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DOI:10.1111/eve.12373

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UNIVERSITÀ DEGLI STUDI DI TORINO

This is an author version of the contribution published on:

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EQUINE VETERINARY EDUCATION, 2015

DOI: 10.1111/eve.12373

The definitive version is available at:

<http://onlinelibrary.wiley.com/doi/10.1111/eve.12373/full>

Clinical evaluation of a jejunoo-jejunal end-to-end anastomosis with skin staples in 5 horses

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No external funding was used for this study

Authors declare no conflict of interests

Authors contribution to the work:

Marco Gandini and Gessica Giusto developed the technique, performed the surgery, wrote and reviewed the paper.

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Keywords: equine, abdominal surgery, end-to-end anastomosis, jejunal, skin staples

Introduction

Colonic skin-stapled one-layer end-to-end anastomosis for the treatment of firearms injuries was first introduced into human medicine by military surgeons (Gandini and Bertuglia 2006). Subsequent studies have documented that skin staplers provide for rapid and effective construction of intestinal anastomosis (Edwards and Galbraith 1998, Fraser 1994). End-to-end jejunoojejunal anastomosis is a common procedure in equine abdominal surgery, and various techniques for constructing small intestine anastomosis have been developed, including one- and two-layer handsewn (Latimer et al. 1998) and with mechanical staplers (Sullins et al. 1985). Although surgery time with automatic mechanical staplers is shorter than with handsewn techniques, the cost is higher. Furthermore, while the end-to-end jejunoojejunal anastomosis with the linear stapler is burdened by a higher risk of complications (Sullins et al. 1985), the creation of functional end-to-end anastomosis with linear staplers appears to be both safe and effective, but expensive.

Skin staplers have been used for anastomosis in human surgery (Fraser 1994, Howell et al. 1991) and in the dog and pig in veterinary medicine (Edwards and Galbraith 1998, Coolman et al. 2000). To date, the use of skin staplers in the horse has been evaluated only in *in vitro* studies (Gandini and Bertuglia 2006). Here, we describe the clinical application of an end-to-end anastomosis technique and report the outcome in 5 horses.

Case history

Five horses were referred to our veterinary hospital because of acute colic. Informed written consent was obtained from the owners prior to exploratory laparotomy. History, including signalment, preoperative examination, blood tests, and medications, was obtained in collaboration with the treating veterinarian. Location of the intestinal lesions, resection length, duration of surgery, postoperative complications, and length of hospital stay were recorded.

The owners were contacted by telephone 12 months after the operation to collect follow-up data. Signalment, lesion location, length of removed intestinal tract, and postoperative complications are presented in Table 1.

Clinical findings

After induction, general anesthesia was achieved with isofluorane (IsoFlo®, Esteve, Italy) in oxygen and the horses were placed in dorsal recumbancy. The abdomen was prepared aseptically with chlorhexidine soap and chlorhexidine alcohol. An approximately 30 cm ventral mid-line abdominal incision was created. The abdomen was explored, the intestinal decompression performed and the affected intestinal tract exteriorized. In horse no. 5, a scrotal approach was also required allowing for reduction, resection, and anastomosis of the incarcerated intestine. The mesenteric arteries of the intestinal tract to be removed were ligated with a suture of 2-0 polydioxanone sulfate (Ethicon, Johnson&Johnson, Italy) with two sliding knots proximal to the resection site and distally with one knot. Hartmann clamps were applied to the segment to be resected, the jejunum was resected at a 60° angle to the antimesenteric border. Three inverting sutures were placed to reappose the two segments for anastomosis (Gandini and Bertuglia 2006). The first suture was placed on the mesenteric border, and the other two sutures were placed at equal distances from one another and the first suture along the circumference of the intestine. Light traction on the stay sutures was applied and the borders were gently inverted. Skin staples (Visistat R35, Weck) were then applied about 1-2 mm from one another along the entire circumference of the intestine (Gandini and Bertuglia 2006). In all patients except horse 5 the anastomosis was covered with a mesenteric flap, as previously described (Gandini and Bertuglia 2005). The abdomen was then rinsed with 10-15 L Ringer's lactate solution. The abdominal incision was closed with a two-layer technique. Finally, a protective stent was placed over the wound and removed 24 h after recovery from anesthesia.

Treatments

During the preoperative stage, Ringer's lactate solution (40-80 mL/kg/h IV) to compensate initial dehydration, flunixin meglumine (1.1 mg/kg IV), unless recently administered by the treating veterinarian, antibiotic prophylaxis ampicillin sodium (10 mg/kg IV TID) and gentamicin sulfate (6.6 mg/kg IV SID). and, if tetanus immunization was not up to date, tetanus antitoxins were administered. During the intraoperative stage, continuous infusion with maintenance fluids was continued with Ringer's lactate (20-40 mL/kg/h IV), lidocaine (Lidocaine®, Esteve, Italy) with an initial bolus (1.3 mg/kg IV) then continuous infusion (0.05 mg/kg/min IV) and dimethyl sulfoxide ([DMSO] 1 g/kg in 5 L glucose solution 5%).

Postoperative treatments

Postoperative treatment included administration of continuous rate infusion of Ringer's lactate (20-40 mL/kg/h IV) as needed (as determined by monitoring of packed cell volume and prothrombin time every 4 h), continuous rate infusion of lidocaine (Lidocaine® 0.05 mg/kg IV) for 24 h after initial bolus (1.3 mg/kg IV), and DMSO (1 g/kg in 5 L glucose solution 5%). Low-dose flunixin meglumine (0.50 mg/kg IV SID then 0.25 mg/kg IV TID) and calcium nadroparin (40 IU/kg SC TID) were administered. Antibiotic therapy was with ampicillin sodium (10 mg/kg IV TID) and gentamicin sulfate (6.6 mg/kg IV SID).

All horses were allowed free access to water 12 h postoperatively. Horses were refed at 25% of their energy intake 24 hours following resolution of postoperative ileus. If they tolerated refeeding intake was increased to 50% and 90% at postoperative days 3 and 4, respectively. (Valle and others 2014). Anastomosis was performed by an expert surgeon (MG) with an assistant. The duration of surgery (from the first incision to the final suture) ranged from 110 to 185 min (mean duration, 139.6 min).

Recovery from anesthesia was unremarkable. During the postoperative period, horses 2, 4, and 5 developed gastric reflux (at least 2 L every 4 h) over 24, 32, and 60 h, respectively (Gandini et al. 2005). During the first postoperative days, forced chewing without ingestion of food was induced in horses 4 and 5 to help to reduce the risk or treat existing postoperative ileus (Giusto et al. 2014).

All horses were discharged on postoperative day 10. Owners were contacted by telephone 12 months following discharge from the hospital for follow-up. Follow-up information obtained included, the horses current general health status, did the horse regain their previous level of activity, and the current diet.

Discussion

This is the first report to describe the use of skin staplers for *in vivo* end-to-end jejunojejunal anastomosis in the horse. This rapid and effective technique offers numerous advantages, including rapid creation of jejunal anastomoses, optimal tensile strength and stoma dimension that preserves anatomic and physiological normality to the intestinal tract. A further advantage is that less handling of intestines is needed for applying the staples. Added to this is its lower cost as compared to suturing with mechanical staplers. Its potential disadvantages are the lower hemostatic effect at the anastomosis site. In this patient series, no clinically overt signs of bleeding or anastomosis dehiscence were noted. To minimize these risks the anastomoses were constructed using healthy intestinal tissue, at the cost of removing a slightly longer segment than the strangulated portion.

Owners were contacted by telephone 12 months postoperative to collect long-term follow-up information. None of the horses were reported to manifest abdominal pain or other complications and all resumed normal diet and returned to pretreatment activity levels. In all horses except no. 5, the anastomosis was covered with a mesenteric flap to prevent the formation of adhesions (Gandini and Bertuglia 2005). While we cannot be certain that this procedure was truly effective in preventing adherences, no cases of postoperative colic were reported.

The novel technique described in this report was a safe and effective method of performing end-to-end jejunojejunal anastomosis for the treatment of strangulating lesions in the horse. Based on the results of previous research and this case series this technique should be considered as a viable anastomotic technique in the horse.

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