Complications of Ovariohysterectomy and Orchiectomy in Companion Animals

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KEYWORDS

• Spay • Neuter • Ovariohysterectomy • Orchiectomy
• Castration • Complications

Ovariohysterectomy (OVH) and orchiectomy are two of the most commonly performed surgeries in companion animal practice. Techniques for accomplishing surgical sterilization vary widely between geographic areas. While a ventral midline OVH is the standard technique in the United States, veterinarians in continental Europe commonly use a ventral midline ovariectomy, and practitioners in the United Kingdom perform flank OVH.[1] Interestingly, retrospective analyses have shown no significant differences in the rate of stump pyometra, urinary incontinence, or other complications when these techniques are compared, so there is no strong rationale to prefer one technique over another.[2–5] In fact, a recent prospective study showed that there were no significant differences in operative time or pain scores when ovariectomy was compared to OVH, calling into question the previous assertions that ovariectomy is faster and carries less morbidity.[6] Given the audience of the current publication, the author will refer to the OVH as the standard procedure in this text but will refer other techniques as indicated.

Given the frequency with which sterilization procedures are performed, it is not surprising that a number of complications have been described, including hemorrhage, wound healing complications, ovarian remnant syndrome,[7] stump pyometra, uterine stump abscess/granuloma formation,[8,9] obstipation,[10] ureteral trauma,[8,11–13] inadvertent prostatectomy,[14,15] vaginoperitoneal fistula formation,[16] enterocutaneous fistula formation,[17] gossypyboma,[17,18] and urinary incontinence.[19,20] Interestingly, the overall incidence of complications is high (around 20% in one representative study),[21] and when the incidence of common complications is compared between retrospective studies performed over time, it does not appear that any major

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improvements have been made in the incidence of common postoperative complications over the past 30 years.[21–25]

COMPLICATIONS OF OVARIOHYSTERECTOMY

Hemorrhage

Hemorrhage has been described by some authors as the most common complication associated with OVH,[23,24] with a 79% incidence of intraoperative hemorrhage being reported in 1 group of 87 dogs greater than 50-lb body undergoing OVH at a teaching hospital.[24] In this same study, the rate of hemorrhage was only 2% in 290 dogs that were under 50-lb body weight, suggesting that large body size and intra-abdominal fat cause a significant increase in the risk of this complication. Other retrospective analyses of OVH reported a much lower rate of intraoperative hemorrhage, ranging from 4%[25] to 9%.[21] Specific criteria for characterizing hemorrhage are not described in any of these retrospective studies, and it is likely that some authors reported only clinically significant or major hemorrhage (dropped pedicle), while others reported any hemorrhage that was identified in the medical record. Despite these discrepancies in the prevalence of intraoperative bleeding, postoperative mortality due to ongoing hemorrhage is extremely rare. Not 1 of the 968 animals described in three retrospective studies of canine OVH was reported to have died due to postoperative hemorrhage and all but one were successfully addressed prior to abdominal closure.[21,24,25] Another study suggested that postoperative death due to hemorrhage occurred in 1 of 1016 dogs and in 1 of 1459 cats undergoing elective sterilization or declaw surgeries.[22] Given the low mortality reported in these and other published reports, it appears that intraoperative hemorrhage during OVH rarely translates into life-threatening postoperative hemorrhage.

Diagnosis/Therapy

Detection of intra-abdominal hemorrhage can be difficult, and clinical signs of intrahemorrhage after OVH involve nonspecific findings such as a slow recovery from anesthesia, pale mucous membranes, and tachycardia. A clinical observation is that many dogs with acute postoperative hemoperitoneum will leak large volumes of nonclotting, bloody fluid from the incision, a sign that may be mistakenly attributed to hemorrhage from subcutaneous vessels. Animals with the aforementioned signs should be examined for the presence of significant hemoperitoneum using ultrasound imaging and abdominocentesis. In the absence of an ultrasound machine, abdominocentesis can be performed blindly using 20-gauge needles placed in paramedian locations along the ventral abdomen, using appropriate aseptic technique. Insertion of the needles 3 to 4 cm from midline avoids the falciform ligament, which can clog the needle and prevent successful detection of fluid. Nonclotting abdominal fluid with a packed cell volume (PCV) that approximates or exceeds the animal's peripheral blood PCV is diagnostic for intra-abdominal hemorrhage. Prior to considering surgical intervention, coagulation testing should be considered. Depending upon the breed and history, evaluation of prothrombin time, activated partial thromboplastin time, buccal mucosal bleeding time, and platelet count should be performed, ruling out preexisting inherited or acquired defects in hemostasis, before considering surgical exploration. It is important to realize that elective sterilization surgery is often the first invasive procedure that is performed on an animal and would therefore be the most likely time for discovery of a congenital disorder in hemostasis. Using data obtained on physical examination, ultrasound examination, and hematologic testing, the clinician must decide whether intra-abdominal hemorrhage should be treated in a conservative manner (abdominal pressure bandage, intravenous fluid therapy) or by

surgical exploration and religation of the pedicles. One recent report suggested that therapy with abdominal pressure bandages was successful in 3 of 4 dogs with postoperative bleeding, while surgery was required on 1 dog that failed conservative therapy.[21]

Avoidance

Intraoperative hemorrhage during ovariohysterectomy is most commonly associated with rupture of the right ovarian pedicle during attempted release of the suspensory ligament.[21] Occurrence of this complication has been attributed largely to rough tissue handling by novice surgeons, with many of the reports arising from teaching institutions where surgery is performed by fourth-year veterinary students.[21,24,25] One early study suggested no difference in complication rate when surgeries were performed by veterinary surgeons, although students tended to perform elective surgeries while veterinary surgeons performed some OVHs in dogs with underlying diseases (eg, pyometra).[25] Another common cause of ovarian pedicle hemorrhage is insufficient knot-tying technique, a problem that is most often revealed when a surgeon-in-training attempts to ligate a large, fat-filled pedicle in a mature female dog. In a training institution, avoidance of ovarian pedicle rupture is facilitated by encouraging ample abdominal exposure through incisions that extend from the umbilicus to the last mammary teat, allowing access to the right ovarian pedicle, which is located in the craniodorsal abdomen. Rather than strumming the suspensory ligament, the author recommends grasping the cranial edge of the suspensory ligament between the thumb and index finger, sliding the thumb and finger down into the incision, and breaking the supensory ligament with a twisting motion of the finger and thumb right at the point of attachment on the body wall. This technique allows for controlled rupture of the cranial edge of the suspensory ligament at a location that is distant from the origin of the vascular pedicle. Ligation is performed using 3-clamp technique, with each ovarian pedicle being double-ligated and transfixed. When rupture of a pedicle does occur, hemorrhage from the small ovarian and uterine vessels in prepubertal bitches is typically slow, giving the surgeon ample time to lengthen the incision and retract the duodenum to the left, using the mesoduodenum to hold back the viscera before attempting to grasp the dropped pedicle. The pedicle should be grasped with the tip of a mosquito hemostat, being careful to avoid inadvertent trauma to the ureter, aorta, vena cava, and renal artery and vein that lie in the adipose tissue of the retroperitoneal space. A similar maneuver is used to expose the left ovarian pedicle, placing the small intestines and spleen medial to the mesocolon and retracting the descending colon to the right. Hemorrhage from the uterine pedicle is identified by retroflexing the bladder (pulling the apex of the bladder in a ventrocaudal direction) and exposing the uterine stump, which lies between the urinary bladder and the descending colon. It should be noted that it is often difficult to identify active bleeding during reexploration of the abdomen, even in an animal that has experienced significant intra-abdominal hemorrhage. Presumably, decreases in perfusion pressure associated with general anesthesia and positioning in dorsal recumbency may temporarily decrease hemorrhage from ovarian or uterine pedicles. For this reason, the author recommends re-ligation of all pedicles at the time of surgery, regardless of intraoperative findings.

Wound Healing Complications

Although understated in most textbook descriptions of elective sterilization surgery, problems associated with incisional healing are some of the most frequently reported complications following OVH surgery, far exceeding the incidence of intraoperative

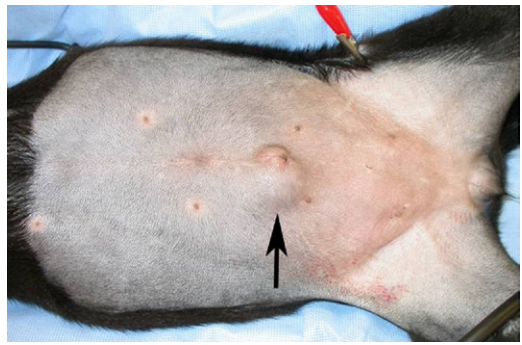

Fig. 1. An abdominal wall hernia (*black arrow*) was noted 7 days after ventral midline ovariohysterectom in a domestic short-haired cat. The etiology of the swelling was diagnosed based on palpation of an associated abdominal wall defect.

hemorrhage in some studies.[21] It is interesting to note that the incidence of incisional swelling, wound infection, and abdominal dehiscence has not decreased over the past 40 years, although original reports of OVH used surgical gut for closure of the linea alba and subcutaneous tissues—a technique that would now be considered below the standard of care that is achieved in modern teaching hospitals.[1,21,25] In a related manner, the use of preoperative or postoperative analgesia was not described in early reports of ovariohysterectomy,[24] with anesthetic protocols consisting of only a tranquilizer (acetylpromazine), anticholinergic, short-acting barbiturate induction (thiamylal), and inhaled halothane as a general anesthetic agent. Following this protocol, the authors described a 74% rate of self-inflicted incisional trauma in a group of 87 large dogs, with a 43% incidence in 476 cats, a complication that may have been related to postoperative pain. Development of wound complications has also been related to duration of surgery, with an increased incidence of postoperative swelling and wound infections occurring after surgeries that lasted longer than 90 minutes and in anesthetic episodes lasting longer than 120 minutes.[21] Wound infection occurs with a similar rate after elective OVH as in the general population undergoing elective surgery and ranges from 2.2% to 5.7%.[21,22] Seroma formation along the ventral midline is also a quite common complication due to the dependent location of the wound, which facilitates collection of fluid. This complication must be distinguished from the subcutaneous swelling that is associated with more serious abdominal wall dehiscence and herniation of the falciform fat or small intestine (**Fig. 1**). Fortunately, ventral midline incisional dehiscence is extremely rare, occurring in less than 1% of over 2000 cases of elective sterilization surgery.[22] Diagnosis of abdominal wall herniation is usually made by palpation of a defect in the abdominal closure in association with the appearance of a subcutaneous soft tissue mass effect. Unless self-induced trauma has occurred, the skin closure is typically intact and hernia repair can be performed on a semielective basis. Confirmation of the diagnosis can be made with plain radiography, which may show a defect in the ventral abdominal wall on lateral projections or by using abdominal ultrasound examination.

Avoidance

Abdominal wall dehiscence that occurs during the first 7 days after surgery is most commonly due to technical errors, including failure to incorporate the external rectus fascia, inappropriate suture size, or knot failure. Many of these technique errors can

be avoided by use of proper surgical technique. The author recommends clearing of subcutaneous tissues from the external rectus fascia for approximately 1 cm on either side of the linea alba to facilitate proper incorporation of the external rectus fascia during closure. The linea may be closed in either a continuous or an interrupted appositional suture pattern, using monofilament, absorbable suture material. Due to the slow healing rate of abdominal wall fascial incisions, a suture with prolonged retention of tensile strength is recommended, such as polydioxanone or polyglyconate. Perioperative antibiotics are not commonly recommended during OVH procedures, although the surgery classifies as a clean contaminated procedure.[21] Based on the high rate of postoperative wound infection that was reported when surgical time exceeded 90 minutes,[21] the prophylactic use of cephalosporin antibiotics should be considered in training institutions when procedure time is expected to be prolonged.

Ovarian Remnant Syndrome

Ovarian remnant syndrome is a rare complication of OVH in dogs and cats.[26–28] Residual ovarian tissue most commonly results from incomplete resection of the ovary during the initial surgery,[26,27] although 1 experimental study showed that fragments of ovarian tissue can become revascularized through the mesentery or omentum, maintaining functional status indefinitely.[26,27,29] Although this complication is attributable to surgical error, retrospective studies have shown that the vast majority of animals that develop this complication had their original surgery performed by an experienced veterinarian, not by a veterinary student or recent graduate.[26,27] Diagnosis is typically suspected in dogs with a history of OVH that later develop clinical signs of proestrus or estrus, with most commonly reported signs including vaginal discharge, vulvar swelling, and behavioral changes (**Fig. 2**).[26,27] Confirmation of the diagnosis can be made using vaginal cytology, hormonal testing, abdominal ultrasound, and exploratory laparotomy. A recent retrospective study by Ball et al reported that vaginal cytology and hormone assays (serum estrogen $>$20 pg/mol, progesterone $>$2 or luteinizing hormone concentrations $>$1 ng/mL) do not serve as reliable predictors of ovarian remnant syndrome.[27] In that same study, abdominal ultrasound was a useful diagnostic aid in dogs with ovarian remnant syndrome, correctly identifying the ovarian tissue location in 6 of 9 dogs showing signs of proestrus or estrus and in 3 of 3 dogs with no clinical signs. Ultrasonographic appearance of the ovarian tissue was described as being a soft tissue or cystic (hypoechoic) mass, with variable acoustic enhancement, echogenic fluid, or anechoic follicles.[27] Retained ovarian tissue can nearly always be visually identified at the site of original ovariectomy at the time of abdominal exploration (see **Fig. 2**).

Therapy

Surgical exploration and resection of retained ovarian tissue have led to resolution of clinical signs in all reported cases of ovarian remnant syndrome.[26,27] It has been suggested that performing the exploratory surgery during a time of active proestrus, estrus, or diestrus can facilitate identification of ovarian tissue due to the presence of follicles, corpora leutea, and increased size of the ovarian vascular pedicle.[27,28] Retained ovarian tissue is typically noted to be located in close association with the fibrous tissue that marks the location of the original ovarian pedicle ligation and can be distinguished from surrounding adipose tissue by the darker coloration and firm character of ovarian tissue (see **Fig. 2**).[27] Ovarian pedicle remnants are located caudal to the kidneys and are often in close association with the ureters. Thus, the surgeon must take great care in identifying the ureter prior to resecting the ovarian remnant, to

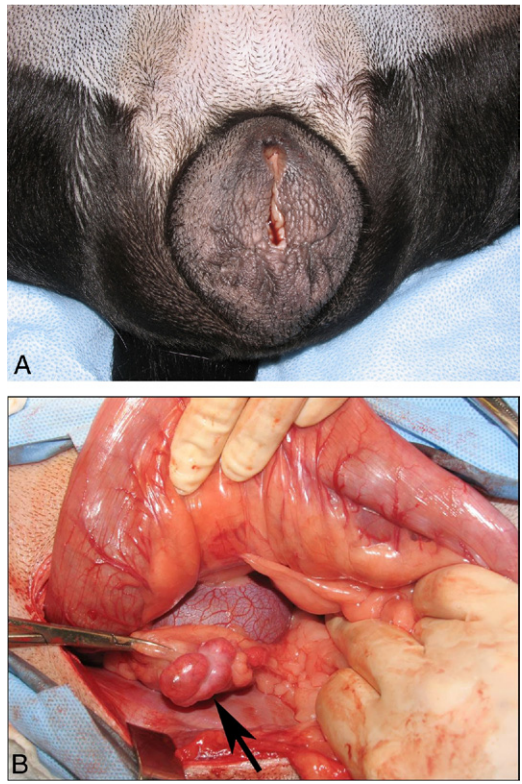

Fig. 2. Marked vulvar enlargement and serosanguinaous vaginal discharge are noted in a dog with ovarian remnant ovarian syndrome (*A*). An ovarian remnant (*B*) is easily distinguished as a multilobulated mass of tissue (*black arrow*) caudal to the left kidney.

avoid causing inadvertent ureteral trauma. If there is any doubt in identifying the ovarian tissue, fibrous tissues associated with both ovarian ligature sites are resected and submitted for histopathology.

Avoidance

The ovary can be very difficult to visualize, especially in dogs, due to the large amount of adipose tissue associated with the mesosalpinx in this species. As a result, a variety of strategies have been used to ensure complete removal of the ovary during OVH. First, adequate exposure is obtained in the initial midline abdominal incision so that the ovary can be completely exteriorized during clamp placement. The suspensory ligament is ruptured or stretched to a degree that allows mobilization of the ovary so that there is adequate space to place two hemostatic clamps on the ovarian pedicle without encroaching on the ovary. Because visualization of the ovary is often obscured by fat in the mesosalpinx, digital palpation of the ovary is performed while placing the hemostatic clamps on the ovarian pedicle, making sure to place the clamps at least 1 cm proximal (or deep) to the ovary on the ovarian pedicle. Ligatures are then placed proximal to the clamp, ensuring that the ovary will be completely resected when the pedicle is severed distal to the ligatures. As a final precaution, the ovary is examined directly before releasing the ovarian pedicle. The ovary can then be

examined for completeness of resection by inserting a Metzenbaum scissor blade into the opening of the ovarian bursa, incising the bursa until the mesosalpinx is reflected.

Stump Pyometra

A common misconception is that stump pyometra occurs as a result of incomplete resection of the uterine body. In fact, numerous large studies performed in Europe have demonstrated that ovariectomy alone (without removal of the uterus) prevents the later occurrence of pyometra with equal efficacy as complete OVH.[5] It is important to remember that the pathophysiology of stump pyometra is identical to that of classic canine pyometra, involving repeated exposure of the uterus to progesterone from either an ovarian remnant or, much more rarely, the therapeutic administration of exogenous progestogens. Thus, stump pyometra is not caused by retained uterine tissue; it is actually a rarely reported complication of ovarian remnant syndrome. Interestingly, a recent report of ovarian remnant syndrome in dogs described that 11 of 12 uterine stumps that were submitted for histopathology had evidence of cystic endometrial hyperplasia.[27] Stump pyometra can occur with an open cervix, causing obvious clinical signs of purulent vaginal discharge in a dog with a previous history of OVH. In dogs with a closed cervix, signs are of pyometra are nonspecific (eg, lethargy, fever, decreased appetite),[30] and diagnosis of closed stump pyometra can be extremely difficult when clinical signs are not directly referable to the urogenital tract. A key diagnostic finding is the presence of a fluid-filled uterine stump on abdominal ultrasound in a dog that has a history of previous OVH. Further examination by a skilled operator may allow detection of the retained ovarian tissue that is invariably the cause of this complication. Ultrasound-guided fine needle aspiration of the uterine fluid can be performed to allow cytologic interpretation and confirm diagnosis, but results are unlikely to alter the plan for surgical intervention and aspirates have a risk of seeding the abdomen with bacteria.

Therapy

Resolution of stump pyometra is achieved by resection of the uterine stump at the level of the cervix. A caudal midline celiotomy is performed and the uterine stump is located by retroflexing the urinary bladder and identifying the uterus between dorsal to the urinary bladder and ventral to the colon. The uterine stump is double-ligated and transfixed with absorbable monofilament suture, just cranial to the cervix. Inverting the uterine stump with a Parker Kerr oversew is now considered unnecessary and may even contribute to walling off bacteria in the remaining uterine lumen. Instead, the uterine stump is flushed copiously with sterile 0.9% NaCl. If there is remaining concern about ongoing contamination, the omentum may be sutured to the end of the uterine stump to form a fibrin seal while providing physiologic drainage of the area.

Avoidance

Uterine stump pyometra is one manifestation of ovarian remnant syndrome. As a result, avoidance strategies are identical to those described above and are directed at ensuring complete removal of the ovaries at the time of sterilization surgery.

Ureteral Injury

The ureters travel through the retroperitoneal space caudal to the kidney and are crossed by the gonadal arteries, where they can be inadvertently traumatized or ligated during OVH (**Fig. 3**). At their distal insertion into the bladder, the feline ureters

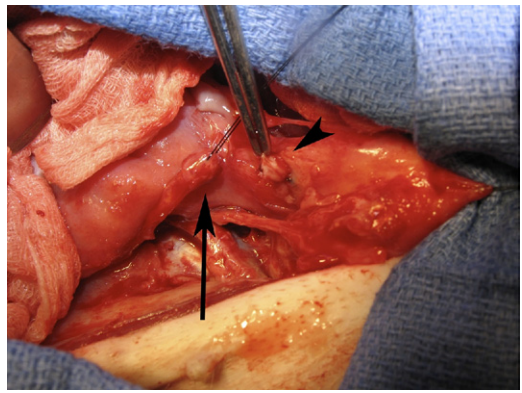

Fig. 3. Abdominal exploration was performed in a dog that was suffering from uroabdomen 1 week after ventral midline ovariohysterectom. The right ureter (*black arrow*) had been traumatized during ligation of the uterine pedicle (*black arrowhead*). A right ureteronephrectomy was performed. (*Courtesy of* Andrew Mercurio, DVM, The Ohio State University.)

are also rather closely associated with the uterine body where they are in danger of being ligated with the uterine pedicle, particularly when the bladder is full and in a more cranial position. Despite this anatomic proximity with the urogenital tract, there are only 3 individual case reports of ureteral injury secondary to OVH in dogs.[11–13] although it is likely that this complication is far more common and goes undetected, as unilateral ureteral obstruction would not cause azotemia in a previously healthy animal. Clinical signs in the reported cases were highly varied. In 1 dog, ureteral injury was detected due to severe clinical signs associated with uroabdomen 5 days after unilateral ureteral transaction.[11] In the other 2 case reports, ureteral obstruction occurred as a late complication, with suture reactions adjacent to the ureter causing extramural ureteral compression at 1 and 9 years after OVH.[12,13] Diagnosis of ureteral injury is typically obtained using a combination of imaging modalities since no single modality is ideal for all situations. Intravenous urography is most useful in detecting the location of upper urinary tract rupture in animals with normal renal function, but abdominal ultrasound is more adept at imaging the urinary tract in cases of chronic obstruction, when deteriorated renal function can limit the detectable contrast that reaches the collecting system.

Therapy

Ureteral repair is technically demanding and, in smaller animals, requires the use of microsurgical instruments and an operating microscope. As such, animals with suspected ureteral injury after OVH should be referred to a surgeon with the equipment and experience required to successfully perform these surgeries. Repair of acute ureteral laceration is typically accomplished by end-to-end or end-to-side ureteral anastomosis.[11] Swelling of the tissues at the anastomotic site is common in the immediate postoperative period, while stricture can occur in a more delayed fashion at 3 to 4 weeks after surgery. To maximize the ureteral diameter at the site of anastomosis, each end of the ureter is spatulated by inserting a scissor into the cut end and incising longitudinally to expose the ureteral lumen. Anastomosis is then performed using 6-0 to 10-0 suture in a simple interrupted pattern. Stenting of the ureter by bridging the anastomotic site with a red rubber catheter or ureteral stent can

minimize the risk of anastomotic leakage and preserve the lumen diameter. Ureteral lacerations or obstructions that are located near the urinary bladder are treated by resection of the distal segment and neoureterocystostomy (ureteral implantation into the bladder apex). Anastomosis with the urinary bladder has a lower complication rate than ureteroureterostomy and is technically simpler to perform.[31,32] In cases where ureteral injury is irreparable or where no residual renal function is present, unilateral ureteronephrectomy can be performed.

Avoidance

Ureteral injury is avoided by constantly being aware of the anatomic location and proximity of the ureter to the operative site. Inadvertent injury to the ureter can occur if a surgeon grasps to retrieve a dropped ovarian pedicle that has retracted into the retroperitoneal fat caudal to the kidney. Due to the slow rate of blood loss from an ovarian pedicle, it is recommended that a surgeon take the time to increase exposure by lengthening the abdominal incision cranial to the umbilicus and using suction or laparotomy sponges to improve vision of the dropped pedicle. The pedicle is then grasped carefully with noncrushing Debakey forceps and elevated away from the ureter before clamping the vessel with a hemostat. Inadvertent incorporation of the ureters in the uterine stump ligation is facilitated by complete preoperative emptying of the urinary bladder during preparation of the skin. The empty bladder moves caudally in the abdomen, pulling the ureters away from the region of uterine stump ligation and improving visualization during ligation.

Bowel Obstruction

Numerous early studies and case reports described the development of bowel obstruction following uncomplicated ovariohysterectomy.[10,23,33–35] In each of these early studies, bowel obstruction occurred as a result of granuloma or abscess formation around a pedicle that had been ligated using multifilament nonabsorbable suture material.[9,10,23,33–36] Although the use of multifilament nonabsorbable suture has been largely replaced by the use of monofilament absorbable suture, uterine stump abscessation is still reported.[9] In addition, a new phenomenon of colonic obstruction due to the formation of fibrous adhesions of the broad ligament, uterine stump, and colon has been described.[10] Presenting signs are nonspecific (ie, lethargy, vomiting, dysuria, and constipation) and are often attributable to compression of the adjacent colon and urinary bladder neck in affected animals. Granulomas and abscesses may be detected between the urinary bladder and colon during abdominal palpation or imaging studies[9,36] (**Fig. 4**), while fibrous adhesions appear as an extraluminal compression of the colonic lumen.[10] The detection of leukocytosis, pyrexia, or hypoechoic fluid in association with a uterine stump mass is consistent with abscess formation.[9,36] Colonic obstruction after OVH has been described in both cats and dogs, with insufficient information to discern a species predisposition.[10,34,35]

Treatment

Conservative therapy with stool softeners, highly digestible diet, and anti-inflammatory medications may be attempted in animals with partial colonic obstruction due to granuloma formation. Animals with fibrous adhesions or abscesses would not be expected to respond well to medical management and surgical intervention is recommended. A ventral midline exploratory surgery is performed and the cause of obstruction is assessed. In animals with uterine stump granulomas or abscesses, complete resection is performed if possible. In animals with inflammation involving the ureters or the neurovascular supply of the urinary bladder, partial resection and

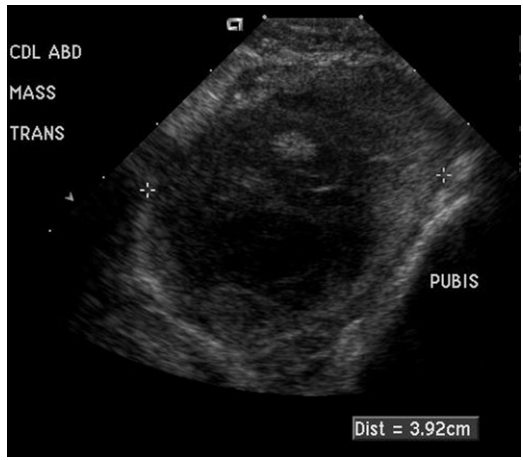

Fig. 4. Ultrasonographic image of a uterine stump abscess in a 3-year-old whippet that underwent ventral midline OVH 1 week prior to presenting for pollakiuria.

omentalization are indicated to avoid iatrogenic injury.[9] Fibrous adhesions are disrupted using blunt and sharp dissection to free the colon and relieve obstruction.[10] The prognosis is good in animals that undergo surgical therapy and whose clinical signs resolve without need for further interventions.[9,10]

Avoidance

Historical information would suggest that the use of multifilament nonabsorbable suture for ligations is contraindicated during elective OVH.[36] Prevention of adhesions is never completely ensured, although strategies to minimize serosal irritation would include avoidance of bowel dessication, eliminating powder from surgical gloves prior to surgery, and using gentle tissue handling during surgery.

Acquired Urinary Incontinence

Urethral sphincter mechanism incompetence (USMI) is a form of acquired urinary incontinence that can develop after OVH in dogs. Estrogen increases the number of alpha receptors and the affinity of those receptors to adrenergic binding, increasing urethral smooth muscle tone. Removal of the positive influence of estrogen on urethral tone is the major mechanism involved in acquired USMI, although estrogen replacement therapy is only successful in restoring continence in 60% of affected dogs, suggesting that other factors contribute to this condition. While USMI is an indirect result of surgery, it is arguable that this problem should be listed as the most common complication after OVH. The relative risk of USMI is increased 7.8-fold by OVH,[37] and most retrospective studies estimate that nearly 1 in 5 dogs develop incontinence after OVH.[38] Signs of urinary incontinence can begin any time between 2 weeks and 10 years after OVH, with an average of 2.9 years.[38–40] Incontinence is most commonly noted during sleep and recumbency but may also manifest during times of excitement or nervousness.[39,40] Large breed dogs appear to be at increased risk, with incidence approaching 30% in dogs greater than 20-kg body weight.[38] Diagnosis is largely based on a history of acquired incontinence that developed after OVH, although complete blood count, serum biochemistry panel, urinalysis, abdominal

ultrasound, and cystoscopy are often recommended to rule out other metabolic, infectious or anatomic conditions that may be contributing to incontinence. Definitive diagnosis requires urodynamic studies to document the changes in the urethral pressure profile associated with USMI.[41] In clinical practice, many veterinarians use a therapeutic trial as an initial method of both treatment and diagnosis of the condition.

Therapy

The vast majority of dogs with USMI will respond to treatment with the sympathomimetic drug phenylpropanolamine (PPA). A prospective placebo-controlled study reported an 85% success rate in resolving incontinence when PPA was dosed at 1 mg/kg 3 times daily.[42] Side effects of this alpha agonist drug are predictable and include restlessness, anorexia, and hypertension. Dosing is titrated until incontinence is controlled or side effects are noted. Estrogen-related drugs such as diethylstilbesterone (DES) are synergistic with PPA and can be added to the treatment regimen in dogs that are refractory to PPA alone.[43] Bone marrow suppression is a rare complication of DES administration, and complete blood counts should be monitored serially in dogs that are receiving the drug.[43] Several procedures are available for dogs that fail to respond to medical therapy or develop drug-related side effects, including submucosal collagen injection, colposuspension, and placement of an artificial urethal sphincter.[44–47]

Avoidance

Historically, authors asserted that the rate of incontinence was increased when dogs were spayed before the first estrus cycle or when the cervix was removed during OVH; however, subsequent studies in larger groups of animals have disproved these theories[20,37] and there are no known methods to avoid this problem, aside from avoiding OVH entirely. Based on the incidence of USMI after OVH and on the significance of urinary incontinence in a pet dog, this is an area that deserves great attention by the veterinary community. In particular, research into alternative methods for sterilization would seem appropriate, given the high incidence of incontinence after traditional OVH.

Complications of Orchiectomy

Hemorrhage

Orchiectomy is performed through a prescrotal incision in mature dogs. The vascular pedicle can be double-ligated and transfixed through a closed technique, or an incision is made in the parietal vaginal tunic to expose the vascular pedicle, allowing direct ligation of the pampiniform plexus. In contrast to OVH, overt hemorrhage following orchiectomy is most often related to bleeding from the tunic and is therefore self-limiting, causing incisional hemorrhage, subcutaneous bruising, and scrotal hematoma. Scrotal hematoma was reported to occur in 7 dogs and 2 cats in a series of 218 animals undergoing elective sterilization surgery, although the data were not presented in a manner that allowed calculation of overall incidence.[22] Serious hemorrhage from the vascular pedicle is actually harder to detect, as vessels can retract into the abdomen and cause hemoperitoneum with few external signs of hemorrhage. Animals with significant intracavitary hemorrhage will present with more subtle signs, such as pale mucous membranes, tachycardia, and slow recovery from anesthesia. Diagnosis should be carried out with evaluation of blood coagulation, platelet function, and abdominal ultrasound examination as described for hemorrhage following OVH.

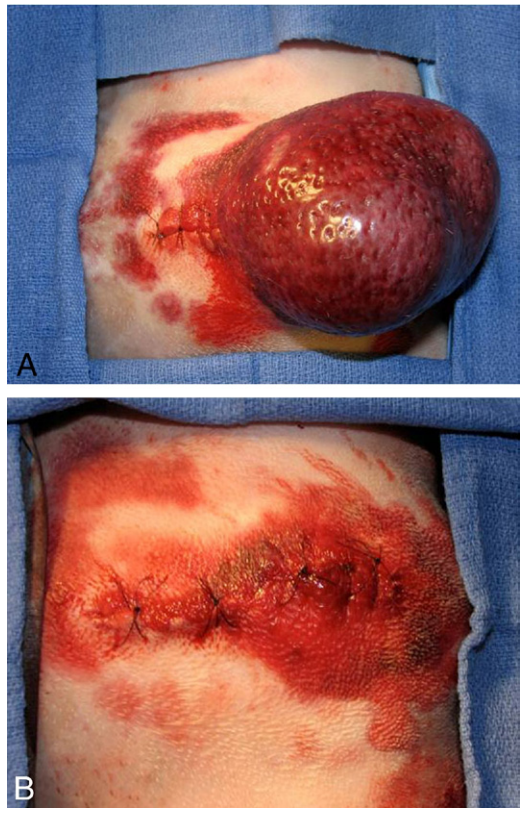

Fig. 5. This large scrotal hematoma (*A*) was diagnosed 48 hours after closed orchiectomy in an adult male mixed breed dog. The dog was treated by scrotal ablation (*B*).

Treatment

Initial treatment of mild scrotal hematoma formation involves cryotherapy (ice packing for 10 minutes every 4 hours) and sedation to minimize activity in the immediate postoperative period. Dogs with severe scrotal hematoma often go on to suffer from necrosis of the scrotal skin, and scrotal ablation is recommended in the early postoperative period to minimize morbidity to the animal (**Fig. 5**). In animals with significant abdominal hemorrhage secondary to failed ligation of the testicular pedicle, abdominal exploration is performed via a parapreprutial skin incision and caudal midline abdominal approach through the linea alba.

Avoidance

Prophylactic scrotal ablation should be considered in older intact dogs to avoid the risk of scrotal edema, hematoma formation, and poor cosmetic outcome after orchiectomy. It has been suggested that performance of a closed castration (without incising the parietal tunic) decreases the incidence of scrotal hematoma following orchiectomy.[48] Nonetheless, open castration provides a more secure ligation of the large pampiniform plexus and is recommended in dogs greater than 20-kg body weight.[49,50]

Inadvertent Prostatectomy

Cryptorchidism is a common congenital anomaly in dogs, with 9% of 466 animals undergoing castration surgery at a veterinary teaching hospital having been diagnosed as unilaterally or bilaterally cryptorchid.[22] Intra-abdominal testicles are removed through a parapreputial caudal abdominal approach to avoid the development of testicular neoplasia in the retained testis. Unintended removal of the prostate is a rare but devastating complication of cryptorchid castration.[14,15,51,52] Due to inadequate exposure and improper identification of anatomic structures, the surgeon grasps an ovoid object in the caudoventral abdomen and removes it, mistakenly identifying the prostate instead of the retained intra-abdominal testicle. Unfortunately, the prostatic urethra is resected with the prostate, leading to uroabdomen, or, if the urethra and bladder neck are ligated, to complete urinary obstruction and rapidly progressive uremia.[14] Diagnosis of this problem is largely based on detection of azotemia and anuria in association with a recent history of cryptorchid castration. Confirmation of urethral trauma or ligation can be performed by positive contrast urethrography (**Fig. 6**).

Treatment

Surgical exploration through a caudal abdominal approach is performed as soon as the patient is stabilized. The urethral transection is repaired by reanastomosis with the urinary bladder neck using interrupted sutures in an appositional pattern. The author recommends the use of magnification (×3.5) and availability of microsurgical instrumentation to facilitate direct apposition of urethral mucosa with a fine (5-0 to 6-0) monofilament absorbable suture material, minimizing the likelihood of urine leakage or postoperative stricture. Anastomosis is performed over a urinary catheter to prevent inadvertent incorporation of the back wall during suture placement (see **Fig. 6**). A Foley urinary catheter is maintained for 5 to 7 days to facilitate bridging of the repair with urothelium. Although complete prostatectomy is associated with a high rate of incontinence when performed in dogs with malignant neoplasia, a functional outcome is often achieved in previously healthy dogs that have undergone inadvertent prostatectomy.[14,51]

Avoidance

Prevention of inadvertent prostatectomy can be achieved by obtaining definitive identification of anatomy during cryptorchid castration. A paramedian caudal abdominal incision is made extending along the entire length of the prepuce and terminating at the cranial aspect of the pubic bone. The prepuce is retracted and a ventral midline abdominal incision is carried out in similar fashion. The urinary bladder is retroflexed so that the dorsal bladder neck and trigone can be examined. The paired, white deferent ducts are identified near the trigone as they course over the ureters and insert on the dorsal surface of the prostate. The ductus deferens are used to locate the retained testicle(s) by tracing each duct to its origin from the epididymis of the abdominal testicle or, for a descended testis, until it exits through the inguinal ring. Although the intra-abdominal testicle may be atrophied or affected by a neoplastic process, the characteristic appearances of the epididymis and the vascular pampiniform plexus are helpful in confirming the origin of the tissue before resection. Keep in mind that an undescended testicle lacks the parietal vaginal tunic, exposing the vascular pedicle, ductus deferens, and gubernaculum to direct examination. Exposure of the vascular anatomy facilitates both identification of the testicle and subsequent ligation of the vascular pedicle. Resected tissue is submitted for histopathologic examination to confirm removal of the testicle and to investigate for

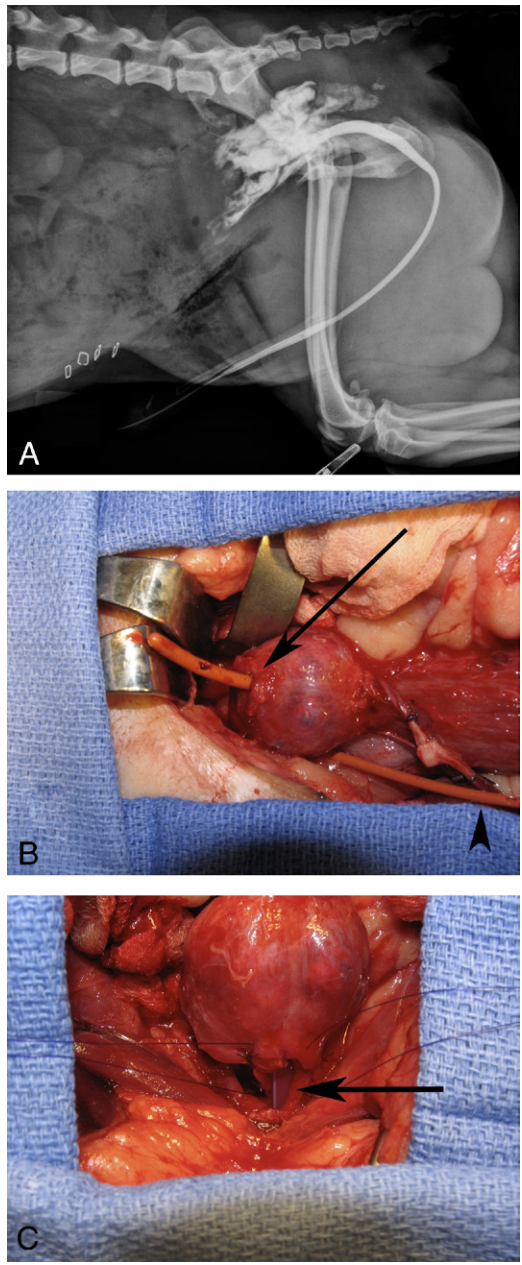

Fig. 6. Positive contrast urethrography (*A*) showing extravasation of contrast from the post prostatic urethra in a dog that underwent abdominal cryptorchidectomy 24 hours earlier. Urethral transection had occurred, due to confusion of the prostate with the abdominal testicle. Antegrade passage of a urinary catheter from the urinary bladder shows the site of urethral transaction caudal to the prostate (*B, black arrow*). A second catheter was placed retrograde from the penis (*B, arrowhead*), allowing identification of the pelvic urethra. The prostatic urethra was anastomosed to the pelvic urethra over a urinary catheter (*C, black arrow*). (*Courtesy of* Dr Stephen Birchard, The Ohio State University.)

the development of testicular neoplasia, which occurs at a higher rate in retained testes.[49]

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