only without ligation has been described, but this author prefers ligation to prevent intra-abdominal hemorrhage. Abdominal testicles are normally much smaller than their normal counterparts, and one must be sure to remove the entire testicle and epididymis, which is not closely attached to the testicle as in the scrotum.

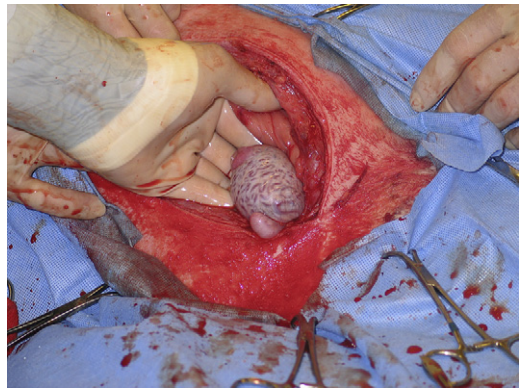

Fig. 5. Limited exposure of intra-abdominal cryptorchid testicle by parainguinal approach (*Courtesy of* Matt D. Miesner, DVM, MS, Manhattan, KS.)

Inguinal hernia

Inguinal hernia results in the herniation of abdominal contents (usually omentum or jejunum) through the internal inguinal ring. If this continues, scrotal hernia results as inguinal hernia contents move through the external inguinal ring into the scrotum. Inguinal hernia results in enlargement of the neck of the scrotum or obvious enlargement of the scrotum itself (Fig. 6) [3]. Inguinal hernias are common in cattle, and may be congenital or acquired. Congenital hernias are usually hereditary, are seen in cattle less than 12 months of age, and occur because of large inguinal rings. The author has seen these mainly in Herefords and Hereford cross cattle.

Acquired inguinal hernia occurs in adult bulls following trauma, or because of age-related relaxation and stretching of the abdominal musculature [3]. Most inguinal hernias occur on the left side. It is speculated that this occurs because of the normal sternal position of cattle with the right hind leg

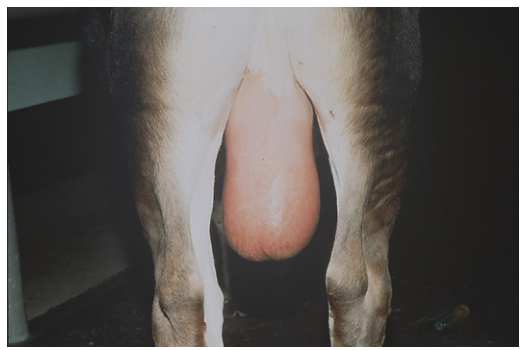

Fig. 6. Inguinal hernia in a bull. Note the loss of the normal scrotal neck.

under the body and the left hind leg extended [3]. This position promotes eructation and regurgitation, but stretches the left inguinal ring open.

Diagnosis of inguinal hernia requires careful palpation of the scrotum, rectal palpation, and often ultrasonography. Herniation is often painful for the bull, and gastrointestinal obstruction or hind limb problems may be initially suspected. Hydrocoele, orchitis, epididymitis, inguinal fat, periorchitis, and neoplasia may all resemble an inguinal hernia. Inguinal hernia may result in swelling of the scrotal neck; the testicle itself (because of venous congestion); or enlargement of the entire scrotum. A hernia may be initially manually reducible, but if the hernia is present for sufficient time to cause irritation, adhesions may occur between the tunica vaginalis and the herniated tissues.

Surgical correction of inguinal and scrotal hernias should be attempted as soon as possible to prevent damage to the affected testicle and damage to the contralateral testicle by swelling and heat. Surgery is best performed under general anesthesia in lateral or dorsal recumbency with the hind end somewhat elevated. If strangulated intestine is not present, withholding feed and water for 24 to 48 hours before surgery helps reduce the abdominal size. The skin incision is made over the external inguinal ring near the base of the scrotum [3]. Blunt dissection is used to locate the external inguinal ring and vaginal tunic. The hernia is reduced manually if possible by pressure or by twisting the testicle and spermatic cord to return the hernia contents to the abdomen [19]. If the hernia cannot be reduced, the tunic is opened and the hernia reduced manually. Adhesions are bluntly separated if necessary. Intestine is resected only if obviously devitalized, and devitalized omentum can be resected if desired. Following reduction of the hernia, the tunic is closed with absorbable suture in a continuous pattern. The internal and external inguinal rings must then be closed using preplaced interrupted sutures of heavy nonabsorbable suture material in the cranial aspect of the rings. It is recommended that there be enough space remaining for the spermatic cord and one finger to pass through. Closure is simplified if unilateral orchiectomy is performed at the same time. This allows complete closure of the inguinal opening. The subcutaneous tissues are closed using absorbable suture material, and the skin closed routinely with nonabsorbable suture material. Postoperative antibiotics and anti-inflammatory drugs are used for several days after surgery. Hydrotherapy is helpful in preventing and reducing postoperative swelling. Sexual rest is recommended for 3 months after surgery [3].

Hernia correction by flank incision in a standing animal has also been described, but may be difficult or impossible if adhesions are present [3]. With this technique, the internal inguinal ring is closed blindly within the abdomen.

Regardless of technique used, it is important to remember that herniation can recur in any animal that does not undergo unilateral orchiectomy and complete closure of the inguinal ring. It is also possible for the testicle to

be damaged or devitalized, requiring unilateral orchiectomy at a later date. Congenital inguinal hernia correction should only be performed with bilateral castration because this is considered a hereditary defect.

Epididymectomy

Caudal epididymectomy is an easy field technique used to create teaser bulls for estrus detection. This technique prevents fertilization, but does not prevent intromission, so disease transmission can still occur; however, libido and natural behaviors are preserved.

Epididymectomy is performed in a standing bull in a squeeze chute. The distal scrotum is clipped and prepared for surgery. Anesthesia is provided by local infiltration anesthetic or caudal epidural, or a combination of the two. Push the testicles into the scrotum by applying pressure to the neck of the scrotum. A small (1-in) incision is made over the caudal epididymis (identified as a bulge on the distal testicle). The incision is continued through the parietal tunic until the epididymis is visible at the incision. It is helpful to maintain downward pressure on the testicle within the scrotum to simplify identification of the epididymis because it protrudes from the incision. The epididymis is then grasped with a hemostat or towel forceps. Traction is applied to exteriorize the entire caudal tail of the epididymis. Hemostatic forceps are then placed across each arm of the epididymis (Fig. 7), and the epididymis is excised with scissors or scalpel. Care must be taken to avoid incising the tunica vaginalis of the testicle, because hemorrhage results. If this occurs, suture closure of the tunic is required. The procedure is repeated on the second epididymis. Closure of the incisions is not required [20,21]. It is recommended that the excised tissue be examined to ensure that the entire epididymis has been removed, and that no section remains that could recanalize and restore fertility.

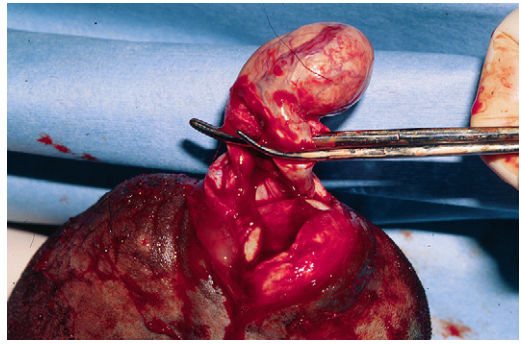

Fig. 7. Epididymectomy in a bull demonstrating the exteriorized and clamped epididymis immediately before excision.

Providing that the entire epididymis has been removed, success rates are near 100% with this technique. Occasional local infection can be managed with antibiotics and hydrotherapy. Tetanus may be a problem in some areas, and prophylactic penicillin or clostridial vaccination may be necessary. The author is aware of a few reports of granuloma formation at the epididymectomy site, but these did not interfere with the function as a teaser bull.

Vasectomy

Bilateral vasectomy also can be used to create infertile teaser bulls. This technique also prevents fertilization, but allows intromission. There is still a risk of disease transmission.

Vasectomy can be performed with the bull standing in a squeeze chute; however, ventral abdominal support is recommended in case the patient should go down during surgery. If performed in lateral recumbency (preferred by the author), the bull is placed in lateral recumbency with the upper leg drawn somewhat caudally to expose the scrotum. This technique is best performed with the bull under general anesthesia to prevent motion, but can be performed under heavy sedation with local anesthetic infiltrated in the area of the incision. The neck of the scrotum is clipped and aseptically prepared for surgery. A 1- to 2-in vertical incision is made over the neck of the scrotum just above the testicle. The author prefers to make an approach on the cranial aspect of the neck, although there are reports of approaching the spermatic cord from the cranial, caudal, and lateral aspects [19]. The incision is extended through the skin and tunica dartos until the spermatic cord is visible. A finger or forceps is then used to exteriorize and stabilize the spermatic cord at the incision. A 1-in incision is then made carefully through the tunica vaginalis to expose the spermatic cord components [20]. The cremaster muscle must be avoided in this process, and the vascular tunic opened instead. Identify the ductus deferens within the vaginal tunic. It appears as a light-colored firm tubular structure approximately 2 to 3 mm in diameter. The ductus lies within a separate fold of the visceral tunic called the ''mesoductus deferens,'' which can assist in identification. Place a proximal and distal ligature of absorbable monofilament approximately 2 in apart around the ductus. After placing the two ligatures, the ligated segment of ductus is excised. Close the tunica vaginalis, tunica dartos, and skin routinely. An alternative approach useful in small ruminants has been described [22]. The author has no experience with this technique, or knowledge of its use in cattle.

It is essential to confirm that the ductus deferens has been identified and ligated, so extreme care must be taken during surgery to identify the testicular artery and vein before placement of ligatures [20]. After surgery, the author has retained the segments of ductus deferens in labeled jars of formalin to confirm by histopathology that the correct structure was removed, if ever a question should arise. If the correct structure is ligated and excised, 100% success is attained. Infection at the incision site is rare. Poor surgical

technique resulting in damage to the testicular artery or vein can result in local hemorrhage and hematoma formation or reduced blood supply to the testicle.

Summary

Scrotal surgery is common in routine veterinary practice. Many techniques are available for the commonly performed surgeries, and most can easily be accomplished in private practice and in the field. Changes in current thinking about the timing of castration and about pain control in cattle surgery will likely alter the way veterinarians perform scrotal surgery in the years to come.

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