Laparoscopic Evaluation of Umbilical Disorders in Calves

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Objective: To describe a laparoscopic technique for evaluating umbilical disorders in calves, including feasibility, visualization of umbilical structures, and related complications.
Study Design: Prospective clinical study.
Animals: Male calves (15 Holstein, 2 Montbeliard) with umbilical disorders (n=17).
Methods: Calves <2 months old with obvious umbilical disease were assessed by clinical examination and ultrasonography of the umbilical structures. Laparoscopic evaluation was performed in dorsal recumbency under subarachnoid lumbosacral anesthesia and sedation. An open insertion technique with short 60 mm cannulas was used after creating 2 portals 10 cm cranial to the umbilicus (one 5 cm left of midline for the laparoscope and one 5 cm right of midline as an instrument portal). After laparoscopy, abnormal tissues were resected by laparotomy during the same anesthetic period.
Results: Laparoscopic evaluation of umbilical structures was performed quickly (mean surgery time 7.1 ± 2.5 minutes). Umbilical structures could be completely visualized in all calves without intraoperative complications. In addition to abnormalities previously detected on ultrasound, laparoscopy enabled detection of adhesions 7 calves that were not suspected on ultrasound, as well as focal enlargements of the umbilical arteries and urachus close to the bladder in 5 calves. Laparoscopy failed to detect abnormalities observed with ultrasound or laparotomy in 4 calves, including small hernias and omphalitis.
Conclusion: Laparoscopic evaluation of umbilical structures was performed safely and quickly in young calves and allowed complete evaluation of intra-abdominal umbilical structures and may, therefore, be a useful adjunct to physical examination and ultrasound to fully assess the abdomen in calves.

Umbilical disorders are a common and clinically relevant problem in calves.[1,2] They can be classified as noninfectious disorders (eg., hernias or urachal cysts), infectious disorders (involving extra- or intra-abdominal umbilical structures), or a combination of both. Infection of the umbilical remnants can be responsible for septicemia, septic arthritis, dysuria, and chronic unthriftiness.[3,4] The current recommended treatment for umbilical disorders, with the exception of umbilical hernias <5 cm, is ventral midline laparotomy in dorsal recumbency after careful case selection.[1,3–7] Despite complication rates as high as 73%, surgery is generally associated with a positive outcome, with up to 98% survival, and allows calves to be used for production.[8] However, a precise diagnosis of umbilical disorders is of paramount importance because the treatment, prognosis, and costs depend on the specific disease process and structures involved.[2,4,9] Ultrasonography has been widely used since 1986[10] in the preoperative evaluation of umbilical disorders in calves.[2,4,5,11–13] It is accurate for all umbilical structures despite its inability to detect adhesions[2,5,11] and is currently the gold standard for assessment of umbilical disorders in large animal neonates.

In foals, a laparoscopic technique has been described to assist resection of umbilical vessels before removing the urachal remnants and the apex of the bladder by an open approach.[14] In calves, laparoscopic resection of the apex of the bladder and umbilical structures was described in calves without umbilical abnormalities using the Endo stitch suturing device,[15] but this technique has not been reported in calves with umbilical disease. The goals of this study were to describe a laparoscopic technique for evaluating umbilical disorders in calves, to assess the feasibility and visualization of umbilical structures, and to report related complications.

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MATERIALS AND METHODS

Animals

This study protocol was approved by the ONIRIS institutional animal care and use committee (SBEA-CRIP2014/034) and by the national ethical committee (2016021421534211/APAFIS

4094). It was part of a larger project investigating the anesthetic effects of procaine chlorhydrate (Procamidor, Axience, Pantin, France) used by subarachnoid lumbosacral administration for umbilical surgeries in calves.[16–18] Young calves (<2 months old) with visual enlargement of the umbilical stalk and abnormal palpation (presence of a hernia, firm and thick umbilical tissue, or intra-abdominal mass continuous with the umbilicus) were included in the study. Breeds included 15 Holstein and 2 Montbeliard. A complete clinical exam, including thorough cardiac and pulmonary auscultation, was performed on all calves. Calves that presented with hyperthermia (>40°C), distended joints, lameness, or abnormal lung sounds were excluded. In this way, only calves with an American Society of Anesthesiologists (ASA) status <3[19] were included because subarachnoid lumbosacral anesthesia (SLS) is known to cause moderate cardiovascular depression[17,20] and causing further depression in already compromised calves was not deemed appropriate for our anesthetic protocol.

Ultrasound Examination

The day before surgery, an ultrasound examination of the umbilical area was performed by an experienced bovine clinician (NC) according to previously described methods.[1,2,21] Calves were clipped from the xiphoid to the inguinal area up to the costal arch on the right abdominal wall and a 3.5–5 MHz curvilinear probe (Aquila CRII Vet, Esaote-Pie Medical, Saint-Germain-en-Laye, France) was used with the calves standing to image the umbilical stalk, umbilical vein, liver, umbilical arteries, urachus, and bladder. Size and ultrasound characteristics of these structures from the umbilicus to their termination were recorded in a standardized form. For the umbilical vein, the size and ultrasound appearance were recorded at the level of the umbilical stalk, just as it crossed the abdominal wall, halfway between the body wall and liver, and at the entrance into the liver. Umbilical arteries were evaluated lateral to and at the midpoint of the bladder. The urachus was scanned from the apex of the bladder to the caudal umbilical stalk.[21] Infection was suspected from both objective and subjective parameters. Size of the structure (vein, arteries, urachus) was used as an objective measure, comparing with published reference range in healthy calves.[21] Echogenic fluid or gas content, previously judged useful when evaluating umbilical disorders with ultrasonography,[11] were used as subjective parameters.

Surgical Procedures

Calves had water provided until surgery but were kept off feed for 12 hours before surgery. The day of surgery, they received ceftiofur suspension (6.6 mg/kg subcutaneously) 2 hours before SLS anesthesia and had both a jugular IV (52 mm 16 gauge) and an auricular intra-arterial (25 mm 22 gauge) catheter aseptically placed without sedation following local anesthesia (subcutaneous 2% procaine and topical prilocaine cream [EMLA 5%, Astrazeneca, London, UK], respectively). The anesthesia protocol and monitoring, described in detail elsewhere,[16–18] briefly consisted of 3 anesthetic groups using SLS procaine chlorhydrate based-anesthesia combined with xylazine administration: (1) SLS procaine (3–4 mg/kg) and xylazine (0.2 mg/kg IV); (2) SLS procaine (4 mg/kg) and xylazine (0.2 mg/kg); and (3) SLS procaine (4 mg/kg) and xylazine (0.2 mg/kg) with systemic xylazine (0.02 mg/kg IV) and butorphanol (0.1 mg/kg IV). Drugs given by SLS and IV routes were given simultaneously. Calves were positioned in dorsal recumbency on a hydraulic table using a U-shaped foam cushion (Doggy relax, Dinan, France). The preputial orifice and any draining umbilical mass were sutured closed using 2-0 nylon in a continuous Lembert pattern to prevent contamination and the ventral abdomen was aseptically prepared and draped.[3]

Laparoscopic Procedure

A surgical assistant was present during all the surgical procedures and the surgeon performing the procedure (MR) was unaware of the ultrasound results. Supplemental local anesthetic infiltration was performed using 5 mL 2% procaine per site subcutaneously and in the abdominal wall at the laparoscopic and instrument portal sites. Their location close to the last rib was deemed too cranial to be reached by the subarachnoid injection with the dose and volume used.[20] The laparoscope portal was located 5 cm left from midline 10 cm cranial to the umbilicus and the instrument portal was located 5 cm right from midline 10 cm cranial to the umbilicus. A 15 mm skin incision was made using a #24 scalpel blade down to and including the abdominal musculature at the laparoscope portal. A 60 mm long and 12 mm wide disposable trocar-cannula unit (Medical Technical Promotion, Tuttlingen, Germany) was inserted with an open approach under visual control. Allis tissue forceps were used to close the skin around the cannula to prevent leakage of CO_2 during the laparoscopic procedure. A 31 cm 10 mm wide 0° laparoscope (Karl Storz GmbH, Tuttlingen, Germany) was inserted into the cannula and the abdomen was distended with CO_2 to 8 mmHg using a laparoscopic insufflator (Endo-Arthroflator-Vet, Karl Storz GmbH), as described previously in young calves.[15] For the instrument portal, the skin and subcutaneous tissues were incised with a #24 scalpel blade. A second disposable trocar-cannula unit of the same size was inserted sharply through the abdominal musculature under laparoscopic visualization to prevent visceral damage. Laparoscopic Babcock forceps were inserted into the cannula for manipulations of the abdominal viscera.

The table was initially placed in a horizontal position for evaluation of the umbilical structures then was moved to a 20° Trendelenburg position to optimize visualization of the caudal abdomen[1,15] or reverse Trendelenburg if necessary for the cranial abdomen. All procedures were video recorded. Abnormalities of the visual aspect of the umbilical structures were noted, including change in color of the surface or increase in size of the umbilical remnants, presence of adhesions, umbilical hernia, intra-abdominal umbilical abscess, or liver abscesses. Intraoperative complications were defined as major (visceral damage or perforation) or minor (laceration of superficial epigastric vessels, retroperitoneal insufflation,

insufficient visibility). Laparoscopic surgical time from skin incision for the first trocar placement to the end of the laparoscopic procedure was recorded. Upon completion of the laparoscopic examination, the cannulas were removed and the surgery was converted to an open procedure.

Laparotomy

Laparotomy procedures were performed as previously described.[22] The skin was incised elliptically with a #24 scalpel blade around the umbilicus. The subcutaneous tissues were bluntly dissected with Mayo scissors until the external sheath of the rectus abdominis muscle was reached and a 2 cm long midline body wall incision was made just cranial to the umbilical stalk to digitally palpate any structures associated with the mass. An elliptical body wall incision was then made using Mayo scissors. The incision was extended cranially if an abnormal umbilical vein was present or caudally when the urachus and/or umbilical arteries were involved. A systematic examination and palpation of all structures around the resected umbilicus were performed and abnormalities recorded. In cases of an infected umbilical vein not reaching the liver, the vein was double ligated with 1 polyglactin 910 and transected distal to the ligatures after application of a clamp to prevent abdominal contamination. When omphalophlebitis reached the liver, the umbilical vein was marsupialized using 2 layers of 2-0 polyglactin 910 in simple interrupted patterns to secure the vein through the previously described right laparoscopic instrument portal, which was enlarged sharply if necessary. If the urachus and/or umbilical arteries were infected, the arteries were double ligated with 1 polyglactin 910 and used as stay sutures to facilitate bladder retraction and stabilization. A clamp was applied to occlude the urachus, vesicular apex, and arteries before removing them by sharp incision. The apex of the bladder was closed with 2 inverting layers (Cushing pattern followed by a Lembert pattern) using 2-0 polyglactin 910. If the urachus and umbilical arteries were normally involuted, they were ligated with a simple strand of 1 polyglactin 910 before transection. Laparoscopic portals were closed with 2 polyglactin 910 in a cruciate pattern on the external sheath of the rectus abdominis muscle and 0 nylon on the skin in a simple continuous pattern. The midline incision was closed in 3 simple continuous layers using 2 polyglactin 910 for the linea alba, 2-0 polyglactin 910 for the subcutaneous tissues, and 0 nylon for the skin. Surgical time of the laparotomy from umbilical skin incision to the final suture placement was recorded.

Postoperative Management

Meloxicam (0.5 mg/kg IV) was administered once after the incision was closed for postoperative pain management. It was not given preoperatively so as to not interfere with evaluation of the anesthetic protocol.[23] Time from SLS anesthesia to standing was recorded. Calves were subsequently monitored 3 times daily for the first 2 days, then once daily until day 7. Any abnormalities were recorded.

RESULTS

Animals

Seventeen calves aged 15–33 days (mean, 23 ± 5) and weighing 33–62 kg (mean, 44 ± 6) were included in the study. All calves were male. All were judged to have an ASA status <3.[19]

Ultrasound Findings

Ultrasound examination of the umbilical structures showed abnormalities in all calves (Table 1). An umbilical hernia was detected in 8 calves, with 2 containing omentum, 4 containing part of the abomasum, and 2 containing small intestine. The umbilical vein appeared abnormal, at least in one part of its length, in 11 of 17 calves and was either increased in size or had modified echogenicity. Two calves had bilateral umbilical artery abnormalities. The urachus looked either enlarged or hyperechoic in 3 calves. Overall, no adhesions were observed or suspected on ultrasound.

Laparoscopic Findings

All procedures were performed without intraoperative complications. For examination of the cranial abdomen, all calves but 1 were placed in a horizontal position. The first calf was positioned in reverse Trendelenburg but the visual improvement was deemed minimal and the reverse Tredelenburg position was not required in further cases. The described technique of laparoscopy allowed excellent visualization of the entire length of the umbilical vein and visceral surface of the liver cranially (Fig 1). The umbilical vein was attached ventrally to the body wall by the thin falciform ligament, which was perforated during introduction of the trocar-cannula unit for the instrument portal because of its close proximity to the body wall. This step was performed safely in all calves under laparoscopic guidance, including those with omphalophlebitis, and was not considered harmful because of the subsequent en bloc resection of the umbilicus. The umbilicus itself, and possible associated abscess or hernia, could also be visualized. Hernias appeared as ovoid defects in the ventral abdominal wall, whereas umbilical abscesses were observed as a rounded and protruding mass over the umbilicus.

For examination of the caudal abdomen, all calves were placed in Trendelenburg position. The umbilical arteries, urachus, and urinary bladder were easily observed using the laparoscopic Babcock forceps to gently mobilize the apex of the bladder (Fig 2). Laparoscopy allowed accurate identification of the abnormal structures because of their increased size, inflammatory appearance (hyperemia), or the clear presence of abscessation (Figs 3 and 4). Adhesions were identified in 7 calves: between the body wall and the bladder (calf 12), between the omentum and umbilical vein (calves 6, 9, and 10), between the omentum, small intestine, and umbilical vein (calf 7), between the omentum and urachus (calf 4), and between the umbilical arteries and the body

Table 1 Ultrasound findings and final diagnosis in 17 calves examined for umbilical disorders

			Umbilical vein													
			In cord		Crossing body wall		Between liver and body wall		Liver		Umbilical arteries		Urachus			
Calf	Age (days)	Hernia	Fluid/ gas	Size* (mm)	Fluid/ gas	Size† (mm)	Fluid/ gas	Size‡ (mm)	Fluid/ gas	Size§ (mm)	Fluid/ gas	Size¶ (mm)	Fluid/ gas	Size** (mm)	Gross Appearance	Final diagnosis
1	17	–	–	N	+	17.3	+	N	+	N	–	N	–	N	Fistula	Infected hernia
2	15	+	–	N	–	N	–	N	–	N	–	N	–	N	Fistula	Omphalitis
3	26	–	+	12.6	+	12.6	–	N	–	N	+	13.9	+	16.3	Firm	Urachal infection + arteritis
4	30	+	–	N	–	N	–	N	–	N	+	8.4	+	21.0	Firm	Urachal infection + arteritis
5	23	+	–	N	–	N	–	N	–	N	–	N	–	N	Reducible hernia	Simple hernia
6	20	–	+	23.9	+	22.4	+	21.9	+	20.0	–	N	–	N	Firm	Omphalophlebitis
7	20	–	+	N	+	20.0	+	13.0	+	9.0	–	N	–	N	Firm	Omphalophlebitis
8	20	+	–	N	–	N	–	N	–	N	–	N	–	N	Reducible hernia	Simple hernia
9	27	–	–	N	+	25.2	+	N	+	20.6	–	N	–	N	Firm	Omphalophlebitis
10	24	–	–	N	+	14.7	+	9.4	–	N	–	N	–	N	Fistula	Omphalophlebitis
11	19	+	–	N	–	N	–	N	–	N	–	N	–	N	Reducible hernia	Simple hernia
12	26	+	–	N	–	N	–	N	–	N	–	N	+	N	Fistula	Omphalitis
13	18	+	+	9.6	+	N	–	N	–	N	–	N	–	N	Reducible hernia	Simple hernia
14	26	–	+	11.0	+	9.8	–	N	–	N	–	N	–	N	Fistula	Omphalitis
15	17	–	+	19.8	+	N	–	N	–	N	–	N	–	N	Fistula	Infected hernia
16	25	+	+	12.6	+	15.6	–	N	–	N	–	N	–	N	Reducible hernia	Simple hernia
17	33	–	+	16.8	+	9.0	–	N	–	N	–	N	–	N	Fistula	Omphalitis

N=normal. Reference ranges[21]: *1.0 ± 1.5 (14 days); †5.3 ± 4.6 (14 days), 7.9 ± 4.7 (21 days); ‡1.2 ± 2.4 (14 days), 4.4 ± 3.4 (21 days); §1.3 ± 2.8 (14 days), 2.8 ± 4.2 (21 days); ¶6.8 ± 1.0 (14 days), 8.4 ± 1.9 (21 days); **0 ± 0.

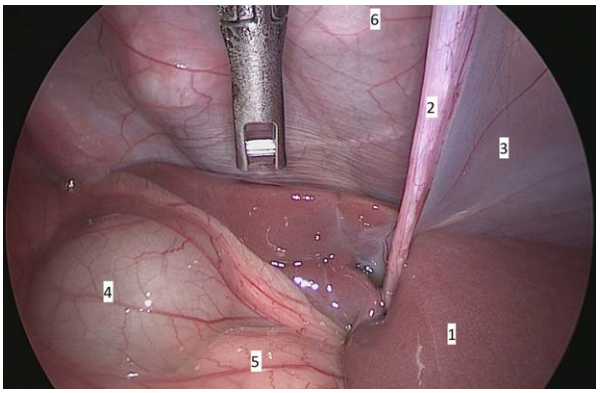

Figure 1 Laparoscopic image of the normal cranial abdomen in a calf. The ventral abdominal wall (6) is at the top of the image and cranial is to the right. 1 = liver; 2 = umbilical vein; 3 = falciform ligament; 4 = gallbladder; 5 = small intestine covered by omentum.

wall (calf 3). Interestingly, focal thickening of 1 umbilical artery close to the bladder apex was noted in 4 calves without extension toward the umbilicus (calves 2, 8, 13, and 14; Fig 5). These thickened arteries were all unilateral and visible lateral to the bladder apex. A similar focal thickening was observed at the level of the bladder apex/distal urachus in calf 16. In 4 calves, no laparoscopic abnormalities were found, including 2 infected hernias, 1 simple hernia (calf 16), and 1 omphalitis. Mean (± SD) time for the laparoscopic evaluation was 7.1 ± 2.5 minutes (range, 3–13 minutes).

Laparotomy Findings

Regarding the final diagnosis at the end of the laparotomy, 7/17 calves (41%) had an umbilical hernia (5 simple hernias and 2 hernias associated with a localized umbilical abscess), 4 (23%) had a simple omphalitis, 3 (18%) had an omphalophlebitis without liver involvement, 2 (12%) had an omphaloarteritis with urachal infection, and 1 calf (6%) had an

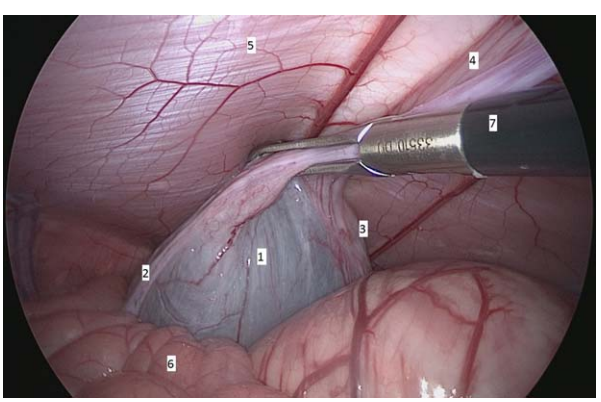

Figure 2 Laparoscopic image of the normal caudal abdomen in a calf in Trendelenburg position. The ventral abdominal wall (5) is at the top of the image and cranial is to the right. 1 = bladder; 2 = left umbilical artery; 3 = right umbilical artery; 4 = median ligament of the bladder; 6 = small intestine; 7 = laparoscopic Babcock forceps grasping the urachus to mobilize the urinary bladder.

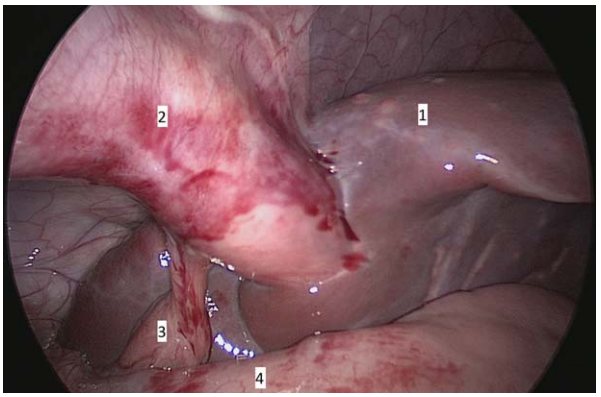

Figure 3 Laparoscopic view of a calf 6 that had omphalophlebitis and liver abscessation showing the enlarged liver with irregular white spotted surface (1), severely enlarged umbilical vein (2), adhesions between umbilical vein and omentum (3), and the omentum (4).

omphalophlebitis with liver abscessation. Two calves (#6 and 9) had a marsupialization performed, 2 (#7 and 10) had en-bloc resection of the umbilical vein and 2 (#3 and 4) had a partial apical cystectomy with en-bloc resection of the umbilical arteries. In the 4 cases with focal thickening of the umbilical arteries and in the case with a thickened distal urachus observed laparoscopically (#16), the abnormal structures could not be followed down during the open umbilical resection and were left in situ. Mean time for the laparotomy alone was 28.4 ± 13 minutes (range, 11–60 minutes).

Postoperative Period

Regardless of the anesthetic protocol, calves were able to stand in 113 ± 31 minutes post-SLS anesthesia. They all developed mild to moderate incisional edema that persisted despite decreasing in size for the 1 week follow-up period.

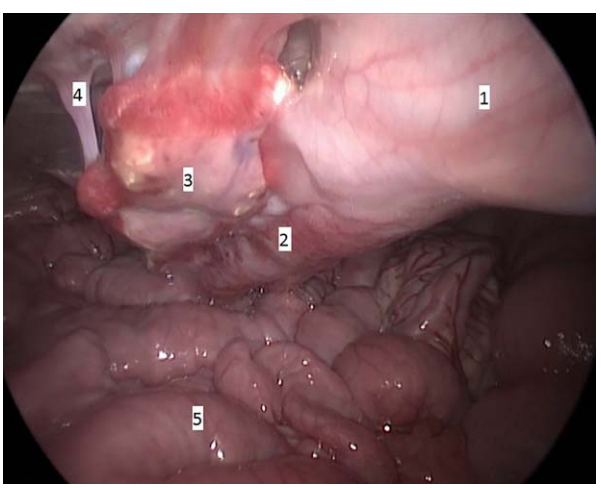

Figure 4 Laparoscopic view of calf 3 with omphaloarteritis and a urachal infection showing the umbilicus (1), enlarged urachus (2), abscessed left umbilical artery (3), adhesions to the ventral body wall (4), and the small intestine (5).

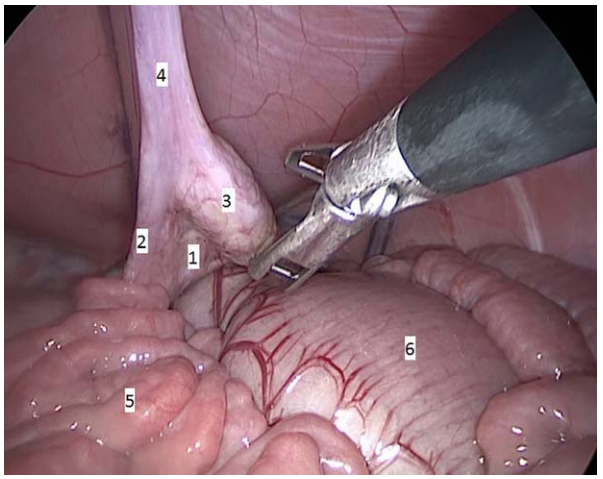

Figure 5 Focal thickening of the right umbilical artery (3) close to the bladder (1) in calf 14. 2 = left umbilical artery; 4 = urachus; 5 = small intestine; 6 = cecum.

Besides edema, all but calves 3 and 6 had otherwise normal physical exams during the follow-up period. Calf 3 that had an infected urachus, left arteritis, and multiple adhesions at surgery was humanely euthanatized 24 hours postoperatively because septic polyarthritis developed despite the long-acting ceftiofur administered preoperatively. He rapidly developed pyrexia and right front limb lameness associated with swollen fetlock and carpal joints on the same limb. Calf 6 died 48 hours after surgery from generalized sepsis. He had diffuse liver abscessation observed during surgery and progressively developed hyperthermia and signs of septic shock despite receiving IV fluids, tildipirosine antimicrobial (4 mg/kg subcutaneously) and additional meloxicam. A post-mortem exam was not performed on either of these 2 calves.

DISCUSSION

The laparoscopic technique described in our study allowed a quick and thorough evaluation of umbilical disorders in calves positioned in dorsal recumbency under SLS anesthesia with xylazine and procaine and local anesthesia. Previous studies have investigated the role of laparoscopy to assist resection of umbilical structures in foals[14,24] or to resect the apex of the bladder and umbilical structures in normal calves.[15] However, these curative laparoscopic procedures required surgical times as long as 160 minutes.[15] The diagnostic laparoscopic technique described in our study was performed in a mean time of 7 minutes, with only 1 laparoscopic and 1 instrument portal. The mean total surgical time was 36 minutes, including umbilical resection. These restricted operating times allowed the surgery to be performed under regional anesthesia and sedation. This is probably beneficial when treating calves with umbilical disorders that may have concurrent diseases and reduced ability to adapt to general anesthesia.[1,8,25] For evaluation of the SLS anesthesia protocol, only calves with ASA<3 were included. This could have affected the laparoscopic and total surgical time as well as outcome. The efficacy, cardiovascular, respiratory, and metabolic effects of our SLS protocol are presented elsewhere.[16–18] For more complicated and longer surgeries involving larger umbilical structures than those we treated, general anesthesia with either total IV or inhalant anesthesia may remain the best option.

It has previously been reported that in foals the laparoscopic trocars should be inserted carefully because of the shallow depth of the abdominal cavity to prevent damage to abdominal structures.[14] The same holds true for calves. As a consequence, the laparoscopic portal was created using an open technique, as suggested previously.[14,15] This avoided complications associated with blind placement, particularly visceral perforation[26] and retroperitoneal insufflation.[15] Similarly, short 60 mm long trocars allowed safe and ample craniocaudal movements when performing the laparoscopy. Establishing the laparoscopic and instrument portals in the described locations did not seem to be harmful to the underlying organs and kept the instruments sufficiently away from the infected umbilical structure.

Laparoscopy provided excellent observation of the umbilical remnants, bladder, liver, and the abdominal portion of the umbilicus and any possible associated abscess. Overall it allowed a precise detection of macroscopic umbilical disorders with results grossly correlated to ultrasound and laparotomy but with specific abilities. Because of the large visual field it offers, laparoscopy may be more likely to detect large multifocal abscesses of the liver than ultrasonography, particularly on the cranial visceral side of the liver, where air contained in the right lung can prevent ultrasound examination. On the other hand, ultrasonography can detect small abnormalities deep within organs that would probably be missed with laparoscopy, such as micro abscessation of the liver. When examining the vesicular apex, laparoscopy was not affected by the degree of bladder distension, as the bladder could be gently mobilized using Babcock forceps. With ultrasonography, examination with a full bladder helps diagnosing abnormalities in the apex region.[11] Another potential advantage of laparoscopy would be in evaluating the umbilical arteries close to their ramification with the internal iliac artery, which has been described as difficult with ultrasonography because of their deep location.[5] Laparoscopy also allowed detection of focal thickenings of some umbilical arteries and one urachus, close to the bladder and without extension to the umbilicus. These focal thickenings may represent either a delayed involution of the normal structures, persistently inflamed structures that were previously infected, or less likely encapsulated abscessation. Histological evaluation of these enlarged structures would be interesting to perform in future cases to determine possible clinical consequences or any influence on prognosis.

Unlike ultrasonography, laparoscopy allowed detection of adhesions, which have been reported in 47% of calves with umbilical abnormalities[5] and in 7 of 17 (41%) of our calves. Although the influence of adhesions on the prognosis of umbilical infections in calves is unknown, their presence can complicate the surgical procedure, making intraoperative hemorrhage more likely to occur and making dissection

more challenging. Adhesions can prevent mobilization of the umbilical vein when performing a marsupialization and overall increase the surgical time.[1,4] When adhesions exist between the body wall and the bladder (such as in calf 12), it is anticipated that bladder retraction would be more difficult if an apical cystectomy must be performed. If adhesions are numerous and extensive in laparoscopy, the surgical plan can be adapted in order to improve efficiency during the laparotomy. For example, an electrosurgery unit can be prepared, the size and location of the incision could be determined, and the need for more complex procedures, such as intestinal resection, could be evaluated before continuing with the omphalectomy. In one retrospective study reporting umbilical ultrasonography in calves, the accuracy of ultrasound to correctly diagnose all abnormalities in a calf with multiple umbilical defects was poor.[11] Laparoscopy might be advantageous in these cases.

In 23.5% of our calves (4 of 17), laparoscopy failed to detect abnormalities observed with ultrasound or laparotomy, such as small hernias or omphalitis that were not strictly intra-abdominal. In addition, our technique might be further improved using a 30° laparoscope instead of the 0° scope used in our and other studies[15] to detect abnormalities close to the body wall.

Intraoperative ultrasound was recently described as a potential help when operating on calves with omphalophlebitis.[4] It could be an interesting option when detecting mild abnormalities with laparoscopy to decide if removal of these abnormal structures must be performed.

In our study, a high prevalence of umbilical vein abnormalities was found on ultrasound examination when imaging the vein just underneath the abdominal wall. These features were not observed during laparoscopy and subsequent laparotomy. The use of a higher frequency ultrasound[2,4] probe might have allowed a more precise evaluation of the umbilical structures near the body wall, but it was unavailable at the time. The presence of gas within the intestines, rumen, or umbilical abscesses may have also prevented accurate ultrasound assessment of structures close to the body wall. Positioning the calves in dorsal or lateral recumbency during the ultrasound exam could have reduced intestinal gas artifacts.[5,11]

Two of our calves died postoperatively because of septic complications associated with their umbilical disease and probable bacteremia. Septic complications are classically reported in cases of umbilical remnant infection with bacteria spreading through the blood stream and gaining access to remote organs such as joints and carries a poorer prognosis.[4] Despite intraoperative precautions, abdominal contamination might still have occurred in these 2 calves during resection of the infected umbilical remnants. The mortality rate in our study (11.7% for all cases and 33% when considering only calves with deep infection) is greater than previous reports (1.2–10.3%).[4,8] This increase could be explained by our low number of calves and/or by the fact that our calves were housed in groups of 4 to 5 calves after purchase from local farms, possibly contaminating each other despite antibiotic treatment. Other calves in our study developed ventral edema, a frequent complication after umbilical surgeries in young calves that generally resolves spontaneously.[8]

In conclusion, the laparoscopic technique described in our study allows a thorough and fast evaluation of umbilical disorders in young calves with ASA status <3. It allowed detection of abnormalities that could not be explored with ultrasound and certainly might be a useful adjunct to physical examination and ultrasound to fully assess the abdomen in calves. Further cases would be needed in order to determine the therapeutic possibilities of the laparoscopic technique for umbilical disorders in calves.

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DISCLOSURE

The authors declare no conflicts of interest related to this report.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Video Clip S1. Laparoscopic exploration of the umbilical structures in a normal calf used in a preliminary study.