Peritoneal Drainage With Fenestrated Balloon Catheters in Standing Horses: A Comparative Study

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One multiple-fenestrated silicone balloon catheter is justified to allow drainage of the abdominal cavity in clinical cases. Authors’ address: University of Lyon, Ecole Nationale Vétérinaire de Lyon, Equine Department, Marcy l’Etoile F-69280, France; e-mail: o.lepage@vet-lyon.fr (Lepage). © 2009 AAEP.

1. Introduction
Prompt and aggressive treatment of peritonitis is often essential in horses. After stabilizing the animal’s condition and correcting the primary cause of peritonitis, abdominal lavage and drainage can be helpful, especially in acute cases. Beneficial effects of abdominal drainage and lavage include the removal and consequent decrease in concentration of bacteria, enzymes, toxins, degenerative neutrophils, and cellular debris in the peritoneal cavity. It also dilutes fibrinogen and fibrin, which decreases adhesion formation.1,2 Different procedures for peritoneal lavage have been documented in adult horses,3–5 but factors such as the abdominal area treated by lavage solutions, optimal methods, ideal catheter materials, and lavage solutions remain to be elucidated. A variety of drainage techniques exist, including open or closed techniques6 and active and passive drainage system.3–5 Inclusion of antiseptics and antibiotics in the lavage fluid are reported to induce chemical peritonitis,3,7 but heparin inhibits fibrin formation and can be added to the lavage solution at 5000 IU/l.8 Usually, 10–20 l of the solution is administered, and it is stopped if signs of discomfort are apparent.2

The purpose of the study reported here was to compare the efficiency of drainage using a multiple fenestrated or a single fenestrated balloon catheter with the hypothesis that the multiple fenestrated silicon balloon catheter would allow better abdominal drainage and be less reactive.

2. Materials and Methods
Twelve adult horses, 4–7 yr of age and weighing between 450 and 590 kg, were used in this experiment. Horses were divided into three groups of four animals. They were kept under the same conditions and had no history of medical disorders in the previous 2 mo. None had undergone abdominal surgery, and there were no abnormal findings on rectal examination. Hematological status was assessed by means of a complete blood cell count, total plasma protein, and fibrinogen concentration. Peritoneal fluid was collected and evaluated for total fibrinogen concentration.
protein concentration, total nucleated cell count, and cytological examination with differential cell count.

Horses were sedated using 0.013 mg/kg of detomidine IV. After a sterile scrub, 5 ml of 2% lidocaine was injected in each paralumbar fossa before inserting the lavage catheter.

Drainage Catheter A: Multiple Fenestrated Silicone Balloon Catheter

In groups 1 and 2, drainage of abdominal fluid was carried out using catheter A, which was a 30-cm, 20-F multiple fenestrated balloon silicone catheter. This catheter is made of medical silicone and has 25 side holes, each measuring 4 mm in diameter, over the proximal 20 cm. It has a 3-cm diameter inflatable balloon that is located 20 cm from its proximal end, and an adjustable locking ring is positioned distal to the balloon and its one cap (Fig. 1). The catheter was inserted into the most ventral part of the abdomen 4 cm to the right of the linea alba. In group 1, a second drainage catheter was placed 4 cm lateral to the linea alba at the level of the umbilicus. The catheters were inserted through a 1-cm stab incision (#11 blade) in the skin and muscle using a metal obturator to puncture the peritoneum. The obturator was inserted through one of the side holes located ~10 cm from the proximal tip of the catheter. The balloon was inflated with 15 ml of demineralized water and gently pulled down so as to place the balloon tightly against the peritoneum. The locking ring was pushed against the skin and locked in position by external compression using a self-locking plastic cable tie. The catheter lumen was closed with the cap supplied with the catheter.

Drainage Catheter B: Single Fenestrated Foley Catheter

In group 3, drainage of abdominal fluid was carried out using catheter B, which was a 16-F latex sili-
cone, single fenestrated Foley catheter (Fig. 2). It was inserted in the same anatomical location as in group 2 (through a 1-cm stab incision using a #11 blade in the skin and muscle) and by means of a standard trocar to cross the peritoneum. After placement in the abdomen, the catheter's cuff was inflated with 5 ml of demineralized water and retracted against the abdominal wall. No sutures were used.

Lavage and Drainage Procedures

**Group 1**
Lavage was carried immediately after catheter placement using a total of 10 l of room temperature (18 ± 3°C) lactated Ringer’s solution (5 l through each paralumbar fossa).

**Group 2**
Lavage and drainage were carried out one time per day for 3 consecutive days using a total of 10 l of warmed (37°C) lactated Ringer’s solution on each occasion (5 l through each paralumbar fossa).

**Group 3**
Lavage and drainage were carried out one time per day for 3 consecutive days using a total of 10 l of warmed (37°C) lactated Ringer’s solution on each occasion (5 l through each paralumbar fossa).

In all groups, abdominal drainage was allowed after the administration of the lavage fluids was complete. In groups 1 and 2, catheters were removed after drainage was complete; in group 3, the catheters were removed after the third procedure.

3. Results

Insertion of the drainage catheters was uneventful, and after removal of the obturator a flow of abdominal fluid was observed in all horses except one. In that horse of group 3, the Foley catheter was inadvertently placed in the retroperitoneal fat. This was confirmed by ultrasound examination, and the catheter was immediately repositioned without difficulty. However, fluid was not recovered the same day in this horse. Catheter A was fixed in place using the balloon cuff and the locking ring without sutures. In one case, the catheter came out on day 2 and was replaced after surgical preparation of the insertion site. Catheter B remained in place in all horses despite not being sutured.

In group 1 (two A catheters and single lavage), >90% of the lavage solution was recovered in a 60-min period. Mean drainage time was 24 min. In 83% of the procedures in group 2 (one A catheter and 3 days of lavage), ≥60% of the lavage solution was recovered in a mean time of 26 min. In group 3 (one B catheter and 3 days of lavage), ≥60% of the lavage solution was recovered in only 4 of 12 drainage procedures (33%) in a mean time of 50 min. In the other 8 procedures, drainage resulted in a mean 22% recovery (0.4–4.2 l) of the lavage solution in a 60-min period. The volume of lavage solution recovered using catheter A (group 2) was significantly higher (p = 0.004) than that recovered using catheter B (group 3). No significant difference (p = 1) was observed between drainage time using one or two multiple fenestrated catheters (group 1 versus group 2). Results of peritoneal fluid analysis are listed in Table 1. Total protein concentration was significantly higher in group 3 (latex silicone catheter) than in group 2 (medical silicone catheter) on day 30 (p = 0.008).

In all groups, edema developed at the site of drainage catheter insertion on day 1. Group 1 animals improved after 48 h. In groups 2 and 3, edema increased until day 3 (up to a maximum of 20 cm diameter around the catheter). Edema regressed after catheter removal to spontaneously resolve by day 7. Omentum prolapsed through the orifice left by catheter A removal in one case. A flow of abdominal fluid was observed in 7 of 12 cases after removal of the drain. Flow ceased within 24 h in affected horses of group 1 (n = 3) and group 3 (n = 2) and within 3 days in affected horses of group 2 (n = 2).

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<th>D1</th>
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<td>41.3 (p = 0.008)</td>
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Table 1. Peritoneal Fluid Analysis
4. Discussion

The multiple fenestrated balloon silicone catheter (catheter A) used in this study was originally designed for use in foals with uroperitoneum, in which drainage of abdominal urine helps to improve ionic disturbances in the blood and decrease risk of general anesthesia. Although it has been used by the authors for many years in adult clinical cases of abdominal or thoracic cavity infection or inflammation (Fig. 3), no objective data to assess its efficacy has been reported.

The position of the cuff in the distal one-third of the multiple fenestrated balloon catheter increases the intra-abdominal length compared with single fenestrated Foley catheters or mushroom drains. In addition, the presence of multiple side holes limits the potential plugging by omentum or fibrin. This catheter is made from medical silicone and may be reused, provided that the clinician adheres to recommendations of the manufacturer. In particular, the cuff should be inflated using demineralized water, because silicone is porous to gas after several days and ionic solutions can cause silicone deterioration, both of which predispose the cuff to failure. Also, different catheter materials have been investigated; PVC has been shown to cause some reaction, whereas medical silicone drains are non-reactive. In our study, the multiple fenestrated balloon catheter was well tolerated based on results from the peritoneal fluid cytological examination in repeated procedures and is less reactive than the Foley catheter.

The proximal extremity of the drain is blind-ended, allowing a metal obturator to be placed inside to act as a rigid guide; this makes insertion into the abdomen through a stab skin incision easy. Also, entering the obturator through a side hole located ~10 cm from the proximal part of the multiple fenestrated balloon catheter rather than through the distal lumen makes its removal easier after its introduction into the abdominal cavity. Drainage sites were chosen 4 cm to the right of the linea alba to avoid damaging the spleen, decrease resistance to insertion, and decrease the risk of infection should a midline laparotomy be required. The presence of a locking ring allowed the catheter to be fixed to the abdominal wall without sutures.

The multiple fenestrated balloon catheter was effective for the collection of lavage fluids in adult standing horses. Over 60% of the lavage solution was recovered in <1 h in 83% of drainage procedures using the multiple fenestrated balloon catheter and in only 33% of the drainage procedures with the Foley catheter (p = 0.004).

Simultaneous insertion of two multiple fenestrated catheters did not significantly decrease the drainage time (p = 1). Therefore, this technique is unlikely to be beneficial in clinical cases. Omental herniation occurred one time, but cathe-
ter site edema was present in almost every case with both types of catheter; this reaction resolved within 1 wk. Clinicians should pay careful attention to local wound and catheter management to avoid retrograde SC infection during that period.

5. Conclusion

The multiple fenestrated balloon silicone catheter assessed in this study provided the most efficient peritoneal drainage in adult normal standing horses. It was less reactive and more efficient at collecting the lavage solution compared with the single fenestrated Foley catheter. Based on this study and on the authors’ experience, this catheter is justified in clinical cases of peritonitis.

References and Footnotes


*Detomidine, Dormosedan, Orion Corporation, Espoo, Finland.*

*2% lidocaine, Xylovet, CEVA Sante’ Animale, France.*

*30-cm, 20-F multiple fenestrated balloon silicone catheter, V-EBDC-20–30.0-LEPAGE, Global Veterinary Products.*

*Metal obturator, V-TCS-119–45, Global Veterinary Products.*

*Standard trocar, 200/805/320, Portex.*