Surgical Approaches to Ovariectomy in Mares

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ABSTRACT: The preoperative considerations, surgical techniques, postoperative care, and complications associated with the surgical techniques available to perform unilateral or bilateral ovariectomy in horses are described. Standing techniques described include the colpotomy (vaginal), flank laparotomy, and laparoscopic approaches. Procedures that require general anesthesia, including flank laparotomy, ventral midline celiotomy, paramedian celiotomy, diagonal (oblique) paramedian celiotomy, and laparoscopic approaches, are also discussed. Complications following surgery can range from mild incisional swelling and pain to fatal intraabdominal hemorrhage or eventration. Careful consideration of the advantages and disadvantages of each procedure allow equine surgeons to select the most appropriate approach for each patient.

Equine ovariectomy is a commonly performed elective surgical procedure. Various surgical approaches are used for unilateral or bilateral ovariectomy. The surgical approaches described include vaginal or colpotomy, flank, diagonal or oblique paramedian, ventral midline, caudal paramedian, and numerous laparoscopic techniques. The decision as to which approach to use for a particular case depends on the following factors:

- Specific indications for ovariectomy
- Size of the affected ovary
- Surgeon's preference
- Financial constraints imposed by the client
- Temperament of the mare
- Equipment available
- Client expectations

An understanding of the benefits and disadvantages of all approaches can aid the clinician in selecting the appropriate surgical approach for each patient. This article reviews the surgical approaches used to perform unilateral and bilateral ovariectomy in mares.

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PREOPERATIVE CONSIDERATIONS

Special preoperative preparation of the mare should be instituted before performing ovariectomy. Food should be withheld for 12 to 24 hours before surgery to help decrease the amount of ingesta and gas within the gastrointestinal tract, thereby making it easier to exteriorize the ovary and suture the abdominal wall incision. Depending on patient positioning, laparoscopic techniques require that food be withheld for 12 to 48 hours prior to surgery\(^\text{1,2}\) to improve visualization of intraabdominal structures and to decrease the likelihood of penetrating a viscus when the laparoscopic instruments are introduced into the abdomen.\(^\text{3,4}\)

Abdominal palpation per rectum (with or without ultrasonographic evaluation) is useful in detecting abnormalities associated with the reproductive tract and should be performed in all mares presenting for ovariectomy regardless of the reason. Results of this evaluation may help dictate the necessary surgical approach based on the palpable size of the ovary to be removed. In addition, identifying pathology, such as adhesions or abscessation associated with the reproductive tract, may provide valuable information regarding the optimal surgical approach.

The rationale for and use of antibiotics to treat horses undergoing ovariectomy vary among surgeons. If antibiotics are used, they should be administered preoperatively to ensure that adequate systemic concentrations are present at the time of surgery. Administration of broad-spectrum antibiotics should be continued postoperatively if a break in aseptic technique occurred during the procedure.\(^\text{5}\) Postoperative administration of broad-spectrum antibiotics should be continued for 3 to 5 days. Administration of ceftiofur sodium and cefoxitin is unnecessary but is recommended, if antibiotics are used, to provide analgesia as well as profound sedation. Acepromazine can be administered for tranquilization as well. Administration of caudal epidural anesthesia is unnecessary but is recommended by some surgeons to help prevent the mare from straining during the procedure.\(^\text{12,13}\) The tail is wrapped and secured away from the perineal region, and all manure should be evacuated from the rectum to prevent contamination of the external genitalia. Routine aseptic preparation of the external genitalia and perineal region is performed, and the vagina is lavaged with sterile saline or dilute povidone–iodine solution. In some mares, catheterization of a large urinary bladder may facilitate the procedure and may help reduce the risk of inadvertent injury during the procedure.\(^\text{14–16}\)

The location of the initial incision in the cranial fornix of the vagina is very important. The incision must be placed in either a craniodorsal (at the 2- or 10-o’clock) or a cranioventral (at the 4- or 8-o’clock) position. Potential complications of a misplaced incision include entering the rectum if the incision is placed too dorsal, injuring the urethra or bladder if placed too ventral, and incising the caudal uterine branch of the urogenital artery if too medial or lateral (at the 3- or 9-o’clock position).\(^\text{11,17,18}\) The incision should be started 3 to 5 cm caudal to the os cervix to avoid disruption of the cervical musculature.\(^\text{12,14,18}\) Using a scalpel blade, scissors, or mosquito hemostat, a small 1- to 3-cm vaginal incision is sharply/bluntly created. This initial incision should penetrate the full thickness of the vagina and peritoneum to prevent the peritoneum from lifting away from the underlying tissues during blunt dissection. The incision is then bluntly enlarged digitally, and the peritoneum is perforated to allow the surgeon’s hand to enter the abdomen. The ovary and associated mesovarium are isolated by direct manual palpation. Anesthesia of the mesovarium can be attempted using gauze sponges soaked with local anesthetic, which are held around the mesovarium for 30 seconds to 2 minutes. To prevent loss of the sponges within the abdomen, a long suture or strand of umbilical tape should be secured to the sponges.\(^\text{13,16,19}\)

To transect the ovary from the mesovarium, a chain ecraseur is used to slowly crush and cut the mesovarium. The chain ecraseur should be carefully placed around the mesovarium, ensuring that bowel, intestinal mesentery, or a portion of the uterine horn is not encircled by the chain.\(^\text{12,17,18}\) Once the chain is properly positioned, it is tightened slowly (over 1 to 4 minutes) using the ratchet system of the ecraseur. Hemostasis of the mesovarium depends on crushing the vascular structures and the resulting vasospasm. While the ecraseur is being tightened around the ovary, the ovary

SURGICAL PROCEDURES

Vaginal Approach (Colpotomy)

In 1903, Williams first described a vaginal approach, or colpotomy, using an ecraseur to ovariectomize mares.\(^\text{3}\) The vaginal approach is now commonly used to improve visualization of intraabdominal structures and to decrease the likelihood of penetrating a viscus when the laparoscopic instruments are introduced into the abdomen.\(^\text{3,4}\)

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should be held within the surgeon's hand to prevent losing it within the abdomen. The contralateral ovary may be removed via the same vaginal incision if a bilateral procedure is to be performed. The vaginal incision is left open to heal by second intention. Optionally, an episioplasty (Caslick's procedure) may be performed to complete the surgery in an effort to decrease the risk of ascending infection. 

Tie stall restriction for 2 to 7 days postoperatively has been advocated to prevent recumbency and reduce the risk of evisceration. However, some authors suggest that this is unnecessary and report no adverse effects with routine stall confinement. Exercise restriction is employed for 1 to 3 weeks following surgery, depending on the rate of healing of the vaginal incision. During this time, limited hand walking or small paddock turnout is important to reduce the potential formation of adhesions to the ovarian stump. Light riding and a slow return to normal work are allowed after this time.

The primary disadvantage to the colpotomy approach is the lack of visualization. By palpation alone, the ovary must be differentiated and isolated from the omentum, local mesentery, loops of intestine, and fecal balls within the small colon. Hemorrhage from the mesovarium may be difficult to determine and control due to the lack of visualization with this approach. Postoperative administration of broad-spectrum antibiotics may be indicated in mares undergoing a vaginal approach because it is difficult to adequately prepare the vagina for aseptic surgery. This approach is not recommended in mares that pool urine or in mares with vaginal, cervical, or uterine infections. Ecraseur transection of large ovaries (larger than 8 to 10 cm in diameter) should not be attempted due to the size of vaginal incision needed to remove the ovary, the possibility of dropping the ovary within the abdomen, and the enlarged vascular supply associated with larger ovaries. Even with adequate restraint and heavy sedation, this approach poses a risk to the surgeon due to positioning behind the mare. Thus only tractable mares are good candidates for this procedure.

Flank Approach

The flank ovarioectomy approach can be performed with the mare in the standing or recumbent position. To perform a standing flank laparotomy, the mare's temperament must be amenable to standing surgery. When performing a standing flank laparotomy, the mare is sedated, restrained in standing stocks, and the tail is wrapped and secured away from the surgical site (as described for the colpotomy procedure). For the recumbent technique, mares are placed in lateral recumbency so that the ovary to be removed is uppermost. The recumbent flank technique requires general anesthesia, resulting in a slightly greater cost to the client and potentially increased risk to the mare. The recumbent flank technique is generally only used for unilateral ovarioectomy, as it offers easy access to only one ovary.

Compared with the colpotomy approach, both the standing and recumbent flank laparotomy approaches enable the surgeon to remove larger ovaries and give better exposure of the mesovarium, thus potentially providing superior hemostasis. The ovary is normally situated beneath the paralumbar fossa. In horses, the limited size of the paralumbar fossa (compared with bovines) and the thickness of the body wall in the flank region may limit the ability to easily exteriorize large ovaries. Ovaries up to 15 cm in diameter can be removed easily through a flank approach. Bilateral ovarioectomy typically requires a second incision through the opposite paralumbar fossa to remove the contralateral ovary. In the standing mare, bilateral ovarioectomy can be achieved through a single flank incision, but the contralateral ovary must be excised blindly within the abdomen using a chain ecraseur. Regardless of positioning, the paralumbar fossa is clipped, aseptically prepared, and draped. Regional anesthesia in the form of an inverted L-block or local infiltration of the proposed incision site is required in standing mares. The incision is started 5 cm ventral to the lumbar transverse processes between the 18th rib and the tuber coxae and is extended ventrally 10 to 15 cm as needed, depending on the size of the ovary to be removed.
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removed (Figure 1). Following incision of the skin and subcutaneous tissues, a grid or modified grid approach may be used to incise the abdominal musculature. The grid approach creates a slightly smaller opening into the abdomen and should only be used for ovaries less than 10 cm in diameter; larger ovaries will necessitate use of the modified grid technique.\textsuperscript{13,14,19} A grid approach involves separating the external abdominal oblique muscle along the direction of its fibers, whereas a modified grid technique involves incising this muscle along the line of the skin incision.\textsuperscript{14} For both techniques, the internal abdominal oblique and transversus abdominis muscles are bluntly separated along the direction of their fibers or incised to expose the peritoneum. The peritoneum may be incised or bluntly perforated to allow access to the abdomen. The ovary is then identified and isolated. In standing mares, the mesovarium is anesthetized by topical administration of anesthetic, similar to that described for the colpotomy procedure, or by direct injection of anesthetic into the mesovarium, if visualization permits. The ovary may be transected within the abdomen or after exteriorization. Aspiration of cystic cavities within the ovary may reduce the overall ovarian size and facilitate exteriorization.\textsuperscript{3,10,18} The means to achieve hemostasis and transection of the mesovarium depend on the ability to exteriorize or visualize the mesovarium through the flank incision. Possible choices include the use of a chain ecraseur, emasculator, surgical stapling device, or transfixing ligatures.\textsuperscript{13,14,16,19,24} Following removal of the ovary, the mesovarium is observed for hemorrhage and oversewn if desired, when adequate visualization permits. Oversewing the mesovarium with 2-0 absorbable suture material may reduce possible intraabdominal adhesions of a segment of bowel to the transected mesovarium.\textsuperscript{14,18} Closure of the laparotomy incision is routine.

Postoperative pain and discomfort may be observed in association with the flank incision. Incisional swelling and discharge may be noted 24 to 72 hours after surgery.\textsuperscript{24,25} Incisions created in a more ventral position on the flank tend to develop more swelling and cause increased postoperative pain and discomfort.\textsuperscript{24} Incisions in the flank have been associated with incisional discharge and partial dehiscence.\textsuperscript{13,14,22} Occasionally, this approach results in a poor cosmetic outcome if scarring of the incision site occurs.\textsuperscript{10-12} Exercise should be restricted to hand walking or turnout in a small paddock for 4 to 6 weeks following surgery, after which light riding and a slow return to normal work may be allowed, provided the incision has healed without complications.

Diagonal (Oblique) Paramedian Approach

The diagonal (oblique) paramedian approach has been reported to be superior to other approaches for ovariectomy, especially for the removal of ovaries up to 20 to 25 cm in diameter.\textsuperscript{26,27} Because the incision is created so close to the intraabdominal position of the ovary, exteriorization through a diagonal paramedian incision generally results in less traction being placed on the mesovarium. In addition, the body wall is thinner at this location, as compared with other approaches, which allows greater flexibility in retracting the wound edges. Improved visualization of the ovary and mesovarium can often be achieved with this approach. Bilateral ovariectomy can be performed; however, two incisions are generally required. General anesthesia is necessary to perform an ovariectomy with this approach; therefore, the cost and risks associated with recumbency are also associated with this technique.

Perioperative preparation and care is similar to that for the previously described approaches. Following induction of general anesthesia, the mare is placed in dorsal recumbency. Slightly tilting the mare toward the side opposite the affected ovary helps minimize the tendency for bowel to protrude from the incision. Following routine aseptic preparation of the ventral abdomen, an incision is started approximately 5 to 10 cm cranial to the ipsilateral mammary gland and extended approximately 20 cm (or as needed, depending on the size of the affected ovary) cranially and laterally toward the fold of the flank\textsuperscript{11,15,16} (Figure 2). The incision is extended through the underlying external rectus sheath,
parallel to the initial skin incision. The rectus abdominis, internal rectus sheath, and peritoneum are bluntly divided in the direction of their fibers or incised (depending on surgeon preference) to allow access to the abdomen. The ovary is located and exteriorized. Local anesthesia of the mesovarium, either by topical application of anesthetic-soaked gauze sponges or direct injection of local anesthetic, may be used to diminish the pain response secondary to traction on the ovary. Fluid within cystic cavities may be aspirated to reduce the size of the ovary and facilitate its removal from the abdomen. Large suture material placed as stay sutures within the ovary and retraction on the incision edges may aid the surgeon in exteriorizing large ovaries. Overlapping transfixation ligatures of No. 2 absorbable suture material or application of a TA-90 stapler (US Surgical) may be used for hemostasis prior to transection of the mesovarium. Ligatures should be tightened and staples should be applied to the mesovarium in a relaxed position; application under tension may result in failure to provide adequate hemostasis. Following complete transection of the mesovarium, closure of the abdominal incision is routine. Due to the location of the incision on the ventrum, a good cosmetic outcome usually follows ovariec- tomy by the diagonal paramedian approach.

Exercise restriction during the early postoperative period should consist of stall confinement with hand walking for the first 2 to 4 weeks following surgery. After this time, small paddock turnout may be allowed for an additional 2 to 4 weeks of confinement, the actual length of restriction depending on the individual patient’s wound-healing progress. Return to a full exercise schedule and/or the allowance of natural service should not be allowed for at least 8 to 12 weeks postoperatively. Mares may be bred by artificial insemination when the estrous cycle occurs following surgery.

**Ventral Midline Celiotomy Approach**

A ventral midline celiotomy approach offers good exposure of the ovaries in the majority of mares. The ventral midline incision can easily be extended as necessary, depending on the individual case, making it the technique of choice for removal of extremely large, tumorous ovaries. The ventral midline approach is generally used to remove very large granulosa–theca cell tumors but can also be used to perform a bilateral ovariec- tomy. A good cosmetic outcome is expected with this approach, provided no complications with incisional healing occur.

Perioperative preparation and care are similar to previously described approaches. For a ventral midline technique, general anesthesia is required and the mare is placed in dorsal recumbency. A caudal ventral midline linea incision is created, beginning at the mammary gland and extending cranially 25 to 35 cm as needed for adequate exposure (Figure 2). The ovary is located by manual palpation and exteriorized. Local anesthesia of the mesovarium can be used if desired. Topical application of anesthetic-soaked gauze sponges or direct injection of the mesovarium with local anesthetic may decrease the pain response related to traction on the mesovarium. Intraoperative hypotension believed to cause myopathies and neu- ropathies has been associated with excessive traction on the mesovarium, and these complications may be reduced by the application of local anesthetic. Hemostasis and transection of the mesovarium are similar to what was described for the flank and diagonal paramedian approaches. Closure of the ventral midline incision is routine.

Postoperatively, care is similar to the other ovariec- tomy approaches. Stall confinement with hand walking should be enforced for the first 2 to 4 postoperative weeks, at which time sutures or staples used to close the ventral incision should be removed. Small paddock turnout may be allowed after this, for an additional 2 to 4 weeks of confinement, after which light riding or pasture turnout may be allowed. Full exercise should not be allowed for a minimum of 8 to 12 weeks after surgery, depending on the progress of incisional healing.

**Paramedian Approach**

The paramedian approach can be used to remove large pathologic ovaries or to perform bilateral ovariec- tomy through one (contralateral ovary must be tran- seeted blindly) or two incisions. The paramedian approach is similar to the ventral midline approach except for the location of the incision. The incision is made 4 to 8 cm lateral to midline and extends cranially from the level of the mammary gland for 25 to 35 cm or as needed for adequate exposure (Figure 2). Methods to exteriorize the ovary and pro- vide hemostasis of the mesovarium are similar to those described for other approaches. Postoperative care fol- lowing a paramedian celiotomy is similar to the ventral midline and diagonal paramedian approaches.

**Laparoscopic Techniques**

In the past 10 years, laparoscopic ovariec- tomy tech- niques have been described for mares in the standing positions and dorsally recumbent positions. Laparoscopic techniques can greatly improve visualization of the ovary and mesovarium, potentially decrease postsurgical complications, and allow tension-free ligation of the vessels within the mesovarium.
ever, important considerations when performing equine laparoscopic ovariectomy include the requirement of specialized equipment, the technical difficulty of certain procedures, and the potential for anesthetic complications in horses placed in the Trendelenberg position.\textsuperscript{4,21,33} Additionally, the use of laparoscopic equipment may be cost prohibitive in certain situations.\textsuperscript{3,21}

**Laparoscopic Ovariectomy in the Standing Mare**

Laparoscopic ovariectomy in the standing mare avoids the need for general anesthesia, eliminates the cardiovascular derangements associated with the Trendelenberg position, and shortens the required preoperative fasting time (12 hours instead of 24 to 48 hours).\textsuperscript{1,3,32} Mares are sedated using either xylazine hydrochloride or detomidine hydrochloride in combination with butorphanol tartrate. For bilateral ovariectomy, both paralumbar fossae are prepared for aseptic surgery and draped. The paralumbar fossa is desensitized using regional anesthesia or by direct infiltration of the proposed laparoscope and instrument portal sites.\textsuperscript{4,5,36} The abdominal cavity can be insufflated with carbon dioxide through either a Verres-type needle inserted dorsally in the paralumbar fossa or a teat cannula inserted ventrally, as if performing abdominocentesis.\textsuperscript{7,37} As an alternative (to avoid the potential complication of inadvertently insufflating the retroperitoneal space), the trocar–cannula can be inserted through the paralumbar fossa prior to insufflation of the abdominal cavity.\textsuperscript{6,32,33,38}

A 15-mm skin incision is made at the dorsal border of the internal abdominal oblique muscle, and the sharp laparoscopic trocar–cannula is introduced into the abdominal cavity perpendicular to the paralumbar fossa\textsuperscript{1,3,39} (Figure 3). The trocar is replaced by the laparoscope, and the caudal portion of the abdomen is examined to identify the ovary. The first instrument portal is made 4 to 8 cm ventral to the laparoscope portal, and a second instrument portal is made 4 to 8 cm ventral to the first\textsuperscript{4} (Figure 3). Trocar–cannula units are passed through each instrument portal perpendicular to the flank musculature. Using a long spinal needle inserted separately through the flank musculature or a laparoscopic injection needle placed through a cannula, the mesovarium can be infiltrated with local anesthetic.\textsuperscript{7,31,38} Hemostasis of the mesovarium can be achieved using suture ligatures, staples, laser energy, electro surgical instrumentation, a vessel-sealing device, or a harmonic scalpel.\textsuperscript{1,3,32,33,36,38–41} The ovary is transected using laparoscopic scissors distal to the site of ligation or coagulation. The ovary is removed by enlarging one of the instrument portals or by connecting the two instrument portals.\textsuperscript{5,36} After removing the ovary, the abdomen is deflated through a laparoscopic cannula. The superficial abdominal fascia and skin at the portals are closed separately. The same procedure is then performed through the opposite paralumbar fossa to remove the contralateral ovary in bilateral procedures.

A hand-assisted laparoscopic ovariectomy technique in standing mares can be used to remove granulosa–theca cell tumors as well.\textsuperscript{42} A standard flank approach is used, but the process of injecting local anesthetic into the mesovarium, application of a surgical stapling device, and transection of the mesovarium is performed intraabdominally with digital manipulation while using laparoscopic observation of the procedure.\textsuperscript{42} After transecting the ovary from its mesovarium, the ovary is placed within a sterile plastic bag and sharply transected. Placing the ovary within the bag facilitates removal through a smaller incision and prevents abdominal and body wall contamination from the ovarian cystic fluid.\textsuperscript{35,42} The standing, hand-assisted, laparoscopic ovariectomy technique is technically easy to perform, can be used for large pathologic ovaries (up to 30 cm in diameter), allows accurate placement of the staple line, and eliminates the potential risks and costs associated with general anesthesia.\textsuperscript{42}

**Laparoscopic Ovariectomy in the Anesthetized Mare**

To perform unilateral or bilateral ovariectomy in an anesthetized mare using laparoscopy, the horse is anesthetized and positioned in dorsal recumbency, and the...
The tail is secured to the surgery table. The caudal abdomen is aseptically prepared and draped. To improve visualization of the caudal abdomen, a urinary catheter can be passed to decompress the urinary bladder. A 10-mm skin incision is made just cranial or lateral to the umbilicus (Figure 4). The abdomen is insufflated with carbon dioxide through a teat cannula to a pressure of approximately 15 to 20 mm Hg. A laparoscopic trocar–cannula unit is introduced into the abdomen, and the trocar is replaced with the laparoscope. In the recumbent technique, patient positioning becomes important for adequate visualization of the caudal abdomen. In routine dorsal recumbency, the female reproductive tract is obscured by intestinal viscera, so the surgical table must be elevated in such a way that the mare’s head is lower than the hindquarters. For removing ovaries, an angle of inclination of approximately 30° from horizontal (Trendelenberg position) is generally required. Two instrument portals (cranial and caudal) are created on both the left and right ventral abdomen (Figure 4). The cranial instrument portals are located midway between the ipsilateral mammary gland and the umbilicus. The caudal instrument portals are placed midway between the ipsilateral mammary gland and the cranial instrument portal. After creating the four instrument portals, the ipsilateral uterine horn is elevated using a Chambers catheter (Jorgensen Laboratories) inserted through the contralateral caudal instrument portal. A knot push rod equipped with a modified Roeder knot or a commercial suture loop is inserted through the ipsilateral caudal instrument portal (left caudal instrument portal for removing a left ovary). Sharp-toothed laparoscopic grasping forceps are passed through the cranial instrument portal on the same side as the suture loop. The jaws of the forceps are passed through the suture loop and used to grasp the ovary. The suture loop is passed over the ovary and tightened around the mesovarium. The mesovarium is then transected distal to the suture ligature. The transected ovary is maintained in the jaws of the grasping forceps while the same series of steps are reversed to allow removal of the opposite ovary. The abdomen is deflated and the ovaries are removed by enlarging one of the cranial instrument portals. For the enlarged incision, the external fascia of the rectus abdominis, subcutaneous tissue, and skin are closed separately. All remaining incisions are closed by simply apposing the skin.

Because most laparoscopic ovariectomy techniques can be accomplished through small incisions, the mare can be returned to exercise shortly after the procedure is performed. Postoperatively, mares should be confined to a stall for the first 24 hours followed by stall or small paddock confinement for 2 to 3 weeks before they are returned to unrestricted exercise.

Laparoscopy can be used to remove large ovarian granulosa–theca cell tumors. One report described two mares that had a granulosa–theca cell tumor removed using a recumbent laparoscopic ovariectomy technique. The mares were placed in Trendelenberg position, and the maximum diameter of the ovaries was estimated to be 20 cm in diameter. Complications that may occur following laparoscopic ovariectomy are similar to those seen with other approaches. Hemorrhage from the mesovarium has been reported following ligature slippage. Subcutaneous emphysema may be observed postoperatively if the abdomen is not decompresed adequately prior to closure of the incisions.

Although great advances have been made in the routine use of general anesthesia and surgical technique in horses, ovariectomy remains a procedure in which potential complications may occur, regardless of the approach used. In general, ovariectomy has been associated with greater postoperative morbidity and mortality than for other elective procedures. Postoperative hemorrhage from the mesovarium can occur if hemostasis of the mesovarium fails. Intraabdominal hemorrhage from branches of the ovarian artery is a serious and possibly fatal complication that
may go undetected at the time of surgery. Therefore, mares should be confined to a stall for the first 24 hours after surgery. Clinical signs associated with blood loss include tachycardia, pale mucous membranes, weakness or ataxia, weak thready pulse, and poor jugular distention. Hemorrhage must be controlled, and initial medical therapy should be aimed at replacing the lost blood volume by intravenous administration of fluids and whole blood.

The vaginal approach also has the potential risk of inadvertently incising the caudal uterine branch of the urogenital artery when making the incision into the abdomen. Care to avoid the 3- and 9-o’clock positions will help prevent this potentially fatal complication. Other potential complications reported when performing a vaginal approach include pain and discomfort; injuries to the cervix, bladder, or a segment of bowel; delayed vaginal healing; evagination of bowel, incisional site hematoma, or abscess; intraabdominal adhesions to the vagina; and chronic lumbar or bilateral hindlimb pain.

Reported complications with the other celiotomy approaches vary depending on position. Intraoperative hypotension, myopathies, and neuropathies have been associated with traditional ovariectomy approaches performed under general anesthesia to remove granulosa–theca cell tumors. Tension placed on the mesovarium during the process of exteriorizing an ovary is speculated to cause a decrease in arterial blood pressure and potentially lead to inadequate peripheral circulation. Cardiopulmonary derangements have been observed during laparoscopic procedures with horses placed in the Trendelenberg position. This positioning exaggerates the force of abdominal insufflation and the weight of abdominal viscera on the diaphragm, decreasing the horse’s ability to adequately ventilate without mechanical assistance and potentially compromising venous return to the heart. Metabolic acid–base disturbances may also occur following prolonged abdominal insufflation with carbon dioxide, which diffuses easily into the systemic circulation. As with traditional surgical approaches, myopathies and neuropathies can be a consequence of prolonged dorsal recumbency. Therefore, proper anesthetic patient monitoring is required when performing laparoscopic ovariectomy with the mare in the dorsal recumbent position.

Regardless of whether the surgery is performed with the mare standing or recumbent, postoperative pain, anorexia, depression, incisional swelling, incisional infections, incisional dehiscence, eventration, peritonitis, intraabdominal adhesions, and death have been reported following ovariectomy in mares. Incisional complications have been associated with ovariectomy techniques to remove granulosa–theca cell tumors. A higher incidence of incisional complications have been observed with approaches through the paralumbar fossa. This may be associated with the increased amount of dead space and possible muscle necrosis that may occur with the paralumbar approach.

Proper aseptic techniques must be employed when performing ovariectomy procedures, or postoperative septic peritonitis may result. This potential complication can be prevented by adhering to proper aseptic technique throughout the procedure and by the administration of perioperative antibiotics. Intraabdominal adhesions can develop after any abdominal procedure; however, the use of proper aseptic technique and ensuring minimal trauma to gastrointestinal serosal surfaces can help prevent formation of adhesions.

Ovariectomized mares may continue to display signs of estrus after ovariectomy. It has been reported that 60% of ovariectomized mares will cease estrous behavior following surgery. If previous hormonal therapy has been successful in altering the mare’s behavior and/or performance favorably, then bilateral ovariectomy is likely to be successful at meeting the client’s expectations. Prospective “jump” mares to be used for stallion collection should stand well during estrus as an intact mare; otherwise, the individual is not likely to be a good candidate for ovariectomy for this purpose.

**CONCLUSION**

The equine surgeon presented with a mare requiring ovariectomy has numerous approaches available. The specific approach to be used should be chosen carefully to minimize traction on the pedicle yet allow adequate exposure and visualization of the ovarian pedicle for secure hemostasis. Standing techniques include colpotomy (vaginal), flank laparotomy, and laparoscopy. Traditional techniques that require general anesthesia are flank, paramedian, diagonal (oblique) paramedian, and ventral midline celiotomy approaches as well as laparoscopic procedures. Laparoscopic techniques are superior in providing visualization of the ovaries and tension-free ligation for maximal hemostatic security. However, laparoscopy requires specialized instrumentation and surgical knowledge, which may increase operative time, at least initially, until experience is gained. Each technique for equine ovariectomy has associated advantages and disadvantages, and as such, there is no single “proper” technique to be used for every case. When deciding which approach to use, clinicians should be intent on completing the procedure in the most efficient way, while at the same time minimizing patient discomfort and postoperative complications.
REFERENCES

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1. Mares undergoing ovariectomy by colpotomy should be in what stage of the estrous cycle?
   a. immediately after ovulation
   b. diestrus or anestrus
   c. actively cycling
   d. pregnant
   e. seasonal transition

2. The initial vaginal incision for the colpotomy approach to ovariectomy should be in which position?
   a. directly dorsal
   b. on the medial wall
   c. on the lateral wall
   d. cranioventral or craniodorsal
   e. directly ventral

3. Oversewing the mesovarium following transection is recommended for which of the following reasons?
   a. decrease adhesion formation
   b. prevent eversion
   c. provide analgesia
   d. ensure adequate hemostasis
   e. complete sterilization

4. Which of the following is considered the main advantage to the ventral midline celiotomy approach to ovariectomy?
   a. little interference from abdominal viscera
   b. ease of performing a bilateral procedure
   c. optimal visualization of ovaries on short pedicles
   d. most tension-free ligation
   e. the ability to extend the incision as needed

5. Which of the following is generally not used for hemostasis when performing laparoscopic ovariectomy?
   a. suture ligatures
   b. staples
   c. chain ecraseur
   d. laser energy
   e. electrosurgical instrumentation

6. What is the main theory for why intraoperative hypotension is associated with traditional ovariectomy procedures performed under general anesthesia?
   a. Tension on the mesovarium decreases arterial blood pressure.
   b. Blood loss from the surgical incision causes hypovolemia.
   c. Hypoventilation causes decreased arterial oxygen content.
   d. Anesthetic agents cause decreased systemic blood pressure.
   e. Abdominal viscera interfere with venous return to the heart.

7. Which incision location has been associated with a higher incidence of complications?
   a. ventral midline
   b. paramedian
   c. laparoscopic
   d. flank
   e. diagonal paramedian

8. What percentage of mares stop showing estrous behavior following bilateral ovariectomy?
   a. 100%
   b. 60%
   c. 75%
   d. 50%
   e. 30%

9. Which of the following are advantages to laparoscopic ovariectomy approaches compared with the traditional celiotomy approaches?
   a. smaller incisions for access to the abdomen
   b. visualization of the ovary and mesovarium
   c. tension-free ligation of the mesovarium
   d. shorter, less complicated postoperative recovery
   e. all of the above

10. Which of the following is not a reported complication following equine ovariectomy?
    a. septic peritonitis
    b. eversion
    c. neurologic deficits
    d. hemorrhage
    e. hindlimb pain