Acta Scientiae Veterinariae, 2018. 46: 1545.

RESEARCH ARTICLE
Pub. 1545

ISSN 1679-9216

Evaluation of Ventral Laparoscopic Abomasopexy Using Surgical Staples Associated with Suture Material in Dairy Cattle

Rodrigo Romero Corrêa[1], Luis Cláudio Lopes Correia da Silva[1], Julio David Spagnolo[2], Leonardo Maggio de Castro[2], Felipe Silveira Rego Monteiro de Andrade[2], Natalia Franco de Oliveira e Oliveira[2], Aline Magalhães Ambrósio[1] & André Luis do Valle de Zoppa[1]

ABSTRACT

***Background*:** Displaced Abomasum is known for being on of the main illnesses that affect milking cows. Increase in diagnosis of this illness is due to advancement in diagnosis techniques. Increase in incidence of this illness can be explained by genetic selection of animals with high production, breed systems and changes to the diet with a higher level of protein. For laparoscopic treatment, several surgical changes were performed to optimize the procedure and thus achieve better results. The main purpose of this study was to evaluate applicability of the ventral laparoscopic abomasopexy technique, using surgical clamps attached to the suture thread, to milking cows.

***Materials, Methods & Results*:** Six adult cows were placed under anesthesia with isoflurane and placed in dorsal decubitus. Animals were kept with no water for 24 h and no food for 48 h. Four laparoscopic accesses were performed. The first one was created with the intention of inspecting the abdominal cavity and the remaining three for access of surgical instruments. Serous membrane of the abomasum was cauterized, combined with suture threads and placed at the greater abomasal curvature. The free part of suture threads was kept out of the abdominal cavity and after traction of the abomasum against the abdominal wall was tied to the skin. Ultrasound exam was performed for abdominal evaluation after abomasopexy. Anesthesia time and surgery time were recorded and analyzes through average and standard deviation (SD). The average anesthesia time recorded was 94 min (SD 14.63 min) and average surgery time was 51 min (SD 14.71 min). The fasting period was considered adequate, however all animals had to undergo intubation with orogastric tube to drain liquids and gas during the procedure. Four of the six animals had lineal adhesion. Three of the four animals that had adhesion did not keep the abomasum at the retroperitoneal area, however viscera movement was stopped in the abdominal cavity.

***Discussion*:** Abomasopexy through laparoscopy is a safe technique, especially when compared with other invasive methods of abomasopexy. However, to perform this type of surgery availability of adequate equipment and a well trained surgical team are required. This study was performed at a surgery room under full anesthesia. In a field situation, the veterinarian can have some difficulties but such adversities must not be considered and impediment for performance of surgery on the field as its performance is possible. Even though surgical clamps were small, they were considered adequate for what was suggested. The applied 0 degree laparoscopic optic presented restrictions for cavity inspection, therefore we believe that an optical lenses with 30 degree angle could facilitate this laparoscopy inspection. To induce greater and more lasting adherence we suggest cauterizing a greater area of the serous membrane of the abomasum. We also suggest not performing this procedure during lactation peak, when fasting and surgery can cause economic losses. Complications associated with this technique could not be avoided. The technique has shown favorable results, but its clinical applicability depends on application on animals subjected to the conditions of a milk production cycle.

Keywords: abomasum, cattle surgery, milking cow, video surgery.

Received: 8 December 2017 Accepted: 14 March 2018 Published: 10 April 2018

[1]Surgery Department & [2]Post-graduation program of the Surgery Department, School of Veterinary Medicine and Animal Science, University of São Paulo (USP), São Paulo, SP, Brazil. CORRESPONDENCE: R.R. Corrêa [romero@usp.br - Tel.: +55 (19) 35656723]. Surgery Department, School of Veterinary Medicine and Animal Science, University of São Paulo – USP. Av. Prof. Dr. Orlando Marques de Paiva n. 87. Cidade Universitária. Bairro Butantã. CEP 05508-270 São Paulo, SP, Brazil.

INTRODUCTION

The abomasal displacement in high production dairy cattle is the main disorder that often requires surgical treatment [2]. There are several conservative or surgical techniques described to correct abomasal displacement. The conservative approach includes motility stimulation and the rolling technique. Surgical techniques includes the closed or minimally invasive approaches, or the opened or invasive approaches. Within the minimally invasive approaches, it has been described the rolling technique with blind stitches, the toggle pin suture and laparoscopic guided abomasopexy [4], using laparoscopy in treatment of left abomasal displacement. Within the invasive approaches, it has been described abomasopexy via left or right, paralumbar fossa laparotomy, or right paramedian access, and omentopexy via right paralumbar fossa laparotomy [2].

The most common complications in invasive techniques are wound infection, incisional hernia, abomasal fistulation and peritonitis. The toggle pin suture has comparable success rate to the invasive approaches, but its associated complications are more serious. Improper fixation, partial forestomach obstruction, other viscera adhesion, localized or generalized peritonitis, abomasal fistula and trocharization site infection are the most common described complications [1].

This study aimed to develop a new technique for abomasal fixation, using surgical staples, replacing the intracorporeal suturing, currently used in laparoscopic abomasopexy. As a second aim the study looked to reduce the complications of ventral laparoscopy in dairy cattle.

MATERIALS AND METHODS

Animals

Six clinically healthy adult taurines, weighting between 400 and 500 kg were used for this study. Seven days prior to surgery the animals were evaluated through general physical examination, abdominal ultrasonography and complete blood to verify that they had no clinical abnormalities. Two days prior to the procedure, and the day of the procedure, platelet count and fibrinogen were assessed. The animals were fasted of food (48 h) and water (24 h) before the procedure. On the day of the procedure the animals received benzathine penicillin (Pentabiótico® Veterinário Reforçado)[1] 40.000 IU/kg bodyweight (BW), IM, and flunixin meglumina (Flumax®)[2] 2.2 mg/kg BW, IM.

Anesthesia

The animals were sedated with xylazine (Xilazin®)[3] 0.03 mg/kg BW, IV) and anesthesia induced with ketamine (Cetamin®)[3] 2.2 mg/kg BW, IV, associated with diazepam (Diazepam®)[4] 0.05 mg/kg BW, IV. After orotracheal intubation, the animals were placed in dorsal recumbency on an operating table and were connected to a large animal rebreathing circuit. Anesthesia was maintained with an end-tidal isoflurane (Isoforine®)[5] concentration between 1.4% and 1.6% in 0.7 inspired oxygen fraction and ventilation using a microprocessor-controlled anesthesia ventilator in volume control ventilation mode.

Surgical procedure

The abdomen was shaved from the xyphoid process to the groin area, extending 20 cm left and right from the ventral midline. The area was washed with chlorhexidine gluconate (Riohex® 2%)[6] and subsequently with alcoholic chlorhexidine (Riohex® 0.5%)[6] . For each laparoscopic approach used, the subcutaneous tissue and abdominal muscles were infiltrated, SC, with 2% lidocaine (Cloridrato de Lidocaína® 2%)[7] without vasoconstrictor.

The surgical access followed the initial techniques described by Babkine *et al*. [1]. A first laparoscopic access was created 3 cm cranial and left of the umbilicus, with trocar insertion 10 mm blunt tip with 45° inclination oriented cranially, allowing the optical input (8 mm, 0° and 42 cm long). This was connected to a 250 W light source, and the corresponding trocar connected to the insufflator for creating and maintaining the pneumoperitoneum (12 mmHg). The optic was attached to the camcorder and the cavity inspection started. The middle region of the abomasal greater curvature was identified, being referenced as the center of the space between the reticuloabomasal ligament and the pyloric antrum, about two centimeters from the greater omentum fixation. This area was used for abomasopexy. Individual abdominal staples were used for fixation and consisted of polyglactine commercially available (Securestrap®)[8]. The staple had "anchor" format with 5 mm in length (Figure 1). These were attached to suture threads 60 cm long (nylon® number 1)[8]. Each staple was individually positioned with its own application tool.

An area was determined in the center of the space between the xiphoid cartilage and the umbilicus, 5 cm right from linea alba. At this point, three new accesses were created, where were inserted the 10 mm trocars, with three centimeters between them, and served as access for the instrument passage for the staples placement (Figure 2).

Figure 1. Application device and surgical staples used. It can be seen the "anchor" shape of the staple end, in addition to its small size when compared to the surgeon's finger. [http://www.medline.com/jump/product/x/Z05-PF44899].

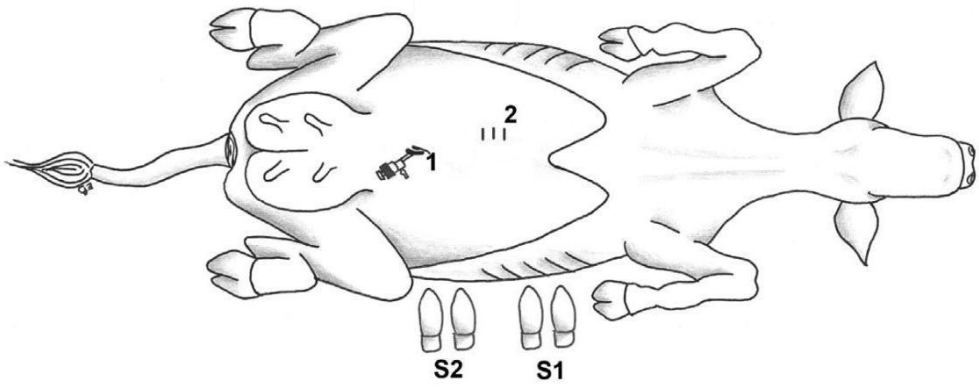

Figure 2. Positioning scheme of the surgical team, patient and surgical accesses. Positioning orientation of the laparoscopic portals to the optical (1) and stapler (2) insertion. The surgeon (S1) and the assistant (S2) stay on the left side of the patient, and the endoscopic equipment on the right side of the patient [1] (modified).

Using the first right access (the most cranial), a laparoscopic clamp connected to the electrosurgical scalpel was introduced into abdomen, and held the serous abomasum cauterization in linear direction and parallel to the attachment staples line, distant two centimeters side to it. The electrosurgical scalpel was used in the function "coagulate" in 35 watts. This cauterization aimed to stimulate the abomasal adhesion to the abdominal wall (Figure 3). With the stapler passage by the same access, the suture thread was fixed with two surgical staples in the greater abomasal curvature, perpendicular to this reference, and two centimeters away from the greater omentum fixation (Figure 4). The threads ends connected to the staples were kept out of the abdomen. Through the other two accesses (medium and caudal), the procedure was repeated using a suture thread for each portal.

After undoing the pneumoperitoneum, the suture threads were pulled and the abomasal positioned in contact with the ventral abdominal wall. Each suture thread was attached to the skin independently. The pneumoperitoneum was restored under pressure sufficient to allow abomasal image formation and the viscera positioning in contact with the ventral abdominal wall was re-evaluated (Figure 5). Abdominal gas was then drained, optics and trocar removed, and skin sutured using single separate pattern with nylon 0.

The total dorsal position and surgical procedure times required were recorded. The skin wounds were treated until complete healing, and access suture thread was removed 14 days after surgery. Abomasopexy sutures were not removed.

Post-surgery evaluation

Physical examination was performed twice a day, and the complete blood count and fibrinogen were evaluated every 2 days, for 8 days, and weekly until the experiment end. The ventral right abdominal region was evaluated by ultrasonography exam every 2 days, for 8 days, and weekly until the end of the study. Another laparoscopic examination was performed thirty days after the first surgery. This procedure and the evaluations followed the same conduct described previously.

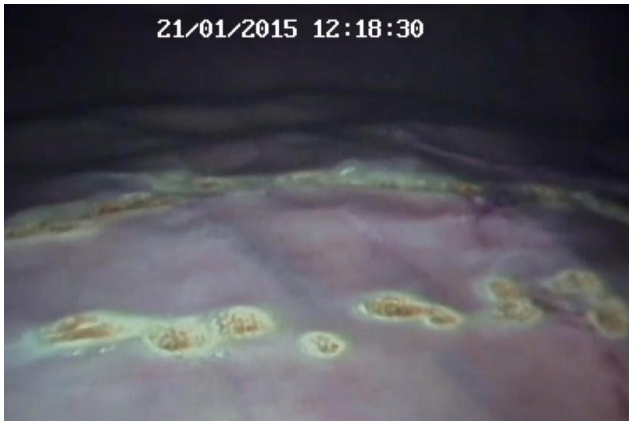

Figure 3. Linear cauterization of the abomasal serosa. Two parallel lines of cauterization points were made medial and lateral to the area previously selected for the abomasopexy.

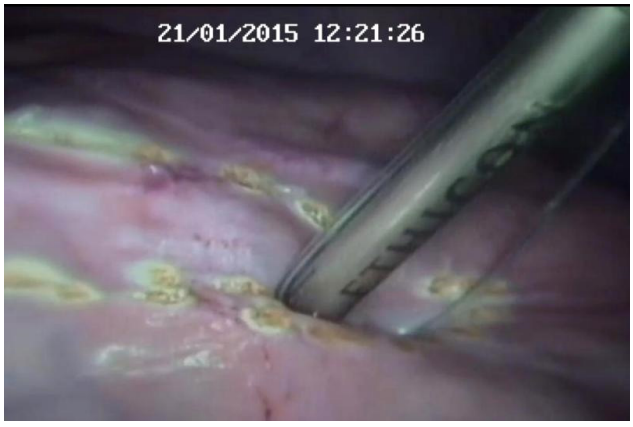

Figure 4. Suture threads fixation with two staples. After the first staple fixation (cranial), the stapler end was held on the suture thread and slipped caudally. The ends of the threads were held outside the abdomen.

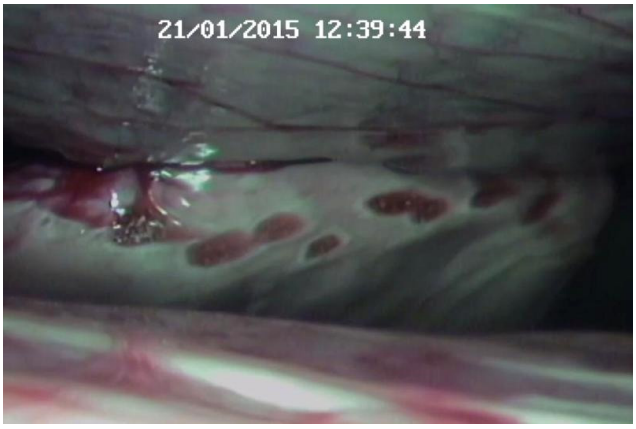

Figure 5. Laparoscopic image after abomasum fixation with suture threads to the skin. The abomasum remained in direct contact with the peritoneal surface, and the cauterization areas surrounded the fixation suture of the abomasum.

RESULTS

The animals did not present changes in laboratory tests and abdominal ultrasound previously to the procedure. The fasting period was suitable but all animals had to be maintained with an orogastric tube for gas and liquid drainage during the procedure. There was increase in rumen volume during laparoscopy in two animals (# 4 & # 5) making the abomasum view difficult at first inspection. The anesthesia and surgical times are shown in Tables 1 and 2 respectively.

The main reasons for the excessive surgical procedure time included the abomasum traction and positioning prior to cauterization (animals # 4 & # 5), the suture thread rupture after excessive strain on the stapler and the pull-out of staples during traction (animal # 2), and suture thread lost during traction (animal # 1), which was recovered by laparoscopic forceps.

During the study, one animal was replaced due to an accidental rumen perforation while performing the first laparoscopic access.

The proper patient positioning in dorsal recumbency made easier the viscera positions inside the abdomen. Ruminal left or right imbalances could produce gas areas shifting the viscera to the sides, and secondarily moving the abomasum, making it difficult laparoscopic inspection by optical positioning.

The surgical procedure could be performed properly, allowing the abomasal fixation by minimally invasively technique. The optical access allowed adequate abdomen evaluation, as well as the abomasum position and fixation. The access for the abomasum cauterization and viscera attachment was also suitable, as much as the staple fixation and pulling abomasum to the wall.

Table 1. Total anesthesia time during laparoscopic abomasopexy of each cow (min).

Animals	A1	A2	A3	A4	A5	A6	Mean	Standard Deviation
Minutes	95	120	95	95	80	80	94	14.63

Table 2. Total surgical time during laparoscopic abomasopexy of each cow (min).

Animals	A1	A2	A3	A4	A5	A6	Mean	Standard Deviation
Minutes	50	80	50	50	40	40	51	14.71

There was a difficulty associated with partial loss of the pneumoperitoneum during stapler use. The procedure needed a 10 millimeters trocar for the stapler passage as well as the sutures thread, allowing some carbon dioxide to scape.

There was no event at recovery from the anesthesia. All animals received food and water at the same day of the surgery.

Two animals showed fever in the second and third day after surgery (animals # 2 & 5), so benzathine penicillin (Pentabiótico® Veterinário Reforçado)[1] [40.000 UI/kg BW, IM] was administrated three days after surgery, and during fever periods animals were treated with dipyrone (D-500®)[1] [22 mg/kg BW, IV].

The laparoscopic access presented edema and moderate pain on palpation during the first evaluation in all animals. There was no secretion draining during its healing period. Animals # 2, 3, 4 and 5 showed increased edema on the fourth day after the surgery, maintaining moderate pain on palpation and increased local temperature. On the sixth day after the surgery, there was purulent exudate at the abomasopexy access (animals # 2, 4 & 5), and wound swelling, pain on palpation and increased local temperature (animal # 6). On the eighth day after surgery, all animals, except the number 1, presented purulent exudate in the abomasopexy wound. There was reduction in local pain and wound swelling after draining the secretion. At the 15th day after surgery, the abomasopexy sutures began to drop, and all threads complete elimination in the 25th day. At this time, granulation tissue and local infection control were observed filling the wounds. There was no complication in surgical wound in the animal number 1, remaining with all sutures until the 30th day.

The first ultrasound examination was performed two days after surgery, which identified hypoechoic material accumulation in laparoscopic access, as well as between the abomasal serous surface and peritoneum. It was also noted edema and abomasal wall folding (Figure 6). In animals 1, 2 and 3, there were a slight gap that allowed the abomasal movement in relation to the peritoneum. During the fourth and sixth days after surgery evaluations, there were abomasal wall edema reduction, reducing the wall folding (animals # 1, 2, 4 & 5), and also identification of greater echogenicity material between the abomasal and peritoneal surfaces (Figure 7). There were a path organization around the abomasopexy suture in the abdomen wall with anechoic content and small volume (animals # 2, 3, 4, 5 & 6) [Figure 8].

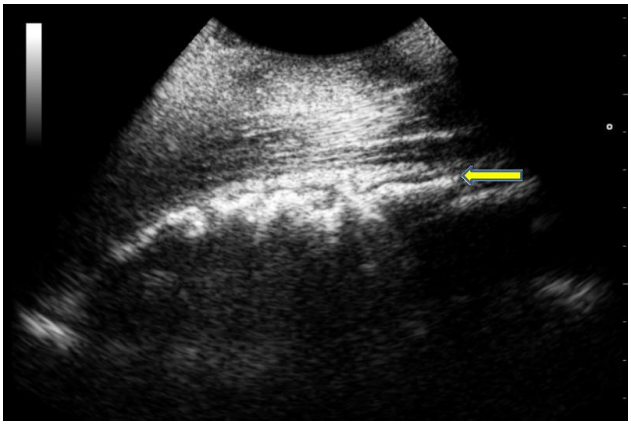

Figure 6. Ultrasonography image of the abdominal wall on the second day after surgery. Note the viscera wall thickening (yellow arrow), as well as the marked pleating induced by the suture tension.

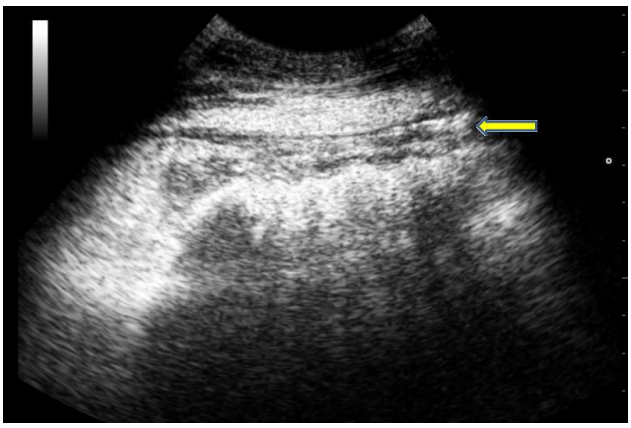

Figure 7. Ultrasound evaluation of the sixth day after surgery. Note the disorganized fibrous tissue, deposited irregularly on the abdominal wall (yellow arrow).

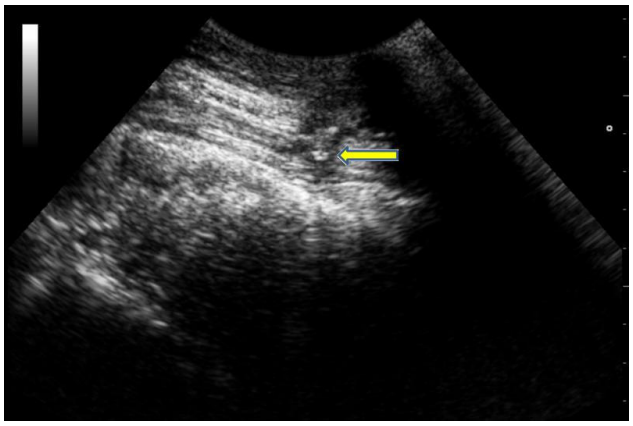

Figure 8. Identification of the fistulous tract on the ventral abdominal wall. Note the organized fistulous tract, of hypoechoic content, surrounding the suture material (hyperechoic dot identified with a yellow arrow).

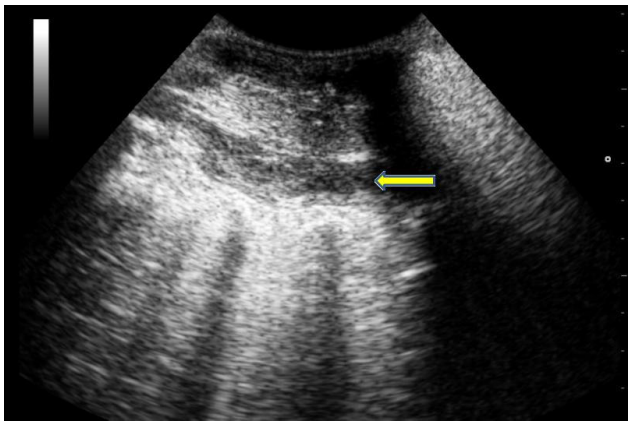

Figure 9. Adhesion initial organization uniting the abomasum to the peritoneum. Note the adhesion flat and disorganized aspect (yellow arrow), aligned with the abdominal wall fistula.

The second ultrasound examination was performed two weeks after the surgery. There was normal abomasal motility, with a distance between the abomasum and the peritoneum (animal # 1). There was abomasal movement restriction with higher echogenicity tissue deposition between the abomasum and the peritoneum (all animals, except # 1)

The third ultrasound examination showed a marked abomasal mobility on animal number 5 and no fibrous tissue deposition between viscera and peritoneum, but it still had the fistulae in the abdominal wall. Animals 2, 3, 4 and 6 remained with abomasal movement restriction, adhesion organization in different formats (Figure 9), and there were fistulas organization in the abdominal wall, with hypoechoic content in the abomasopexy wound.

The last ultrasound examination showed normal abomasal mobility in animals 1 and 5. The animals 2, 3 and 6 showed less abomasal movement restriction compared to the previous week, and lower volume of fibrous tissue between abomasum and peritoneum. The animal 4 maintained the same ultrasound aspect from the previous week, with elliptical aspect adhesion formation (Figure 10). All fistulae were occluded, and there was no fluid accumulation identified in the abomasopexy area.

Thirty days after first abomasopexy, there was a second laparoscopic procedure, which identified a narrow and linear fibrinous adhesion, in animals 2, 3 and 6. The adhesion was formed in compatible region and proportional to abomasum cauterization and fixation to peritoneum, but allowed discrete abomasal movement in relation to abdomen wall. The abomasum was not inserted in the abdominal wall, retroperitoneal region, but there was a firmly serosa adhesion in the peritoneum. There was no cauterization scars identification on the surface of the abomasum (Figures 11 to 13).

The animal 4 showed juxtaposition of abomasal serous and peritoneum, which blocked fibrous tissue identification between the described structures. There was fibrous tissue formation, with flattened and linear aspect, at the cranial and caudal adhesion limits (Figures 14 and 15). The animal 1 showed no abdominal change, and the animal 5 showed a slight omentum adhesion to the wall, at the access region used for abomasopexy, but the abomasum was not attached to the abdomen wall (Figure 16).

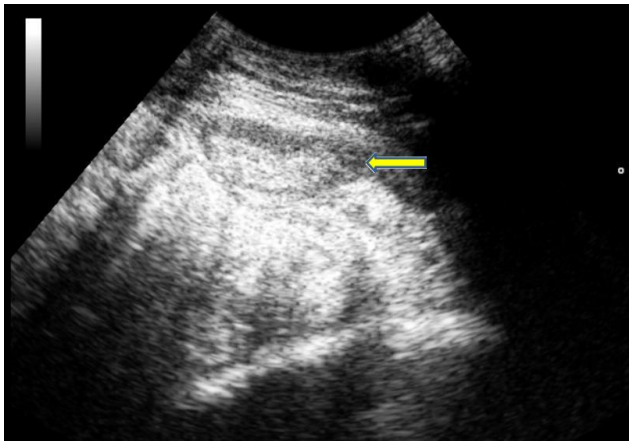

Figure 10. Adhesion identification at the end of the fourth week of the ultrasound examination on animal nº 4. Note the elliptical shaped, well-organized adhesion (yellow arrow), preventing the abomasum movement on the peritoneal cavity.

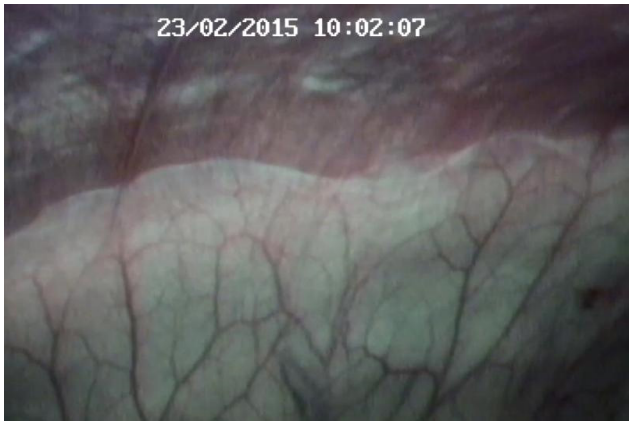

Figure 11. Laparoscopic image of the abomasopexy on animal nº 3. Note the abomasal wall limit (clearer structure) and the fibrous tissue formed between the viscera and the abdominal wall.

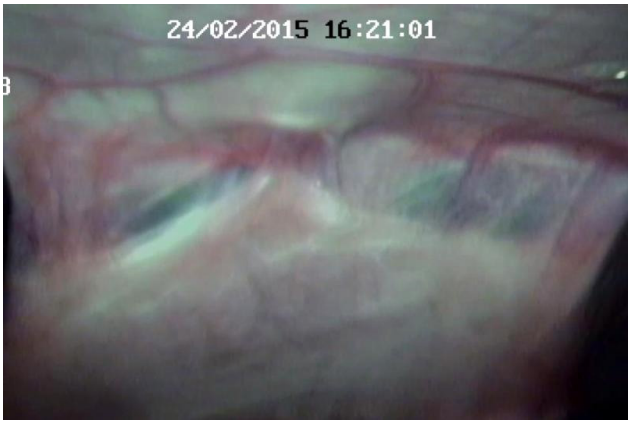

Figure 12. Laparoscopic image of the abomasopexy on animal nº 6. Note the transparent areas on the fibrous tissue of the abomasopexy, crossed with fibrous bundles and vascular structures, showing its thin shaping.

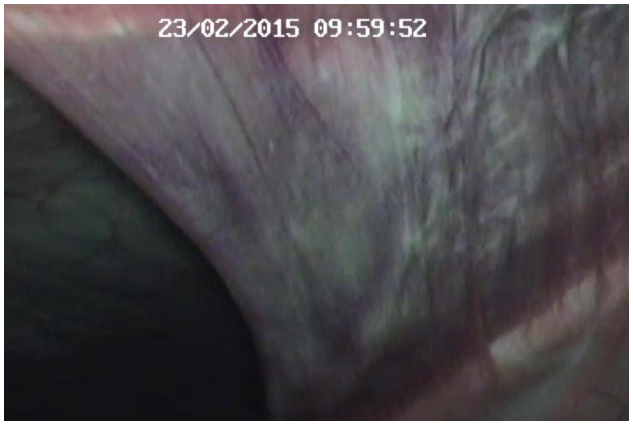

Figure 13. Caudal limit of the abomasopexy on animal nº 3. Note the long fibrous tissue at the caudal limit of the abomasopexy, allowing discreet movement of the abomasum, even after its fixation.

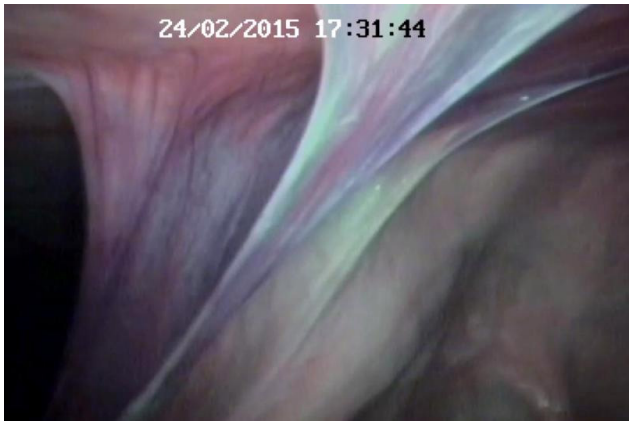

Figure 14. Caudal limit of the induced adhesion on animal nº 4. Note the fibrous tissue flat aspect, just caudal to the junction of the abomasum to the peritoneal surface.

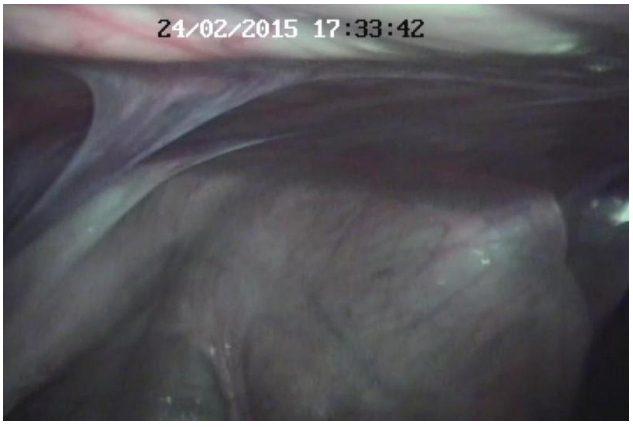

Figure 15. Abomasal wall and peritoneum juxtaposition on animal nº 4. Note the abomasum insertion on the abdominal wall, preventing the viscera movement.

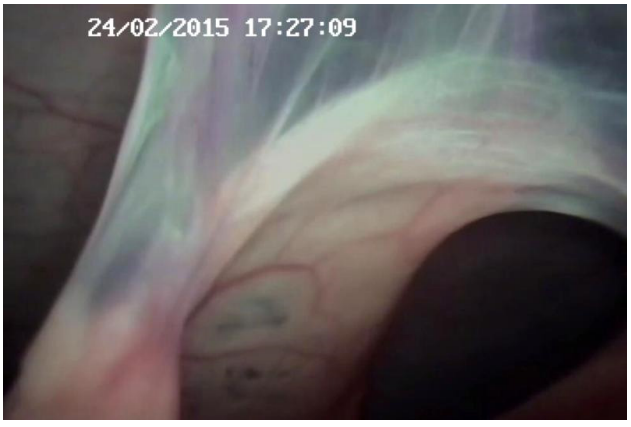

Figure 16. Laparoscopic image of the omentum adhesion identified on animal nº5. Note the adhesion on the omentum extremity, associated to the fibrous tissue on the laparoscopic portal scars.

DISCUSSION

The abomasopexy by laparoscopy, although already established as safe technique with good results [4], depends on the laparoscopic equipment availability, trained staff to handle it, familiarization and surgical team training, in addition to hospital surgical reality gap to dairy production centers.

The present study purpose a technique development, carried out into operating room under general anesthesia. In field conditions, some difficulties and adversities can be found such as physical restraint, anesthesia for maintenance in dorsal recumbency and laparoscopic equipment transport to the location where the surgical procedure will be done. These difficulties cannot be seen as impediments to the technique application, since there is a tendency, as in human medicine, in replacing the great access incisions to minimally invasive procedures.

The staples used in the study were developed for inguinal hernia repair in human beings, and were adapted for this study. Despite the small size staple and the form intended to a different surgical procedure, it was observed suitable staple strength for fixing the suture. The stapler end can be modified to a specific model for the abomasopexy, as the human model can damage the threads when tensioned too hard against the stapler. Despite the difficulties, the association model of staples with suture threads could replace intracorporeal sutures previously proposed [1,7].

Laparoscopic optic 0 degree was used as previously described [1]. Despite allowing anatomical structures inspection involved in the surgical procedure, this optics showed restriction on the surfaces inspection presented in parallel to the image formation. The optical lens use with a 30-degree tilt could facilitate the inspection, since while turning the device the surgeon determines which surface will be the focus of inspection. It is believed that this change may facilitate the trocars passage used in abomasopexy, improve the abomasal surface visualization and facilitate the staples placement in the abomasum.

The abomasopexy can be performed in a single surgical procedure [1,3,7,8]. Surgical difficulties did not prevent abomasal fixation during the procedure, and the outcome obtained showed that the technique could achieve the expected results.

Anesthesia and surgical time achieved in this experiment can be minimized with more training and surgical team familiarization.

One of the animals was replaced due to ruminal drilling at the time of the first laparoscopic access. In this case, laparotomy was performed to remove the trocar, and the animal recovered without complications.

Laparoscopic procedures allowed the determination of high strength characteristic and elasticity in the bovine peritoneum, which hindered the trocar entry at the first abdominal puncture. This difficulty can be attenuated by the pneumoperitoneum creation before the first trocar introduction, using a Veress needle. Thus, there will be abdominal viscera and peritoneum deviation, facilitating the trocar entry without causing damage to abdominal viscera.

The first animal submitted to this abomasopexy technique did not provide the expected evolution. In addition to longer surgical time, technical difficulties were encountered as it was expected to the first procedure.

During abomasopexy, it was noted in some cases, the abomasal ventral wall adhesion on its own opposite wall. This fact led to the conclusion that there had been total abomasal ventral wall perforation, a situation not considered in preoperative period. It was believed that due to the staples size used, there would not be abomasum lumen invasion. Septic complications, described in the literature, did not occur with the proposed technique [4]. In the post-surgical evaluation, it could be determined that there was abomasopexy area contamination, which had evolved with the sutures threads release and cutaneous fistulas formation. These kept the purulent secretion elimination, which was controlled within a few days of treatment, by local dressings, without septic complications. The fever episode in some animals may have been associated with contamination due to abomasum drilling.

The suture threads pulling and the abomasal apposition against the ventral abdomen wall were difficulties encountered during the surgical procedure, even after performing the pneumoperitoneum. In addition, due to the dorsal recumbency, the rumen produced gas elimination was difficult, accumulating in the ventral sac and moving the abomasum to the right region. To overcome this difficulty, we chose initially to decrease the pressure used for pneumoperitoneum to 8 mmHg. When it was not enough, an atraumatic grasping forceps was used to pull the abomasum for ventral median region, and then the wires were tensioned.

Although stimulation induced by cauterizing, and fixation held by sutures threads associated with the staple, the formed adhesion had narrow and linear aspect. We suggest the cauterization of abomasal serous to be of a wider region, in order to induce adhesion in wider and longer segments. This feature can increase the adhesion rigidity, and prevent this formation to brake.

The surgical technique standardization and its adjustments to field condition can perform implementation and assessment of cows used in dairy production cycle, as proposed in the literature [5]. It is suggested to perform the technique during lactation, before the last third of pregnancy that should be occurring during this period. This suggestion is based on avoiding the procedure in early lactation, due to the milk production peak, when fasting and surgery could be responsible for economic losses. The final third of pregnancy should also be avoided. The greatest fetal volume in uterus would difficult the pneumoperitoneum formation and the rumen displacement in dorsal direction.

According to the results found in the present study, and associated to descriptions in the literature [3,4,8], clinical cases of abomasum displaced can be treated by laparoscopic procedure, and abomasopexy can be carried out as proposed by this study.

CONCLUSION

The surgical technique proved feasible and with favourable results. Laparoscopic abomasopexy was performed without intracorporeal suture needs. The induced adhesion was sufficient to maintain the abomasum fixed to the ventral abdominal wall, preventing them from moving. Complications associated with abomasopexy contamination could not be avoided. The suggested technique results statistical determination and its clinical applicability depend on the use thereof in more animals subject to the milk production cycle conditions.

MANUFACTURERS

[1]Zoetis. Campinas, SP, Brazil.

[2]J.A. Saúde Animal. Patrocínio Paulista, SP, Brazil.

[3]Syntec do Brasil. Santana de Parnaíba, SP, Brazil.

[4]União Química Farmacêutica Nacional S.A. Embu-Guaçu, SP, Brazil.

[5]Laboratório Cristália. São Paulo, SP, Brazil.

[6]Indústria Farmacêutica Rioquímica Ltda. São José do Rio Preto, SP, Brazil.

[7]Hipolabor Farmacêutica Ltda. Belo Horizonte, MG, Brazil.

[8]Ethicon Johnson & Johnson Medical. São Paulo, SP, Brazil.

Ethical approval. This study was approved by the Animal Care and Use Committee at our institution (#1921110314).

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of paper.

REFERENCES

1 Babkine M., Desrochers A., Bouré L. & Hélie P. 2006. Ventral laparoscopic abomasopexy on adult cows. *Canadian Veterinary Journal*. 47: 343-348.

2 Câmara A.C.L., Afonso J.A.B. & Borges J.R.J. 2011. Métodos de tratamento do deslocamento de abomaso em bovinos. *Acta Veterinária Brasílica*. 5(2):119-128.

3 Christiansen K. 2004. Laparosckopisch kontrollierte operation des nach links verlagerten Labmagens (Janowitz-operation) ohn ablegen des patienten [Cirurgia de deslocamento de abomaso à esquerda com controle endoscópico (cirurgia de Janowitz) sem o decúbito do paciente]. *Tierarztliche Praxis. Ausgabe G, Grosstiere/Nutztiere*. 32: 118-121.

4 Janowitz H. 1998. Laparoscopic reposition and fixation of the left displaced abomasum in cattle. *Tierarztliche Praxis. Ausgabe G, Grosstiere/Nutztiere*. 26(6): 308-313.

5 Jorritsma R., Westerlaan B., Bierma M.P.R. & Frankena K. 2008. Milk yield and survival of Holstein-Friesian dairy cattle after laparoscopic correction of left-displaced abomasum. *The Veterinary Record*. 162(23): 743-746.

6 Medline. 2015. Securestrap fixation devices by Ethicon. <www.medline.com/jump/product/x/Z05-PF44899> [Accessed online in June 2015].

7 Mulon P., Babkine M. & Desrochers A. 2006. Ventral laparoscopic abomasopexy in 18 cattle with displaced abomasum. *Veterinary Surgery*. 35: 347-355.

8 Newman K.D., Anderson D.E. & Silveira F. 2005. One-step laparoscopic abomasopexy for correction of left-sided displacement in dairy cows. *Journal of American Veterinary Medicine Association*. 227(7): 1142-1147.

9 Wilson A.D. & Ferguson J.G. 1984. Use of a flexible fiberoptic laparoscope as a diagnostic aid in cattle. *The Canadian Veterinary Journal*. 25(6): 229-234.