Surgery of the Forestomach

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KEYWORDS

• Forestomach • Rumen • Rumenostomy • Rumenotomy • Vagal indigestion

KEY POINTS

- Forestomach surgery is usually performed in the left paralumbar fossa.
- Most forestomach surgery is either surgery on the rumen or using the rumen to gain access to other forestomach compartments (reticulum/omasum).
- The prognosis depends largely on the underlying problem, but timely surgical management can greatly influence outcome in certain disease situations.

SURGICAL ANATOMY AND PHYSIOLOGY

The forestomach, or proventriculus, in the ruminant consists of a rumen, reticulum, and omasum. All 3 are nonglandular and lined with stratified squamous epithelium, whereas glandular abomasum is the "true stomach." All are innervated almost entirely by the Vagus nerve which has both motor-parasympathetic and sensory fibers. It is divided into the ventral and dorsal vagi as it enters the abdomen. The ventral vagi innervates the cranial and medial parts of the reticulum, omasum, and abomasum. The dorsal branch innervates the rumen and parts of other segments of the stomach.[1] Blood supply comes from the celiac artery from the aorta and branches into the ruminal and splenic arteries. The left ruminal artery gives off a branch to the reticulum and the celiac continues to become the omasoabomasal artery.[2]

The reticulum is the smallest of the compartments and it lies just cranial to the rumen between the sixth and ninth intercostal spaces with equal parts on either side of midline. Ventrally it contacts the sternum and diaphragm. The left aspect contacts the spleen and costal diaphragm while the right is in contact with the left hepatic lobe, omasum, and abomasum.[2] The interior has a "honeycomb" appearance.[3]

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Reticular contractions are biphasic with one partial contraction followed by a relaxation and another, full contraction just before ruminal contractions.[2]

The rumen lies on the left side of the abdomen extending from the pelvis to the seventh to eighth rib space. It is the largest of the compartments and grows in adult cattle from one-half of the size of the abomasum at birth[4] to holding roughly 100 to 150 L[2] and is the site of fermentation of cellulose. It has a dorsal and ventral sac divided by right and left longitudinal grooves. The left and right longitudinal grooves are also the attachment sites for the superficial and deep leaves of the greater omentum, respectively. The rumen has additional dorsal and ventral grooves demarcating the caudodorsal and caudoventral blind sacs. The ruminal recess refers to the blind end to the cranial most portion of the ventral sac of the rumen, whereas the atrium or cranial sac refers to the cranial most portion of the dorsal sac which opens into the reticulum. This lies between the cranial pillar and the ruminoreticular fold. The ruminoreticular fold is a septum that separates the rumen from the reticulum. The cardiac opening, the opening of the esophagus, is just dorsal to the reticulum at the eighth intercostal space. Internally, the ridges formed by the exterior grooves are referred to as pillars. The inside of the rumen is covered by ruminal papillae, which are roughly 1 cm long. Adequate forage and fiber mat in the rumen is required for appropriate ruminal papillae development.[3] Contractions of the rumen start just after a reticular contraction when the omasal orifice relaxes with a primary contraction. Primary contractions begin cranially and spread over the dorsal sac into the ventral sac. This contraction mixes and distributes ingesta and substrates. Following 2 primary contractions is 1 secondary contraction in which the ventral sac then contracts from caudal to cranial.[2] Secondary contractions push gas to the cardia and allow eructation to occur. There should be approximately 3 rumen contractions in 2 minutes.

The omasum is a spherical viscus that lies between ribs 7 to 11 just right of midline. It is sometimes called the “Butcher’s Bible” as the muscular laminae covered with short papillae resemble pages of a book.[4] It has a capacity of 7 to 18 L. In the normal cow, 2 omasal contractions per minute can be auscultated at the ninth intercostal space at the level of the elbow.[2]

The gastric groove in suckling calves allows milk to bypass the forestomach and go straight to the abomasum. In the adult it is divided into the reticular groove, which leads to the reticulo-omasal opening and the omasal groove (as well as the abomasal groove).[3]

PATHOLOGY OF THE FORESTOMACH

Pathology of the forestomach often falls into a category of what is commonly referred to as “vagal indigestion.” The syndrome was named after the clinical signs were produced experimentally by transecting different branches of the Vagus nerve by Hoflund.[1] This at times leads to confusion, as Vagus nerve damage or inflammation is rarely the cause of vagal indigestion. The classification scheme of vagal indigestion most used by the authors is the Ferrante and Whitlock classification and is as follows: 1, failure of eructation or free gas bloat; 2, omasal transport failure; 3, abomasal impaction; 4, partial obstruction of the stomach. Only types 1 and 2 are conditions of the forestomach, but all 4 types can result in similar presentation so physical examination findings and diagnostics must be used to appropriately diagnose the animal and the type of vagal indigestion.[1]

Type 1 Vagal Indigestion

Excessive free gas in the dorsal sac of the rumen is not a cause of a disease but a clinical sign. Fermentation in the rumen produces gas (methane and carbon dioxide) which must be eructated. Therefore, type 1 vagal indigestion does not occur as a result of overproduction of gas, but a failure to eructate the normally produced gas. This can occur for several reasons. One cause may be a physical obstruction of the esophagus, or choke. This most commonly occurs due to a foreign body but can also more rarely occur with myopathy or lymphadenopathy, as well as other tumors. Lesions may occur along the esophagus or at the cardia. Animals in right lateral recumbency may also occlude the esophageal groove due to ingesta falling onto and covering the cardia.[1]

Bloat may also occur in disorders of fermentation due to grain overload and acidosis. Weak ruminations due to rumen acidosis may not adequately move the gas layer and clear the cardia to allow for eructation. Gas trapped in a stable foam creating frothy bloat would also prevent gas eructation and can be diagnosed by failure to relieve the bloat on passing a tube to the rumen. This is usually attributed to consumption of legumes and rapidly fermented materials resulting in the production of froth and bubbles with high surface tension. The result is that gas is trapped in a foam that cannot be eructated. Severe hypocalcemia can also result in failure to eructate.[1,2]

Type 2 Vagal Indigestion

Type 2 vagal indigestion, or omasal transport failure, is most commonly a result of traumatic reticuloperitonitis (TRP). Adhesions, and peritonitis as well as masses, herniation of reticulum through the diaphragm, or foreign obstruction and impaction may also result in this condition. Inflammatory lesions of the ruminoreticulum may inhibit excitatory input to gastric centers from the Vagus nerve and result in paralysis of the omasum and reticulo-omasal orifice. Reticular adhesions after TRP might prevent delivery of ingesta to the reticulo-omasal orifice and the omasum.[1,4]

Damage to the Vagus nerve itself in the thorax or abdomen are rare, but could result in both Vagal trunks being affected and would result in forestomach atony as well as free gas bloat.[1]

CLINICAL FINDINGS

General signs of disease in cattle include decreased milk production, decreased feed intake, weight loss, and depression.

Free gas bloat results in left-sided distention, particularly dorsally, which progresses to generalized abdominal distention. If the cause is an esophageal obstruction, the head may be extended and the animal excessively salivating. In the case of carbohydrate overload, the rumen pH may be low and animals may have a metabolic acidosis.[4]

Type 2 vagal indigestion creates an “L” or “papple” shape, with left-sided distension accompanied by low, right-sided distention created by overdistention of the ventral sac of the rumen, which reaches across midline to the right side of the abdomen (**Fig. 1**). The rumen will be hypermotile, although some are amotile, and the animal will have a poor appetite along with decreased fecal production as contents accumulate in the forestomach. The feces often have increased fiber size and are pasty. The increased contractions are disordered primary and secondary contractions and result in a homogenously frothy material rather than the 3-layered stratification of the normal rumen. On rectal examination, the ventral sac of the rumen may be felt crossing midline and a full rumen on the left side of the abdomen will be palpated.[1]

Both types 1 and 2 vagal indigestion are often associated with a bradycardia due to stimulation of the Vagus nerve.[1] Types 3 and 4 are involved with outflow of the abomasum and will not be discussed further in this article. Forestomach and

Fig. 1. Type 2 vagal indigestion. Note the bloated left and low distension on the right.

abomasal outflow conditions can be difficult to differentiate. A rumen chloride of greater than 30 meq/L would indicate abomasal reflux and suggest a pyloric outflow issue, as would a systemic hypochloremic, hypokalemic, metabolic alkalosis with hypocalcemia, and aciduria.[1]

If the underlying cause of disease is TRP, the animal may have fever and an elevated heart and respiratory rates. The animal may stand with a kyphotic posture, abducted elbows, and refuse to ventroflex when the withers are pinched due to cranial abdominal pain. In acute cases, bloodwork will reveal a neutrophilia with a left shift and elevated fibrinogen levels. In chronic cases total protein and serum globulin will be elevated.[4]

Imaging such as ultrasonography and radiography can be useful in the diagnosis and treatment of ruminal pathology. Ultrasound is useful in identifying areas of peritonitis or abscessation. Ultrasound can also be useful in guiding abdominocentesis. Radiographs can also be used to identify soft tissue–gas interface indicating an abscess or metallic foreign bodies.[4]

NONSURGICAL THERAPY

Some of the conditions affecting the forestomach may be amenable to nonsurgical management. In the case of esophageal obstruction, orogastric intubation can be performed in an attempt to push the obstruction into the rumen. Gentle water lavage may assist in this maneuver.

TRP prevention can be achieved by administering a magnet orally. Magnets first fall into the cranial sac of the rumen and are brought to the reticulum by normal rumen contractions. Although reticular magnets are very effective at preventing cases of TRP, an animal that is already experiencing disease likely will not be helped greatly by magnet administration. Affected animals often will have decreased rumen contractions and therefore magnets administered orally may not find their way into the reticulum. Also magnets likely are ineffective at pulling metallic foreign bodies back through the wall of the reticulum and do nothing to treat peritonitis, which is a large component to the pathology of the syndrome.

Impactions of the rumen, omasum, or abomasum may be alleviated by oral fluids and laxatives. Omasal or abomasal impactions may be more successfully treated by rumenotomy and direct administration of fluids and laxatives through the rumeno-omasal orifice.

Grain engorgement (rumen acidosis) is one of the most life-threatening conditions affecting the forestomach compartments. Affected animals may require rumenotomy to fully evacuate the rumen and thwart systemic side effects. If surgical management is not an option, rumen lavage may be accomplished with a Kingman tube. These animals will also benefit from a (possibly multiple) transfaunation to reestablish a healthy microbial population. Intravenous fluid therapy will also be beneficial.

Rumen tympany (bloat) typically is 1 of 2 forms, frothy and free gas. Frothy bloat may be treated medically with a detergent such as poloxalene. This surfactant functions to destabilize the foam and allow the small gas bubbles to coalesce and be eructated. Free gas bloat often will be relieved by orogastric intubation.

SURGICAL TECHNIQUES

Left Flank Celiotomy

After the flank is blocked and sterilely prepped, a 25-cm incision is made through the skin, external and internal abdominal oblique muscles, transversus abdominis, and peritoneum 4 cm caudal to the ribs. This facilitates exploration of the cranial abdomen without coming too close to the ribs, which makes closure much more difficult. If the surgeon reaches caudally behind the rumen, the bladder, uterus, left kidney, and intestinal mass can be palpated. Cranially the surgeon can feel the pylorus and abomasum, the omasum, and reticulum. Care is take if adhesions are found to not disrupt and spread possible contamination. If adhesions are found cranially they are likely due to TRP. Rumenotomy can be performed to gain access to the reticulum. If found ventrally they are likely due to abomasal ulcers. The area most suspected of pathology should be explored last to reduce the chances of carrying contamination to other parts of the abdomen.[4]

Rumenotomy

Indications for a rumenotomy include adhesions found cranially associated with the reticulum, hardware disease, foreign body ingestion, such as speculum or drenching tips, or ingestion of toxins or frothy bloat, which must be evacuated. The same approach through the left flank is made. A sufficient seal must be created so that when rumen contents escape the rumen through the incision, they will not contaminate the abdomen or layers of the body wall. The rumen is pulled out of the incision and sutured to the skin with a cutting needle in short runs of a Cushing pattern to create a seal between the rumen serosa and the skin. The mucosa of the rumen should not be penetrated. Interruptions within the continuous pattern should be used to avoid creating a purse-string affect. Blood clots from the incision may form at the ventral aspect of the incision (Fig. 2). These should be left in place, as they help provide

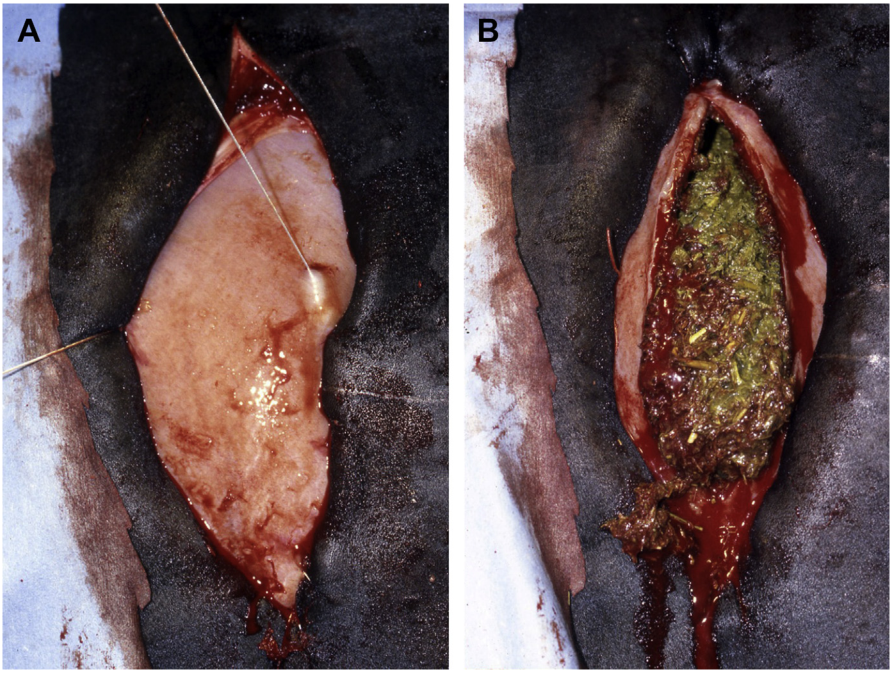

Fig. 2. Rumenotomy. (*A*) The seromuscular layer of the rumen is sutured to the skin in an inverting pattern to create a seal. Blood that has accumulated at the ventral aspect of the incision is left in place because it helps create a better seal. (*B*) The rumen has been opened to complete the rumenotomy. (*Courtesy of* Dr Bruce Hull, Columbus, Ohio.)

additional seal between the skin and rumen serosa. Once a seal has been created, the rumen wall is incised in a vertical direction, leaving at least 3 cm and the dorsal and ventral margins to avoid interfering with the sutures placed. Alternatively, a rumen board (**Fig. 3**) or Weingarth apparatus may be used. In this technique, the dorsal sac of the rumen is grasped dorsally and ventrally with large non-crushing forceps and exteriorized. The rumen is incised ventrally and hooks are placed in the cut edge and attached to the apparatus. As the incision is continued dorsally, more hooks are applied until the ventral forceps are reached. When closing this incision, a double-layer dorsal to ventral inverting pattern is used. Other methods include using only 4 stay sutures or simply clamping the rumen to the skin with 6 to 8 towel clamps spaced evenly around the incision. These 4 techniques were compared in a study by Dehghani and Ghadrdani[5] for time of procedure and postoperative body temperatures and white blood cell counts. Based on these variables, the rumenotomy with skin sutures took significantly longer than the other 3 methods. The stay suture method produced a significantly higher body temperature within its group for the first 4 days, and it had a statistically significantly higher white blood cell count and neutrophil-to-lymphocyte ratio on day 4 when compared with the other groups. Based on these results, the 4 stay suture technique was inferior at preventing abdominal contamination.[5] If available, a wound edge protector can serve as a shroud to protect the tissue edge from excess contamination. Commercial wound edge protectors (Steri-Drape 1076 Wound Edge Protector; 3M, St. Paul, MN) are plastic drapes that have an adhesive surface to adhere to the outside of the patient or the patient's drape. They also have an inner hole attached to a rubber ring that will collapse, allowing it to be inserted

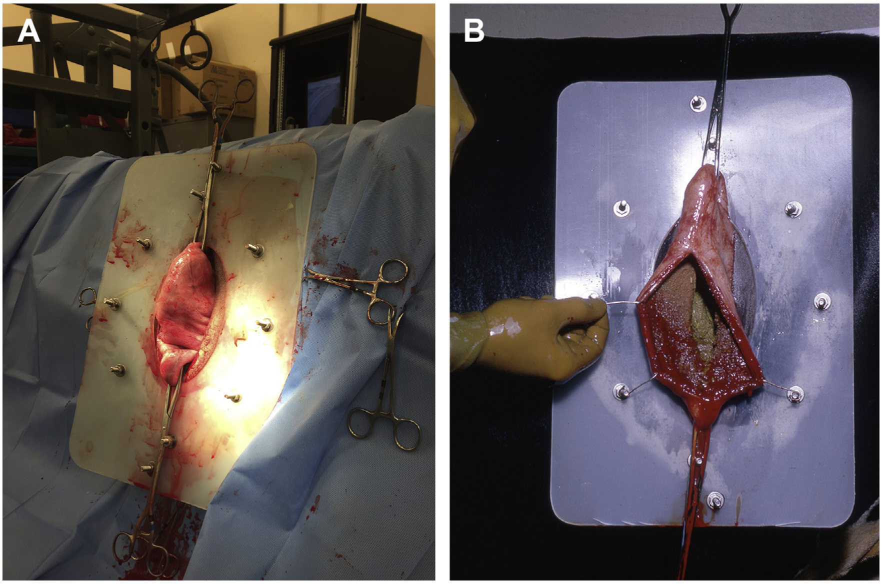

Fig. 3. Gabel rumen retractor (rumen board) is used to prevent rumen retraction and abdominal contamination during rumenotomy. (*A*) The rumen board is holding the rumen exterior to the body via 2 Vulsellum forceps placed on the dorsal and ventral aspects of the rumen. (*B*) The rumen is partially open and the leading edge of the rumen is being retracted by hooks placed around bolts in the periphery of the rumen board. (*Courtesy of* Dr Bruce Hull, Columbus, Ohio.)

through the rumenotomy. Once inside the rumen, it will expand and hold the drape in place. This will prevent rumen contents from touching the surgery site (Fig. 4).

The rumen may be evacuated by hand or by creating a syphon with a Kingman tube if it is filled with liquid. The reticulum, omasum, and abomasum may all be palpated transruminally. The ruminoreticular fold, esophageal orifice, and omasal orifice should all be palpated for lesions. The ventral sac of the rumen should be thoroughly explored for foreign bodies. The reticulum should then be explored for foreign bodies and

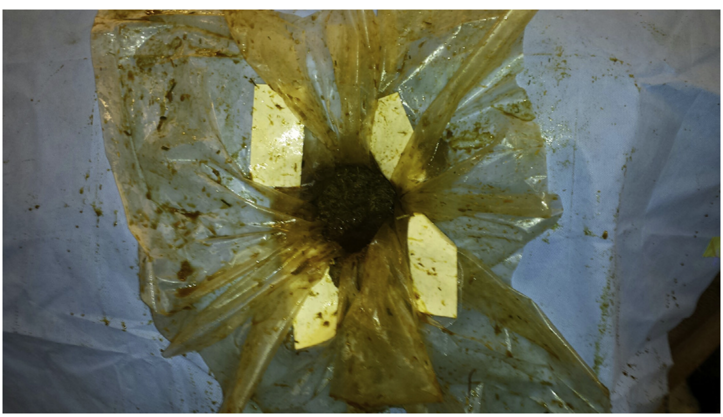

Fig. 4. A wound edge protector is a plastic drape that has an expandable rubber ring, holding the drape open on the interior of the rumen. The outside of the drape is adhered to the patient. This protects the surgical site from contamination from the rumen contents.

adhesions. More ruminal contents may need to be evacuated to reach the cranial portion of the reticulum. All foreign bodies should be removed whether they are penetrating or not. An ultrasound probe may also be used within the reticulum. If abscesses are identified, they can be lanced into the reticulum provided they are tightly adhered. Reticular abscesses are mostly commonly found on the medial wall of the reticulum. If an abscess is identified but not tightly adhered, a ventral midline celiotomy must be performed under general anesthesia to remove or drain the abscess. An ultrasound-guided drain can also be placed into the abscess and flushed daily in lieu of surgery.[4]

Once the ruminal explore is complete, the ruminal incision is closed in 2 layers. The first layer is closed while the rumen is still attached to the skin. Following thorough lavage, the rumen is released from the skin and oversewn with an inverting pattern using #2 absorbable suture. The second layer should be wide enough to oversew the suture holes that were created when the rumen was sutured to the skin. Once the rumen is closed, it is again thoroughly lavaged and cleaned of all debris before being released and allowed to return to the abdomen. The flank incision is closed in 3 layers using #2 or #3 absorbable suture closing the peritoneum and transversus abdominis together and the external and internal abdominal obliques together. The skin is closed with #3 nonabsorbable suture in a Ford-Interlocking pattern with 2 to 3 interrupted sutures at the bottom of the incision, which can be opened in the case of seroma or incisional abscess.[4]

Rumenostomy

Rumenostomy may be indicated in the case of bloat (**Fig. 5**) that is unable to be resolved by orogastric intubation or for enteral support of an animal unable to eat due to oral or pharyngeal trauma (**Fig. 6**). In emergency situations in which an animal is in respiratory distress and will not survive long enough to perform a rumenostomy, a rumen trocar may be used. A self-retaining rumen trocar is preferred if available. Peritonitis following rumen trocarization is very common, so this procedure should be avoided if possible. For rumenostomy, a similar approach is taken as that for a left flank laparotomy, except a small circle of skin is excised. Four stay sutures are placed at 12, 3, 6, and 9 o'clock before incising the rumen. Once incised, towel clamps can be used to secure the incised edges of the rumen to the skin to minimize contamination

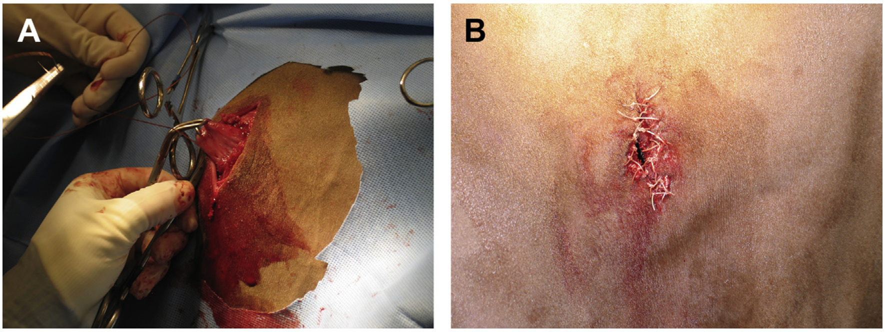

Fig. 5. A rumenostomy is performed in a calf with chronic rumen bloat. (*A*) The rumen is pulled through the gridded abdominal incision with the aid of towel clamps, and the seromuscular layer of the rumen wall is sutured to the body wall creating a seal. This prevents rumen contents from contaminating the peritoneal cavity. (*B*) The rumen is opened, and the leading edge is sutured to the skin creating a permanent stoma. As gas builds in the rumen it will open and allow gas to escape. This stoma will close when the rumen pressure is low, maintaining a favorable anaerobic rumen environment.

Fig. 6. A rumenostomy is created to provide enteral nutrition in a calf with listerosis. A small hard-plastic bottle is cut and used as a cannula to prevent the stoma from closing and to allow periodic feedings.

while the skin is apposed to the rumen. In the authors' experience, interrupted everting patterns with either vertical or horizontal mattress sutures result in the best rumen to skin seal while avoiding contamination of ruminal contents. If left open, the rumenostomy will granulate in on its own. If the surgeon wishes for the rumenostomy to be maintained, a commercial cannula or home-made stoma may be inserted into the rumenostomy (see **Fig. 6**). Chigerwe and colleagues[6] published successful enteral support for 3 cattle, 1 suffering from signs of listeriosis, 1 with mandibular fracture repair, and 1 with severe oral trauma, highlighting the importance of this procedure's potential therapeutic benefits for a variety of conditions.

Rumen Cannulation

Rumen cannulation is a commonly performed procedure typically for animals entering nutritional studies or to create animals to provide rumen contents for transfaunation of sick animals. Rumen cannulation has been described as a 1-stage and 2-stage technique.

One-stage rumen cannulation

After local or regional anesthesia, but before the sterile scrub has occurred, the cannula plug can be traced or scored into the left flank to mark the circular skin excision. Care should be taken to place the cannula in a location in which the edges of the cannula will not contact the transverse processes, ribs, or tuber coxa, as this may result in sores long term. Also rumenostomies placed on the flank fold may result in abnormal pull on the stoma by the internal abdominal oblique muscles and result in an oblong stoma. This effect may result in a loose fitting cannula.

Following the sterile scrub, a circular skin excision is made using the trace previously described, and the circumscribed skin removed. The external and internal abdominal oblique muscles should then be separated parallel with their fibers rather than sharply incised. This creates a grid that will close tightly around the cannula once the procedure is complete. The transversus abdominis and peritoneum are then incised. The serosa of the rumen is scarified with a sterile sponge or scored with a needle to encourage adhesion formation. The rumen is pulled through the incision laterally. The rumen should not be elevated dorsally as this will create excessive tension on the surgical site and the rumen may tear away. The same procedure as described in the rumenostomy section is performed, securing the edges of the rumen to the skin edge (**Fig. 7**). Once a tight seal has been created, the cannula is placed. The method of cannula insertion varies by cannula design. Most traditional cannulas are inserted by partially inverting the inner flange into the cannula's lumen and then allowing it to unfold once it is through the rumenostomy site. The cannula should fit tightly within the stoma created.

Two-stage rumen cannulation

In the 2-stage rumen cannulation, a physiologic seal is created between the skin, body wall, and rumen before the rumen is incised. In this manner, the risk of contamination of rumen contents into the peritoneal cavity or body wall is reduced. The rumen must be secured to the skin for 1 week. Historically, a metal rumen clamp has been described. The use of a wooden rumen clamp was described more recently by Martineau and colleagues[7] in 172 dairy cows. A vertical incision is made through the skin and the muscles gridded as previously described. Stay sutures with #3 nonabsorbable suture are placed on either side of the incision. The rumen serosa is scarified and pulled through the incision. The clamp is placed against the body wall and clamped to the rumen while the sutures are pulled through slots in the clamp. Mattress sutures are tied across the clamp. In this way, the clamp is secured to the flank of the cow and the rumen is held out. After 1 week, sufficient time for adhesions to form between the rumen and the skin, the clamp is removed. An incision is made into the rumen, and a cannula is placed. In the technique described by Martineau and

Fig. 7. Suturing the rumen to the skin in the 1-stage rumen cannulation technique.

colleagues,[7] a 7.5-cm cannula was initially placed and was a replaced with a 10-cm cannula after 1 more week. Complications were rare, but 2 cows experienced perioperative abortion, 3 had either the rumen slip from the clamp or the clamp slip off but were successfully replaced, and 2 developed peritonitis and died due to incomplete seal formation.

Omasal Impaction

The omasum can become impacted. In these cases, oral fluids, transfaunate, and laxatives may be beneficial. If this fails to work, a tube may be inserted into the omasum via a rumenotomy. By injecting fluid, mineral oil, and laxatives into the leaves of the omasum, along with manual massage, omasal impactions can be relieved.[2] The omasum can be found via ultrasound examination between the 6th and 11th intercostal spaces below the costal arches, although it is difficult to assess pathology in this manner.[8,9]

Omasal Dilatation and Displacement

A case series has been published on 4 cattle believed to have omasal dilatation and displacement. In all cases the animals presented due to right-sided abdominal distention and low milk production. Rectal examination on all animals revealed a large, doughy viscus on the right side of the abdomen. A ping was auscultated in 1 cow. Three of the cows underwent right flank laparotomy to decompress the omasum. Rumen, cecum, and abomasum were all identified and ruled out as the viscus in question. Three of the 4 were decompressed and found to have foam, fluid, and gas within them. None of the 3 returned to the normal anatomic position after decompression. One of the 4 was euthanized and the viscus in question was confirmed to be the omasum.[10]

PERIOPERATIVE CONSIDERATIONS

Despite the surgeon's best attempts at sterility, procedures involving the rumen are considered clean contaminated. Perioperative antibiotics are indicated. A study by Haven and colleagues[11] showed that a dose of penicillin at the time of surgery significantly decreased abscess formation after a rumenotomy. However, additional days of penicillin therapy postoperatively did not attribute to lower rates of abscess development.

Animals should be properly restrained and a regional block performed before surgery. Animals that are in shock should be hemodynamically stabilized. Efforts should be taken to prevent excessive movement or to prevent the animal from going down during the procedure. These scenarios increase the risk of abdominal contamination. Obviously, emergency rumenostomies may be life-saving and this risk must be weighed against the risk of immediate death. Recumbent animals should be appropriately restrained to prevent rolling to the opposite side, for example.

Common complications of rumen surgery include incisional abscess and peritonitis. The authors have also seen abscesses between the body wall and skin that were attributed to dehiscence of sutures placed between the body wall and rumen to provide additional security. If sutures are placed between body wall and rumen, it may be beneficial to remove these sutures after the rumen is attached to the skin to avoid sutures creating a hole in the rumen.

According to Hartnack and colleagues,[12] in which medical records of 95 cattle receiving rumenotomy (53 animals), rumenostomy (24 animals), or elective rumen cannula placement (18 animals) were examined, the complication rates were as follows: short-term (less than 30 days) follow-up for rumenotomy had a roughly 15% complication rate, including incisional infection, seroma, continuing regurgitation, and death/euthanasia/removal from the herd. Rumenostomy short-term follow-up showed a 13% complication rate with 1 animal developing an incisional infection and 2 either died or were removed from the herd. Finally, short-term follow-up for cannulated cattle had a 17% complication rate, with 1 animal developing an incisional infection and 2 experiencing cannula loosening.

SUMMARY

Most surgeries of the forestomach are safe and can be performed in the field with the appropriate restraint and equipment. Most surgical approaches to the forestomach compartments are performed in the left paralumbar fossa either on the rumen or using the rumen to gain access to other forestomach compartments (reticulum or omasum). Many surgical lesions cannot be corrected from a left flank laparotomy, so a thorough physical examination and appropriate diagnostics should be competed to determine the cause and the site of the lesion before performing surgery.

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