"Do the Twist"

Right Abomasal Displacement with Subsequent Abomasal Volvulus in the Dairy Cow

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Class of 2019

Prepared for:

Clinicopathologic Conference

Presented on:

June 22, 2018

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Introduction:

Normal abomasal function is essential for the productive success of cattle, and unfortunately, abomasal disease is one of the most common indications for veterinary intervention in adult dairy cows (13). While there are numerous causes for the disruption of abomasal function, right abomasal displacement and subsequent abomasal volvulus are the foci of this manuscript.

Right displacement of the abomasum (RDA) and abomasal volvulus (AV) are both life-threatening abdominal emergencies in dairy cattle that have both physical and economic consequences. A right displaced abomasum occurs when the abomasum fills with gas or fluid and floats dorsally from its normal right ventral position while remaining on the right side of the body (1). Many RDAs result in the abomasum rotating on its mesenteric axis while moving dorsally from its normal position (3). A RDA eventually results in an abomasal volvulus. An AV is more severe than a simple displacement because it results in a hemorrhagic strangulating obstruction, which will lead to death if not treated quickly (6).

Differentiating between a right displaced abomasum or an abomasal volvulus can be difficult to impossible (7). A thorough physical exam and clinical signs can be suggestive of either a RDA or AV, but the only way to be completely certain is by surgical exploration. Furthermore, surgical correction of the displacement or volvulus is necessary, with simultaneous medical management of any associated disease processes (metritis, mastitis, ketosis, etc.). Negative outcome has been reported to range from 8.5% - 15% for RDA and is approximately 65% for AV (1). Therefore, the prognosis for both RDA and AV is relatively poor. Additionally, any associated disease process in conjunction with the RDA or AV such as ketosis, severe dehydration, or omasal involvement further decreases the likelihood of survival (4).

On September 1, 2017, a three-year old pregnant Holstein-Friesian dairy cow identified as #63 presented to the Food Animal Service at MSU-CVM after the owner noticed she had been acting dull, depressed, and inappetant for a duration of three days with substantially decreased milk production. Prior to this event, #63 was apparently healthy. On presentation she was approximately 260 days in milk and 200 days in gestation. According to the owner, #63 was current on all vaccinations and dewormers. No other cows at the dairy were showing signs of illness.

On presentation at MSU-CVM, #63 was down in the trailer and had difficulty rising. Visual examination of her general demeanor suggested significant discomfort. For example, her ears were droopy, her back was arched, and she appeared depressed. On physical examination, she had sunken eyes, a skin tent, and tacky mucous membranes indicating an approximately 10% dehydration status. She was producing scan amounts of watery feces with tenesmus. The sclera of both eyes were injected and her extremities (ears, mouth, tail, distal limbs) were cold to the touch. Also, #63 was exhibiting muscle fasciculations in her axillary and inguinal regions. Tachycardia and tachypnea was present with a heart rate of 96 beats per minute, and respiration of 80 breaths per minute. Her temperature was also mildly elevated at 102.4°F. Thoracic auscultation was normal with no apparent crackles or wheezes. However, simultaneous abdominal auscultation and percussion revealed a “ping” on the dorsal right abdomen extending caudally from the tenth rib past the thirteenth rib. Auscultation and percussion of the left abdomen revealed no abnormalities. No rumen contractions were appreciated on auscultation. . On simultaneous ballottment and auscultation of the right side, fluid could be heard in the area ventral to the ping. Various disease processes can present with a right sided ping including, but not limited to, functional ileus, cecal dilatation and rotation, pneumoperitoneum, or peritoneal

gas. However, the clinical signs and rapid deterioration of #63 indicated a more critical disease process. Due to her clinical signs and physical exam, it was decided that #63 was most likely suffering from either a right displaced abomasum or an abomasal volvulus with concurrent hypocalcemia. Because she was pregnant, a rectal exam was done to check for fetal movement and viability. The fetus was presumed deceased via rectal palpation and confirmed via transabdominal ultrasonography. Due to the seriousness of her condition, emergency surgery with concurrent fluid administration was performed.

Abomasal displacement and abomasal volvulus are common occurrences in dairy cows and should always be given consideration when one presents with an acute abdomen (7). A right displaced abomasum occurs when the abomasum dilates with either gas or fluid and floats dorsally. If the lesser omentum remains flat or folded during the abomasal displacement, it is considered a simple RDA (10). However, if the abomasum twists on the supporting lesser omentum causing an acute obstruction with local vascular compromise and ischemic necrosis, it is termed an abomasal volvulus (2). For clarity, the abomasum does not twist around its own luminal axis, therefore it cannot be called a torsion (10). When an abomasal volvulus occurs, it does so in either a clockwise or, more commonly, counterclockwise direction around the center axis in the lesser omentum. Usually the duodenum becomes trapped ventrally between the cranial aspect of the abomasum and the omasum. Abomasal volvulus is a more serious condition compared to right abomasal displacement, but it is essential to understand that all AVs begin as a RDA. Although there is not a large amount of information on the cause of RDAs, it is assumed that the predominant etiology is similar to left abomasal displacement – decreased abomasal motility (3).

Altered abomasal motility is "the genesis of all abomasal displacements", and there are countless factors associated with it (8). Genetics, age, stress, nutrition, and disease are all capable of altering abomasal motility. Studies show that displacements occur most commonly in the classic dairy breeds – Holstein-Friesians, German Holsteins, Simmental crossbreeds, Brown Swiss, Ayrshires, Guernseys, Jerseys, and German Fleckviehs – likely because of their tall stature and deep body depth. According to Doll et al, a high vertical distance between the abomasum and descending duodenum can impair abomasal emptying, predisposing these cows to displacement and volvulus. Age may also contribute to the occurrence of abomasal displacement, however this is an area of debate. Some authors claim that cows beyond the third lactation are more frequently affected, while others insist that first calf heifers are at a higher risk (2).

Most cows present with a right abomasal displacement or volvulus in mid-to-late lactation, however cases can be distributed throughout the lactation cycle (6). The parturient, periparturient and lactation periods are times of increased stress and numerous opportunities for abomasal motility issues arise. During this time there are alterations in diet, metabolic abnormalities, physical disturbances by the fetus, and hormonal changes just to name a few. Studies have shown a correlation between diet change and increased incidence of displacement – specifically with high-concentrate and low fiber diets. Basically, increased concentrate in feed is associated with decreased abomasal motility. Most dairy herds are fed total mixed rations (TMR), which, according to most studies, increase the incidence of abomasal displacement. However, the key determinant is the composition of the TMR. If it is unbalanced, with too high milling and a high fraction of corn silage, the likelihood of a cow suffering from an AD is increased. Therefore, adequate roughage of a sufficient particle size is needed to maintain

adequate rumen function and help prevent abomasal displacement (2). Pregnant cows or cows that have recently calved are also at an increased risk of abomasal displacement due to the fetus changing the position of the abomasum and the sudden void created within the abdomen post-calving, respectively (13). Metabolic disturbances related to parturition such as hypocalcemia and ketosis are also both known to inhibit abomasal motility. Other diseases besides hypocalcemia and ketosis consist of inflammatory processes such as metritis, mastitis, or endometritis. Endotoxins and inflammatory mediators arising from these conditions can be a direct cause for decreased abomasal motility (2).

Disorders of the enteric nervous system could also be a cause of decreased abomasal motility. Geishauser el al studied abomasal enteric neuron samples from cows with abomasal displacement and determined that the neurons had increased amounts of nitric oxide synthase as well as a decreased sensitivity to acetylcholine (5). Therefore, decreased abomasal motility may be related to abnormally increased activity of enteric inhibiting neurons as well as decreased cholinergic sensitivity of the abomasal muscle (2). Furthermore, Sickinger et al took biopsies of abomasal wall neurotransmitters from German Holsteins and German Fleckviehs and assessed them immunohistochemically. Interestingly, significant differences were found between the two. The concentration of substance P, a stimulating neurotransmitter, was much lower in German Holsteins vs Fleckviehs while an inhibiting neurotransmitter, vasoactive intestinal polypeptide, was markedly higher in the Holstein. This information may explain why German Holsteins are at a higher risk for abomasal displacement (9).

Whatever the cause for decreased abomasal motility may be, the end result is gas accumulation in the abomasum. A gas filled abomasum is buoyant within the abdomen, floating dorsally from its normal position and causing a displacement. As described previously, many

cases of right abomasal displacements will progress to a life threatening abomasal volvulus. Prognosis is guarded for both conditions, but with a quick assessment and diagnosis, they are surgically treatable.

Diagnostic Approach/Considerations:

Signalment and history are important elements for determining the cause of abdominal disease in cattle. Both RDAs and AVs most commonly occur in pregnant or post-partum dairy cows who are in the middle to late lactation period. Therefore, abomasal displacement (left or right) and volvulus should always be considered as differentials for an animal presenting in this manner. In conjunction with signalment and history, clinical signs and a thorough physical exam are crucial for diagnosis. Abomasal displacements commonly present with hyporexia, decreased manure production with fluid or pasty consistency, and decreased milk production. Cows with an abomasal volvulus typically appear depressed, anorexic, tachycardic, tachypnic, have minimal manure production, and suffer from dehydration (3). However, it is important to state that clinical signs can vary between the two disorders and cannot clearly lead to an accurate diagnosis. Hypocalcemia is almost always present with displacements and volvulus and can have corresponding clinical signs. Early signs include a slow pupillary light reflex as well as cool ears and mouth. More severe hypocalcemia may present with muscle fasciculations (4).

Along with the clinical signs listed above, a reliable physical exam "test" for an RDA or AV is an audible ping on the right side of the abdomen. Several other clinical diseases can present with a right sided ping such as cecal dilation/torsion, gas accumulation in the duodenum, spiral colon, ascending colon or small intestine, or right flank pneumoperitoneum (8). Therefore, it is important to differentiate an RDA or AV from these causes of right sided pings. According to Fubini, the location, size, and pitch of the ping can be used to determine the etiology. With an

RDA, the ping is usually in between the 10th and 13th ribs. An AV ping typically extends cranially to the 10th rib and caudally to the 13th rib. Out of the differentials listed previously, cecal gas is most likely to be confused with an RDA or AV, but can then be further differentiated via rectal palpation. The cecum can be palpated rectally while the abomasum does not extend caudally enough to be felt (3). Even if a ping can help narrow a condition down to a RDA or AV, differentiation is nearly impossible (7).

In some cases, various blood tests may be performed to assess any metabolic abnormalities associated with the displacement or volvulus. Some classic findings seen with a displaced abomasum include metabolic alkalosis, hypocalcemia, hypokalemia, hypochloremia, and high liver enzymes due to congestive injury (6). Hyponatremia is also common, even in dehydrated animals. A hypochloremic metabolic alkalosis is one of the most commonly encountered metabolic disturbances associated with abomasal displacement and abomasal volvulus. It is a result of excessive accumulation of hydrogen and chloride in the abomasum due to impaired outflow/decreased motility caused by the displacement or volvulus. Hypokalemia likely occurs as a result of anorexia or, in cases of alkalosis, because of the cellular exchange for hydrogen. In cases of severely dehydrated cattle with hypochloremic alkalosis, hypokalemia, and hyponatremia, paradoxical aciduria could occur. Abomasal volvulus with vascular compromise can also produce a metabolic acidosis that superimposes the metabolic alkalosis associated with abomasal outflow obstructions. It is important to know that if metabolic acidosis occurs secondary to a volvulus, the blood pH, chloride, and potassium levels may return to normal (4).

Obviously, the severity of these metabolic disturbances depends on the duration and degree of the disease process. According to a study on RDAs and AVs, decreased body temperature, increased heart rate, hyponatremia, and an anion gap reflected the progression of

disease (1). Research has been done to test the efficacy of testing L-lactate concentrations to determine a probable outcome of a case. According to the study by Boulay et al, a preoperative L-lactate concentration (LAC) measurement can be beneficial in determining severity of disease. As is commonly seen in small animal and equine medicine, A LAC of ≤ 2mmol/L is a good indicator of positive outcome and can be used to support a surgical treatment decision (1). Practicality of this test in food animal medicine is still up for debate.

Since differentiating an RDA from an AV is nearly impossible, and the progression of an RDA to an AV is likely, surgical exploration is always necessary.

Treatment and Management:

Surgery is the treatment of choice for right abomasal displacements and volvulus. However, it is imperative that any metabolic disturbances associated with the disease process are controlled either prior to or during surgery. The three specific conditions that need to be corrected as soon as possible are hypocalcemia, endotoxemia, and hypovolemia (3). Therefore, systemic fluid therapy should be aggressive. According to Fubini, moderately to severely dehydrated cows with metabolic disturbances should be given 20 – 40 L of isotonic saline with 20 – 40 mEq/L of potassium chloride intravenously. Calcium borogluconate should be administered the cow is suffering from hypocalcemia, and if she is ketotic, 50% dextrose should be added to the fluids. Prophylactic antibiotics are also indicated to mitigate the risk of ischemic injury (3).

Once the metabolic disturbances are addressed, surgery should be initiated. There are multiple approaches that allow for the correction and stabilization of an RDA or AV, but the most common method is the standing right-flank omentopexy/pyloropexy. This technique provides adequate visualization and access decompress and derotate (if needed) the abomasum.

For the right flank approach, analgesia is provided ideally via a right paravertebral or inverted – "L" block. A vertical incision is made through the body wall in the right paralumbar fossa exposing the distended abomasum. The first step after visualizing the abomasum is to decompress it. Once it is decompressed, the surgeon can use palpation to determine if a volvulus has occurred (12). In most cases, the abomasum is distended with gas only and can be deflated using a needle and tubing. However, if fluid is distending the abomasum, it should be removed prior to the gas. This is done by inserting a stomach tube through a purse string suture pattern at a location as far dorsal to the ventral aspect of the paralumbar fossa incision as possible. Fluid should be siphoned out until flow ceases or the site of tube insertion falls ventral to the incision (3). If gas distension is still an issue, it can then be released using a 14 -16 gauge needle attached to sterile tubing (7).

Once the abomasum is decompressed, an attempt to expose the pylorus should be made. If the pylorus cannot be exteriorized at the incision using caudodorsal tension on the greater omentum or a twist is palpable at the lesser curvature of the abomasum, a volvulus is confirmed. Manual correction is required for a volvulus. Basically, the abomasum is pushed in the correct direction to free the cranial duodenum and pylorus. In most cases, a volvulus is twisted in a counterclockwise direction. To correct this, the surgeon should place his or her left arm medial to the abomasal body as far cranially as possible and dorsal to the path of the greater omentum (7). The palm of the left hand should then be used in a long sweeping, "swimmer's" motion to try and untwist the volvulus (6). If this does not work, the surgeon's hand can be moved medially and ventrally to the abomasum and ventral to the omasum. With this approach, the omasum should be lifted dorsally and cranially, freeing the duodenum and allowing exposure of the pylorus when tension is placed on the greater omentum (3). After repositioning of the omasum,

the abomasum can be moved to its normal position. Clockwise volvulus is uncommon and will not be discussed. The surrounding organs should be evaluated and the omentum should be examined for tears. Following evaluation of the abdomen, an omentopexy or pyloropexy can then be performed. An omentopexy involves suturing the greater omentum in the region of the pylorus to the abdominal wall in the right flank. A pyloropexy is similar, but a portion of the pyloric antrum is included in the incisional closure (7).

To perform the omentopexy, a 6 – 8 cm vertical section of thick greater omentum is identified and incorporated into the closure of the peritoneum and transversus abdominal muscle. The closure should start at the ventral aspect of the incision and move dorsally. The remainder of the incision can be closed in two or three layers with absorbable suture for the muscle layer and nonabsorbable suture for the skin. After surgery, the cow should be carefully monitored and given the opportunity to return to normal water and feed consumption. In serious cases, postoperative intravenous fluid administration should be continued (3).

How well the cow recovers after surgery depends on whether severe tissue damage occurred due to a volvulus. Tissue damage can be a result direct of direct injury such as perforation, or a consequence of persistent abomasal dysfunction (decreased motility, bloat, electrolyte disturbances, etc.). Cattle with a simple RDA have a favorable prognosis for long term survival and production, but cows with an AV have a higher fatality rate postoperatively.

Case Outcome:

Initial stabilization of #63 consisted of rapid catheter placement and fluid administration. A 14 gauge catheter was placed in her right jugular vein and she was bolused ringers solution, CMPK (calcium, magnesium, phosphorous, and potassium), 2.5 % dextrose, and 20 meq/L potassium.

The standing right flank omentopexy technique was decided, therefore she received a distal paravertebral nerve block to anesthetize the right paralumbar fossa. This nerve block blocks the spinal nerves arising from T13, L1, and L2. Fifteen mLs of lidocaine were placed above and below the transverse processes of L1, L2, and L4 for a total of approximately 90 mLs used. An approximately 12 inch long vertical skin incision was made with a #20 scalpel blade in the right paralumbar fossa. The external abdominal oblique, internal abdominal oblique, and transversus muscles were incised to match the length of the skin incision. The peritoneum was lifted using thumb forceps and was then extended using Metzenbaum scissors. Upon opening, the abomasum was found to be significantly dilated with gas and fluid. Further exploration revealed an abomasal volvulus. A 14 gauge needle attached to suction was advanced into the dorsal aspect of the abomasum in order to deflate it. Once deflated, the abomasum could be more easily visualized and did not show evidence of congestion or tissue necrosis. The abomasum was then grasped, pushed laterally, then ventrally, and finally caudally in a swimmer's motion to relieve the volvulus. An omentopexy was performed using three catgut suture with a continuous pattern closed ventrally to dorsally simultaneously closing the peritoneum and transversus abdominus. Three catgut suture was used to perform a simple continuous pattern to close the internal and external abdominal oblique. This suture was placed in a dorsal to ventral direction. Three Braunamid suture material on an S-shaped needle was then used to close the skin in a ford interlocking pattern. No complications occurred during surgery. #63 was given flunixin meglumine (Banamine) post-operatively for pain control as well ceftiofur crystalline free acid (Excede) for antibiotic prophylaxis.

The morning after surgery, it was discovered that 63 had passed the deceased fetus overnight. Otherwise, she was quiet and alert and had some interest in both hay and total mixed

ration (TMR). Over the next few days, 63 continued to improve and was discharged on September 4, 2017. As of approximately three months ago, the owner reported that 63 is doing well and is apparently healthy. She has had no more visits to MSU-CVM since the initial presentation on September 1, 2017.

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