

## CASE REPORT

# Hernia formation after single-stage umbilical vein marsupialization in three Percheron foals diagnosed with septic omphalophlebitis

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**Abstract**

Septic omphalophlebitis is a common disease process with a variety of morbidities and possible mortality. Affected umbilical remnant resection is highly successful but may not always be possible. Umbilical marsupialization can be implemented when total resection cannot be accomplished with minimally reported complications. Umbilical vein marsupialization was performed on three Percheron foals with extensive septic omphalophlebitis using the one-stage paramedian translocation technique and prolonged postoperative antimicrobial therapy. Long-term follow-up revealed herniation at the marsupialization site in all foals. Two foals were subsequently treated with herniorrhaphy at the prior marsupialization site. One foal died due to septic peritonitis with hernia formation 3 months after marsupialization. This case series highlights hernia formation as a potential complication following one-stage umbilical vein marsupialization in foals diagnosed with septic omphalophlebitis and should be considered as a possible postoperative complication.

**KEYWORDS**

foal, hernia, marsupialization, omphalophlebitis, umbilical vein

## 1 | INTRODUCTION

Umbilical remnant infections, specifically septic omphalophlebitis, are one of the most common conditions affecting neonates of all species within the first few days to weeks of life.<sup>1–5</sup> Left undiagnosed, septic omphalophlebitis frequently results in fatal secondary complications, such as septic arthritis, phylitis, pneumonia, diarrhea, intraabdominal adhesions, and/or septicemia.<sup>1,3,4,6–8</sup> Two approaches have commonly been employed for treatment of septic omphalophlebitis: broad-spectrum systemic antimicrobial

therapy and an omphalectomy.<sup>1,3,5,7–9</sup> An omphalectomy is indicated in cases of omphaloarteritis, omphalophlebitis, urachal infection, persistent or patent urachus, or in cases of umbilical infection in which antimicrobials failed to resolve the infection.<sup>1,7,10</sup> Additional surgical indications include cases in which concurrent systemic conditions, such as synovial sepsis or septicemia, are present.<sup>1,7,10</sup> Survival rates have been reported to improve after an omphalectomy compared to antimicrobial treatment alone, with a 66.6% survival rate post-surgical excision compared to a 42.9% survival rate with antimicrobial therapy alone.<sup>7,8</sup>

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Omphalectomies have been well-documented using a ventral midline celiotomy in calves and foals.<sup>6–8,11</sup> Laparoscopic-assisted resection has also been described.<sup>2,12</sup> Cases of septic omphalophlebitis with liver involvement carry a poorer prognosis, with up to 50% mortality due to difficulty resecting all infected tissue.<sup>1,7,9,13,14</sup> For those cases, umbilical vein marsupialization is advocated to promote umbilical vein drainage when complete resection cannot be attained.<sup>1,5–9,15,16</sup> A one-stage or two-stage umbilical vein marsupialization have been described in foals and calves, with both techniques having notable advantages and disadvantages.<sup>5,9,15,17–20</sup> In a one-stage marsupialization, the umbilical arteries and urachus are routinely resected prior to paramedian translocation of the umbilical vein through a separate incision to the right of midline.<sup>9,15–20</sup> Advantages of this technique include a reduced risk of incisional herniation or cellulitis, as well as the need for only one anesthetic event.<sup>9,11,15</sup> Disadvantages include passage of the umbilical vein through the abdomen, allowing the risk for potential peritoneal contamination during translocation.<sup>5,9,20</sup> A two-stage marsupialization incorporates the umbilical vein into the cranial aspect of the incision, but a second procedure is required to remove the umbilical vein remnant and close the remaining body wall defect.<sup>5,14,15,17</sup> Although the advantages of a two-stage marsupialization include a reduced risk of peritonitis and creation of only one incision, there is a significantly increased chance of incisional complications compared to the one-stage technique.<sup>9,14–17</sup>

Currently, there are no reports detailing hernia development following one-stage marsupialization of the umbilical vein in foals. This report describes hernia formation in three Percheron foals following one-stage umbilical vein marsupialization for treatment of extensive septic omphalophlebitis.

## 2 | MATERIALS AND METHODS

The medical records of foals presenting to Iowa State University Lloyd Veterinary Medical Center for umbilical infection between January 2007 and June 2020 were reviewed. Inclusion criteria were foals diagnosed with septic omphalophlebitis involving the liver who were treated surgically by omphalectomy and marsupialization of the umbilical vein. Data retrieved from the medical records were signalment (breed, sex, age), presenting complaint, clinical examination, laboratory and ultrasound findings, surgical details, postoperative management, complications, and outcome.

Five cases were reviewed and included based on the inclusion criteria. Two cases (a 15-day-old Quarter horse

colt and a 6-day-old Morgan colt) did not develop a hernia post-umbilical vein marsupialization and were therefore excluded from the study.

### 2.1 | Case 1

#### 2.1.1 | Clinical presentation

A 7-day-old Percheron colt was presented for evaluation of pyrexia and wet umbilicus. The colt was febrile (39.4°C; reference range: 37.5–38.6°C), but bright, alert, and responsive. The remainder of his physical examination was unremarkable. The external umbilicus was moderately enlarged subjectively, with no heat, pain, or discharge appreciated.

Umbilical ultrasonographic evaluation revealed moderately enlarged umbilical arteries and urachus with an abscess at the caudal aspect of the umbilicus. No additional abnormalities were appreciated on sonographic evaluation. Measurements of the umbilical structures were not recorded. A complete blood count revealed mild leukocytosis (17,050 cells/ $\mu$ l; reference range: 5–12  $\times$  10<sup>3</sup>/ $\mu$ l) characterized by neutrophilia (15,580 cells/ $\mu$ l; reference range: 2.18–6.96  $\times$  10<sup>3</sup>/ $\mu$ l). A serum chemistry revealed mild hyperbilirubinemia (3.6 mg/dl; reference range: 0.7–2.4 mg/dl) and a mildly elevated gamma-glutamyl transferase (GGT; 28 IU/L; reference range: 5–24 IU/L). An omphalectomy was recommended and elected by the owner. Pre-operative ceftiofur sodium (5 mg/kg, intravenously [IV], q 12 h), flunixin meglumine (1.1 mg/kg, IV, q 24 h), and omeprazole (1 mg/kg, orally [PO], q 24 h) were administered.

#### 2.1.2 | Surgery

The colt was placed in dorsal recumbency. A fusiform-shaped skin incision was made around the umbilicus, and sharp dissection was used to enter the abdomen. A one-stage umbilical vein marsupialization was performed due to intraoperative findings of a severely enlarged and friable umbilical vein extending to the liver. The umbilical vein was transected as far cranial as possible without increasing peritoneal contamination risk. For paramedian translocation, a second 6 cm incision was made to the right of midline. The umbilical vein remnant was exteriorized through the paramedian incision and subsequently sutured to the skin in a single layer simple interrupted pattern with USP size 2–0 polyglactone 25 (Monocryl<sup>®</sup>; Ethicon Inc). The remainder of the umbilical remnants was ligated with USP size 2–0

poliglecaprone 25 (Monocryl®; Ethicon Inc), transected distal to the ligatures, and then removed. Abdominal lavage with sterile physiologic saline was performed prior to ventral midline incision closure. The linea alba was closed with USP size 2 polyglactin 910 (Vicryl®; Ethicon Inc) in a simple continuous pattern. The subcutaneous tissue and skin were closed in two separate layers with USP size 2–0 poliglecaprone 25 (Monocryl®; Ethicon Inc) in a simple continuous pattern. An Ioban bandage was placed over the marsupialization site and ventral midline incision for recovery.

Postoperatively, antibiotics (ceftiofur sodium, 5 mg/kg, IV, q 12h; 5 days) and omeprazole (1 mg/kg, PO, q 24h; 6 days) were continued. Flunixin meglumine (1.1 mg/kg, IV, q 24h) was continued for 3 days postoperatively. The umbilical vein was lavaged in dilute chlorhexidine solution twice daily during hospitalization. The foal was discharged after 6 days of hospitalization on trimethoprim sulfamethoxazole (30 mg/kg, PO, q 12h) for 7 days and twice daily spray application of the marsupialization site using dilute chlorhexidine solution.

## 2.2 | Case 2

### 2.2.1 | Clinical presentation

A 2-day-old Percheron colt was presented for lethargy and urine dripping from the umbilicus. The colt was lethargic and febrile (39.2°C; reference range: 37.5–38.6°C) on presentation with a firm and subjectively enlarged external umbilicus with urine dribbling appreciated. Ultrasonographic evaluation revealed moderate enlargement of the umbilical vein extending cranially to the liver and mild right umbilical artery enlargement. Measurements of the umbilical structures were not recorded. IgG stall side snap test revealed partial failure of passive transfer (400 mg/dl; reference range: >800 mg/dl). A complete blood count revealed leukopenia (2840 cells/ $\mu$ l; reference range: 5–12  $\times 10^3$ / $\mu$ l) characterized by neutropenia (1562 cells/ $\mu$ l; reference range: 2.1–6.7  $\times 10^3$ / $\mu$ l), lymphopenia (710 cells/ $\mu$ l; reference range: 1.3–4.5  $\times 10^3$ / $\mu$ l), band neutrophils (256 cells/ $\mu$ l; reference range: 0–0.2  $\times 10^3$ / $\mu$ l), and hyperfibrinogenemia (700 mg/dl; reference range: 100–400 mg/dl). Serum chemistry revealed hyperbilirubinemia (3.52 mg/dl; reference range: 0.7–2.4 mg/dl), an elevated alkaline phosphatase (ALP; 1078 IU/L; reference range: 50–220 IU/L), and an elevated icteric index (5; reference range: 0–2). Initial therapy included an intravenous plasma transfusion 1 L, broad-spectrum antibiotics (ceftiofur sodium 5 mg/kg, IV, q 12h and amikacin sulfate 25 mg/kg, IV, q 24h) and flunixin meglumine (1.1 mg/kg, IV, q 24h).

Forty-eight hours after presentation, hematology revealed persistent leukopenia (2140 cells/ $\mu$ l; reference range: 5–12  $\times 10^3$ / $\mu$ l) characterized by profound neutropenia (663 cells/ $\mu$ l; reference range: 2.1–6.7  $\times 10^3$ / $\mu$ l) and hyperfibrinogenemia (700 mg/dl; reference range: 100–400 mg/dl). A serum chemistry was not performed. Repeat abdominal ultrasound revealed persistent umbilical vein and right umbilical artery enlargement. Ultrasonographic measurements were not obtained. An omphalectomy was recommended and elected by the owner. Due to the extensive nature of the umbilical vein infection appreciated on ultrasonographic evaluation, an umbilical vein marsupialization was also recommended.

### 2.2.2 | Surgery

As described in *Case 1*, a one-stage umbilical vein marsupialization was performed. On surgical exploration, an enlarged, thickened, and friable umbilical vein was identified that extended to the level of the liver. The right umbilical artery was also mildly enlarged. The procedure was performed routinely as described above and the foal recovered from anesthesia uneventfully. Postoperatively, ceftiofur sodium (5 mg/kg, IV, q 12h; 1 day) and flunixin meglumine (1.1 mg/kg, IV, q 24h; 1 day) were continued. The foal was discharged one day postoperatively based on the owner's request, with recommendations to continue antibiotics (ceftiofur sodium 5 mg/kg, intramuscularly [IM], q 12h) for 5 more days.

## 2.3 | Case 3

### 2.3.1 | Clinical presentation

An 8-day-old Percheron filly was presented for evaluation of a wet umbilicus. The foal was bright, alert, and afebrile. The umbilicus was wet and subjectively enlarged on external palpation. The remainder of the physical examination was unremarkable.

Ultrasonographic evaluation revealed moderate enlargement of the umbilical vein and left umbilical artery. Portions of the umbilical stump and umbilical vein appeared hyperechoic, but no acoustic shadowing was noted. Measurements of the umbilical structures were not recorded. A pre-operative complete blood count revealed hyperfibrinogenemia (700 mg/dl; reference range: 300–500 mg/dl) with no other significant findings. A serum chemistry was not performed. Pre-operative antibiotics (procaine penicillin G 22,000 IU/kg, IM, q 12h and gentamicin sulfate 6.6 mg/kg, IV, q 24h) and butorphanol (0.01 mg/kg, IV) were administered.

### 2.3.2 | Surgery

An omphalectomy and umbilical vein marsupialization were performed as described for *Case 1* and *Case 2* due to a subjectively markedly enlarged, friable umbilical vein extending to the liver. Recovery from anesthesia was uneventful. Postoperatively, procaine penicillin G (22,000 IU/kg, IM, q 12h) and gentamicin sulfate (6.6 mg/kg, IV q 24h) were continued for 2 days. Butorphanol (0.01 mg/kg, IV) was administered as needed for pain control postoperatively due to clinician preference. The foal was discharged 2 days postoperatively with instructions to continue antibiotics (procaine penicillin G 22,000 IU/kg, IM, q 12h and gentamicin sulfate 6.6 mg/kg, IM, q 24h) for another 7 days.

## 3 | RESULTS

### 3.1 | Case 1

Twenty-one days post-marsupialization, the colt was re-presented for persistent marsupialization site discharge. The site was patent and draining, although granulation tissue was present within the site. The omphalectomy incision was warm on palpation with no other significant findings. Ultrasonographic evaluation showed an enlarged umbilical vein remnant coursing to the marsupialization site. An elastic tape abdominal bandage was placed over the marsupialization site to reduce risk of hernia formation.

Three months post-marsupialization, the colt developed diarrhea and extreme pyrexia per the owner. The foal died en route to the hospital. The cause of death was determined to be moderate acute fibrinous peritonitis at necropsy. A visible focal 5 cm diameter outpouching of the skin on the anteroventral abdominal midline at the site of the previous umbilical vein marsupialization with reducible, non-strangulating herniated small intestine was also observed. There were firm fibrous adhesions of the proximal ileum and jejunum to the herniated site.

### 3.2 | Case 2

Fourteen months post-marsupialization, the colt was re-presented for a large soft, reducible, 8 cm hernia at the previous marsupialization site ([Figure 1](#)). Peri-operative phenylbutazone (2.2 mg/kg, PO, q 12h) and gentamicin (6.6 mg/kg, IV, q 24h) were administered. An open herniorrhaphy was performed under general anesthesia with the body wall defect repaired using 2 USP polyglactin 910 in a simple interrupted pattern. A hernia belt was placed



FIGURE 1 Case 2—14 months after marsupialization



FIGURE 2 Case 2—17 months after marsupialization

following recovery from anesthesia. The colt was discharged 2 days postoperatively with instructions to continue phenylbutazone (2.2 mg/kg, PO, q 12h, 5 days; then q 24h, 5 days) and stall confinement for 30 days followed small paddock turnout for 30 days.

The colt re-presented 20 days post-hernia repair for incisional dehiscence. Ultrasonographic examination verified the body wall remained intact. The colt was discharged with instructions for continuing stall rest for another 2–3 weeks. Follow-up evaluation 3 months later revealed a small, soft subcutaneous swelling at the location of the previous herniation with an intact body wall ([Figure 2](#)).

### 3.3 | Case 3

Fifteen months post-marsupialization, the filly re-presented for a large soft, reducible, fist-sized hernia at the site of the previous marsupialization ([Figure 3](#)). Peri-operative phenylbutazone (2.2 mg/kg, PO, q 12h) and gentamicin (6.6 mg/kg, IV, q 24h) were administered. An open herniorrhaphy was performed under general anesthesia, and the body wall defect was closed using 2 USP polyglactin 910 in a simple interrupted pattern. The filly was discharged two days postoperation with phenylbutazone (2.2 mg/kg, PO, q 12h, 5 days; then q 24h, 5 days) and instructions for strict stall confinement for 30 days, followed by 30 days small paddock turnout.



FIGURE 3 Case 3–15 months after marsupialization



FIGURE 4 Case 3–18 months after marsupialization

The filly presented for recheck evaluation 20 days post-hernia repair. There was firm thickening of the previous surgical site, but the body wall was noted to be intact and no dehiscence was appreciated. The filly was discharged and instructed to be on stall rest for 2–3 more weeks while the incision continued to heal. Follow-up evaluation 3 months later revealed appropriate healing of the previous surgical site with only mild thickening appreciated (Figure 4).

## 4 | DISCUSSION

Umbilical vein marsupialization in septic omphalophlebitis cases is indicated when extensive infection and hepatic involvement prevents en bloc resection.<sup>1,5–9,15,16</sup> Two umbilical vein marsupialization techniques to encourage sustained drainage of the umbilical vein have been described.<sup>5–7,9</sup> One-stage marsupialization employs a second paramedian incision for umbilical vein translocation while the two-stage marsupialization procedure incorporates the umbilical vein into the celiotomy incision.<sup>5,9,14–20</sup> Reported complications include ascending infection, marsupialization site cellulitis, incisional infection, peritonitis, or abscess formation.<sup>9,16,17,19,21</sup> Umbilical marsupialization site herniation postoperatively is only reported in calves, not foals.<sup>9,16,17,19,21</sup>

Reported advantages of the one-stage technique include a reduced risk of herniation and incisional infection.<sup>9,11,15,17,20</sup> However, one-stage marsupialization has been described in calves, with postoperative marsupialization herniation rates up to 40%.<sup>16,21</sup> A previous study in 1995 reported no herniation in 2 foals treated with

one-stage umbilical vein marsupialization.<sup>9</sup> To the authors' knowledge, this is the first to report herniation as a potential sequela to paramedian single-stage umbilical vein marsupialization in foals.

Marsupialization site herniation is thought to be linked with abdominal wall fragility created through vein translocation or the presence of umbilical infection.<sup>7,15,21–24</sup> This was demonstrated by a study in 2004, where heifers with umbilical infections were 5.65 times more likely to develop a hernia than those without an umbilical infection.<sup>22</sup> Traditionally, the healed marsupialized umbilical vein atrophies and the body wall defect subsequently closes.<sup>11</sup> Umbilical remnant inflammation or infection is presumed to weaken the body wall, therefore delaying umbilical closure.<sup>7,22</sup> A previous study of umbilical herniation in 44 foals reported no association between an umbilical infection contributing to the development of an umbilical hernia.<sup>25</sup> However, in that study, the two foals that developed herniation suffered from minor umbilical infections that were responsive to medical management with antimicrobials.<sup>25</sup> In cases of extensive umbilical infection, as in the present study, antimicrobial therapy may be less effective and lead to the recommendation of surgical intervention to reduce systemic infection, which would therefore increase the risk of secondary herniation.<sup>3,7,8</sup> Postoperative marsupialization site herniation may also be related to continued umbilical vein drainage which could lead to protracted marsupialization site closure and result in postoperative hernia formation.

None of the cases above were treated with the two-stage technique due to surgeon preference and to reduce the necessity for a second surgical procedure. The two-stage technique incorporates the umbilical vein in the linea alba closure, where a small hernia develops that requires closure during a later procedure.<sup>11,15</sup> A reduced risk of peritoneal contamination is reported with the two-stage technique, but the risk of herniation, incisional infection, and dehiscence significantly increases.<sup>14–16</sup> A previous study demonstrated this risk by reporting a 60% secondary herniation rate when umbilical vein marsupialization was incorporated into the incisional closure in calves with omphalophlebitis.<sup>14</sup> Although the cases reported in the present study developed a hernia at the marsupialization site, the risk is suspected to be low as other studies have not reported hernia formation in foals from a one-stage marsupialization.<sup>9</sup>

Previous studies have emphasized the importance of thorough and persistent postoperative management, including prolonged antimicrobial therapy and lavage of the marsupialization site, in order to achieve adequate involution of the infected umbilical vein.<sup>9,14,17</sup> Although there is no proven method to prevent herniation of the

marsupialization site, studies have suggested intraoperative and postoperative management to reduce the risk.<sup>16</sup> Because of the possibility of increased herniation rates when attaching the umbilical vein to the body wall, it has been proposed to perform three-layer fixation of the umbilical vein, incorporating the external rectus sheath, subcutaneous tissues, and skin into closure.<sup>16</sup> Additionally, an abdominal bandage has been suggested postoperatively to support the incision site.<sup>15,20</sup> Future studies evaluating the effect of the three-layer fixation technique and abdominal bandage application on herniation of the marsupialization site would be indicated to determine the impact on herniation rates.

Although the described cases included only Percheron foals, the authors do not believe that Percherons are predisposed to herniation following umbilical vein marsupialization. Of the five included umbilical vein marsupialization cases that were performed during the reported time frame, two were excluded as they did not develop a postoperative herniation, one of which was a Morgan colt and the second which was a Quarter horse colt. The hospital's case load includes a large population of draft breeds, many of which are Percherons. As a result, it is likely that the three described cases are Percherons due to the nature of the hospital's case load, rather than a breed predisposition. As this is the first report of herniation following one-stage marsupialization in foals, future case descriptions and studies would be beneficial to determine whether a breed predisposition exists.

Antimicrobial usage is always recommended when umbilical infections are diagnosed.<sup>7,16</sup> Ideally, antimicrobial therapy should be selected based on bacterial culture and susceptibility of the umbilical remnants.<sup>1,16</sup> Additionally, when marsupialization is performed, prolonged antimicrobial administration has been recommended to reduce the risk of complications associated with the longer duration to resolution.<sup>5,16,17</sup> In the three described cases, the owners declined bacterial culture and susceptibility or a blood culture, so this information was not available when selecting antimicrobials. As a result, broad-spectrum antibiotics and duration of treatment were selected based on clinician preference. It is possible that the prescribed antibiotics were ineffective against the present bacteria or that the duration of therapy was too short to fully resolve the infection. As a result, this could have led to herniation secondary to an unresolved infection. Although this cascade of events cannot be determined, the authors recommend future umbilical marsupialization cases be treated with prolonged susceptible antimicrobials.

In this case series, once-daily gentamicin sulfate was administered to one foal (Case 3) at a 6.6 mg/kg dose as

previously recommended.<sup>26</sup> A later study evaluating the effect of age on the pharmacokinetics of gentamicin sulfate in foals concluded that foals less than 2 weeks of age required a dose of 12 mg/kg every 36 h compared to older foals who required the previously recommended lower 6.6 mg/kg dose.<sup>27</sup> The single case described in which gentamicin was used in a foal occurred prior to the discovery of the change in gentamicin pharmacokinetics, so therefore, the previously recommended 6.6 mg/kg dose was utilized.

This study demonstrates that herniation can occur postoperatively following a one-stage umbilical vein marsupialization technique in Percheron foals diagnosed with septic omphalophlebitis. Consequently, owners should be advised that a herniorrhaphy may be required, although the risk is suspected to be low.

#### AUTHOR CONTRIBUTIONS

Klein C, DVM drafted, revised, and approved the submitted version of the manuscript; Caston S, DVM, DACVS-LA revised the manuscript drafts critically and approved the submitted version of the manuscript; Troy J, DVM, DACVS-LA revised the manuscript drafts critically and approved the submitted version of the manuscript.

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#### CONFLICT OF INTEREST

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

#### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

#### ETHICAL APPROVAL

We confirm that the present study conforms to the ethical standards and guidelines of the journal.

#### CONSENT

Not applicable.

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