ORIGINAL RESEARCH

Peritoneal Lavage and Drainage with Fenestrated Balloon Catheters in Standing Horses: A Comparative Study

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ABSTRACT

This experimental study compares the efficiency of two fenestrated balloon catheters in allowing drainage of fluid during abdominal lavage in 12 healthy horses. Catheter A (with multiple side holes) or catheter B (with a single side hole) was placed in the ventral abdominal wall. Lactated Ringer's solution was instilled through a catheter in each paralumbar fossa of the standing horse. Drainage was performed through two catheters A in group 1, one catheter A in group 2, and one catheter B in group 3. Drainage was not significantly faster when using two, as compared with one, catheters A ($P = 1$). Amount of fluids recovered was greater using catheter A compared with catheter B ($P = .004$). Abdominal fluid analysis on day 30 was significantly higher ($P = .008$) for total protein in individuals with catheter B compared with catheter A. Use of one multiple fenestrated balloon catheter may be justified in clinical cases that need abdominal lavage and drainage.

Keywords: Abdominal lavage; Abdominal drainage; Balloon catheter; Standing; Horse

INTRODUCTION

Inflammation of the peritoneal lining of the abdominal cavity can be caused by foreign material, bacterial contamination, and bowel trauma. A successful host immune response results in restoration of the mesothelial lining and, eventually, the removal of fibrin by fibrinolysis.[1] However, continued inflammation may result in abdominal abscesses and adhesions.[1] The prognosis of horses with peritonitis depends on the cause, severity, and duration of the initial problem.[2] Published long-term survival rates in horses range from 40% to 84%.[3,4] Poor response to treatment, low peritoneal pH and glucose concentrations, systemic problems such as endotoxemia, laminitis, and ileus, and development of abdominal adhesions are associated with a worse prognosis.[5] Therefore, prompt and aggressive treatment is essential. After stabilizing the animal's condition and correcting the primary cause of peritonitis, abdominal lavage and drainage can be helpful, particularly in acute cases.[6] Lavage and drainage are performed in the standing horse, usually two to three times per day over several days, until the fluid becomes clear or until adequate improvement of the white blood cell count and total protein concentration of the peritoneal fluid is observed.[1]

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.[1,7,8] It also dilutes fibrinogen and fibrin, thus decreasing adhesion formation.[1,7,8] Various procedures for peritoneal lavage have been documented in adult horses[9-11]; however, factors such as the abdominal area treated by lavage solutions, catheter materials, or lavage solutions temperature remain to be elucidated. Two techniques of abdominal lavage have been described: gravity flow and the ascending technique.[9,12] Inclusion of antiseptics and antimicrobials in the lavage fluid are reported to induce chemical peritonitis[9,12]; however, heparin inhibits fibrin formation and can be added to the lavage solution at 5,000 IU/L.[4] Usually 10 to 20 L solution is administered and is stopped if signs of discomfort are apparent.[1] A variety of drainage techniques also exist, including open and closed techniques[13] and active[11] and passive drainage systems.[9,10] Closed drainage was first described using a single Foley catheter; however, fenestrated drains and chest tubes also can be used.[10,11] An open drainage technique has been reported in horses but is associated with incisional infections.[13] Different catheter materials have been investigated, with polyvinylchloride having been shown to cause some reaction, whereas medical silicone drains are nonreactive.[11]

The purpose of the study reported here was to compare the efficiency of a peritoneal lavage-drainage technique between two lavage solution temperatures and between multiple-fenestrated medical silicone balloon catheter and a standard single-fenestrated latex silicone balloon catheter. The authors hypothesized that (1) warmed lavage

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fluids would be better tolerated; (2) the multiple-fenestrated medical silicone balloon catheter would allow better abdominal drainage; and (3) it would be less reactive.

MATERIALS AND METHODS

This project was approved and performed according to the guidelines of the Animal Ethics Committee of the Veterinary School of Lyon.

Twelve standardbred gelding horses, aged 4 to 7 years, weighing 450 to 590 kg, were used. Horses were divided into three groups of four animals each. They were kept under the same stall conditions and had no history of medical disorders over the previous 2 months. None had undergone abdominal surgery, and there were no abnormal findings on abdominal examination per rectum. Hematologic status was assessed by means of a complete blood cell count, total plasma protein, and fibrinogen concentrations. Peritoneal fluid was collected and evaluated for total protein concentration, total nucleated cell count, and cytologic examination with differential cell count.

Three 15 × 15 cm^2 areas of skin were clipped, two centered on each paralumbar fossa and one centered on the most ventral part of the abdomen. In horses from group 1, clipping was extended 5 cm caudal to the umbilicus. The horses were sedated using 0.01 mg/kg detomidine hydrochloride (Domosedan, Pfizer, Paris, France) and 0.02 mg/kg butorphanol tartrate (Torbugesic 1%, Fort Dodge, IA) intravenously. After aseptic skin preparation, 5 mL 2% lidocaine chlorhydrate (Xylovet, CEVA Santé Animale, Libourne, France) was injected at each site of catheter insertion.

Lavage Catheters

A 2-cm stab incision was made using a number 15 scalpel blade in the center of each paralumbar fossa, halfway between the tip of the tuber coxae and the 18th rib, 1 cm proximal to the internal oblique muscle.

After creating an opening with a 10-mm metallic trocar (30103M1, Karl Storz, Guyancourt, France), one silicone lavage catheter (V-EBDC-20-30.0-LEPAGE, Global Veterinary Products, New Buffalo, MI) was inserted in each paralumbar fossa of horses in groups 1 and 2, and a 16-F Foley catheter (Silkolatex Ruch Gold, Kernen, Germany) was inserted in each paralumbar fossa of horses in group 3.

Once in the abdomen, catheter's cuff was inflated with demineralized water, retracted against the abdominal wall, and sutured to the skin. A Luer-lock adaptor was used to connect both multiple- and single-fenestrated catheters to the fluid line.

Drainage Catheters

Multifenestrated Catheter (Catheter A). In groups 1 and 2, drainage of abdominal fluid was carried out using catheter A, which comprised a 20-F external diameter and a 14-F internal diameter, multiple fenestrated balloon silicone catheter (V-EBDC-20-30.0-LEPAGE, Global Veterinary Products, New Buffalo, MI). This catheter is made of medical silicone and has over its proximal part 25 side-holes, each measuring 4 mm in diameter. It has an inflatable balloon, an adjustable locking ring positioned distal to the balloon, and its one cap (Fig. 1).

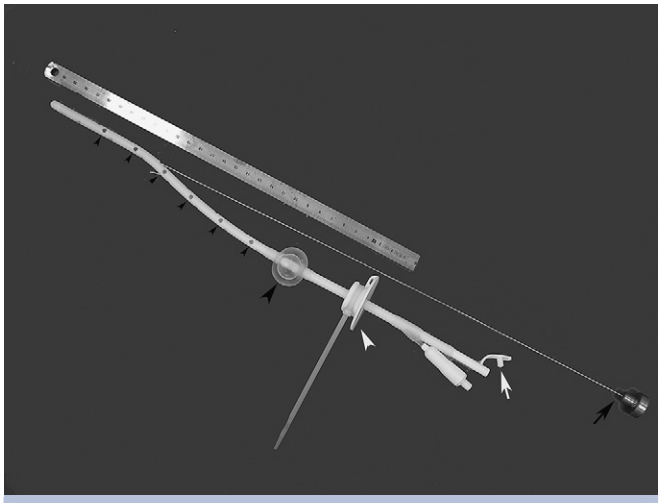

Figure. 1. Catheter A: multiple-side-hole medical silicone balloon catheter used for drainage in group 1 and group 2. Small arrowheads: side holes; big black arrowhead: inflated balloon; big white arrowhead: locking ring with the self-locking plastic cable tie in place; white arrow: catheter cap; black arrow: metal obturator inserted in a proximal side hole.

The catheter was inserted 4 cm to the right of the linea alba into the ventralmost part of the abdomen. In group 1, a second drainage catheter was placed 4 cm to the right of the linea alba at the level of the umbilicus. Catheters were inserted through a 1-cm stab incision (number 11 blade) in the skin and muscle, using a metal obturator (V-TCS-119-45, Global Veterinary Products, New Buffalo, MI) to puncture the peritoneum. The obturator was inserted through one of the side holes located approximately 10 cm from the proximal tip of the catheter. This technique makes removal of the obturator easy once the catheter is inserted. The balloon was inflated with 15 mL 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.

Single Fenestrated Catheter (Catheter B). In group 3, drainage of abdominal fluid was carried out using catheter