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Laparoscopic Hernioplasty in Recumbent Horses Using Transposition of a Peritoneal Flap

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Objective—To evaluate the efficacy of a laparoscopic peritoneal flap hernioplasty (PFH) to close anatomically the vaginal ring and to evaluate its protective effect in horses with a history of strangulated inguinal hernia (SIH) against future herniation.
Study Design—Prospective study.
Animals—A first group of 5 ponies, 3 horses and 1 donkey with no history of SIH and a second group of 4 horses 'clinical cases' with a history of SIH.
Methods—A laparoscopic PFH was effected on all horses under general anaesthesia. Peritoneum ventro-lateral to the vaginal ring was elevated and cut on 3 sides, separated from the underlying muscle, then inverted and attached dorso-medially and laterally to the parietal wall using intracorporeal stitches (6 cases) or laparoscopic staples (7 cases). Animals of the first group (n = 9) underwent a standing laparoscopy 7 days post-operatively to visualize the vaginal rings. Horses of the second group were followed to confirm the absence of re-herniation.
Results—The laparoscopic check-up showed that the vaginal ring had been effectively and completely covered in all cases except the first one. No adhesions was observed. In the four clinical cases, none of the horses have had a reccurence of SIH at the time of writing (6 months to 4 years).
Conclusion—Laparoscopic hernioplasty on a recumbent horse is feasible by closing the vaginal ring with a peritoneal flap. This technique was efficient in our cases to prevent recurrence of SIH but more cases are needed. This technique may reduce inflammation and irritation of the spermatic cord, which could otherwise jeopardise the animal's breeding career.
Clinical Relevance—Laparoscopic PFH coud be used in horses with a history of SIH.

INTRODUCTION

ACQUIRED INGUINAL herniation is rare in stallions. Indirect herniation, with passage of viscera through the vaginal ring, is most common in horses in contrast with humans where direct herniation (passage of viscera through a body wall defect adjacent to the vaginal ring) is most common. The likelihood of inguinal hernia is related to the size of the vaginal ring[1–4] with Standardbred and European Warmblood horses seemingly having a higher incidence than other breeds.[1] After correction of inguinal herniation by repositioning or removal of herniated viscera, recurrent herniation can be prevented by laparoscopic closure of the vaginal ring.

In breeding stallions, testicular preservation after inguinal herniation is important for subsequent fertility. Conventional surgical management of inguinal herniation often involves reduction of the herniated viscera, and hemicastration with attempted closure of the internal and external inguinal rings. Laparoscopic herniorrhaphy techniques can preserve testicular function and are recommended in stallions with a history of inguinal hernia. Our purpose was 2-fold: to evaluate the efficacy of a peritoneal flap hernioplasty (PFH) to close the vaginal

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ring and to evaluate the protective effect of PFH in horses with a history of strangulated inguinal hernia against recurrent herniation.

MATERIALS AND METHODS

Animals

Experimental PFH. Five ponies, 3 horses, and 1 donkey (aged 2–4 years, weighing 180–400 kg) without evidence of inguinal hernia were used. Four had unilateral PFH and 5 had bilateral PFH; all were castrated laparoscopically 7–12 days after PFH.

Clinical PFH. Four horses with a history of inguinal herniation were treated by PFH. Previously, inguinal herniation had been managed by surgical reduction (n = 1), digital manipulation per rectum (2), or spontaneous reduction (1). Effective closure of the vaginal ring was evaluated by rectal palpation 1 month postoperatively. Absence of recurrent herniation was assessed by regular phone calls to the owners between 8 months and 4 years postoperatively.

Preoperative Preparation and Anesthesia

Food but not water was withheld for 36 hours before surgery. Procaine penicillin (20,000 IU/kg intramuscularly [IM]), gentamicin sulfate (6.6 mg/kg intravenously [IV]), and phenylbutazone (4.4 mg/kg IV) were administered preoperatively. After sedation with romifidine (0.08 mg/kg IV), general anesthesia was induced with diazepam (0.04 mg/kg IV) and ketamine (2.2 mg/kg IV). Anesthesia was maintained with halothane in oxygen using intermittent positive pressure ventilation and horses were positioned in dorsal recumbency. A urinary catheter was placed and the caudal abdomen was clipped, aseptically prepared, and draped. The laparoscopy tower was placed caudal to the horse.

Surgical Technique (Fig 1)

A 12 mm median stab incision was created 1 cm caudal to the umbilicus, the peritoneum bluntly perforated, and a 30° laparoscope (Optomed, Les Ullis Cedex, France) was introduced. The horse was positioned in 30° Trendelenburg position. The abdomen was insufflated with CO_2 until the vaginal rings were visible, which generally corresponded to $\leq$ 15 mm Hg intra-abdominal pressure. Portals 2 and 3 were created $\sim$ 7 cm (pony) to $\sim$ 12 cm (horse) craniolaterally to each external inguinal ring under laparoscopic guidance. Peritoneum ventrolateral to the internal inguinal ring was elevated and cut on 3 sides, then separated from the underlying muscle using laparoscopic scissors (Optomed) to form a flap of 6 cm × 4 cm (ponies) or 8 cm × 5 cm (horses; Figs 1 and 2).

For this procedure, laparoscopic scissors were introduced on the ipsilateral side and Babcock forceps (Optomed) on the

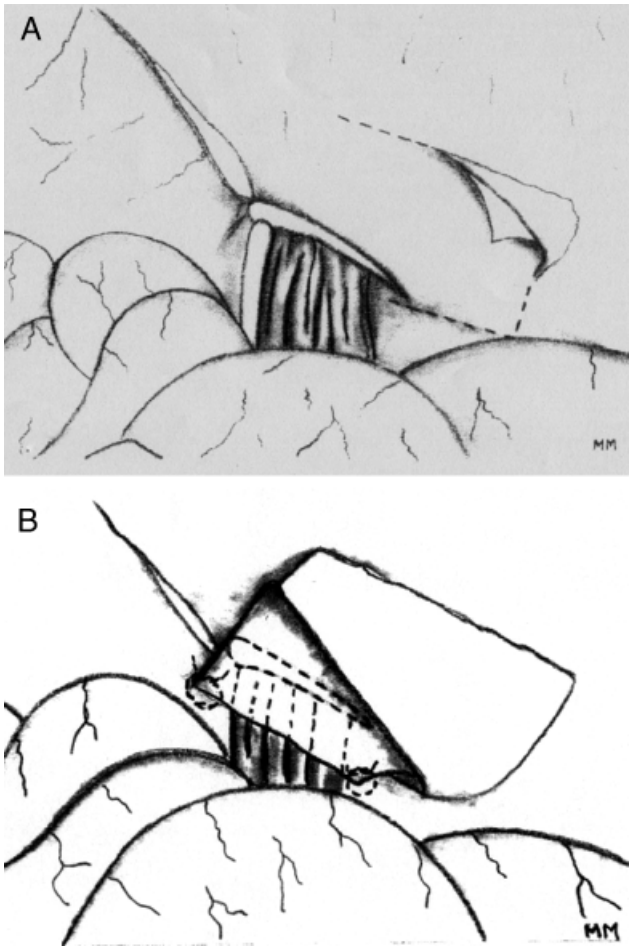

Fig 1. Illustration of the right vaginal ring viewed laparoscopically in dorsal recumbency. (A) Relationship of the intended peritoneal flap to the vaginal ring. (B) Rotation of the peritoneal flap and suture fixation.

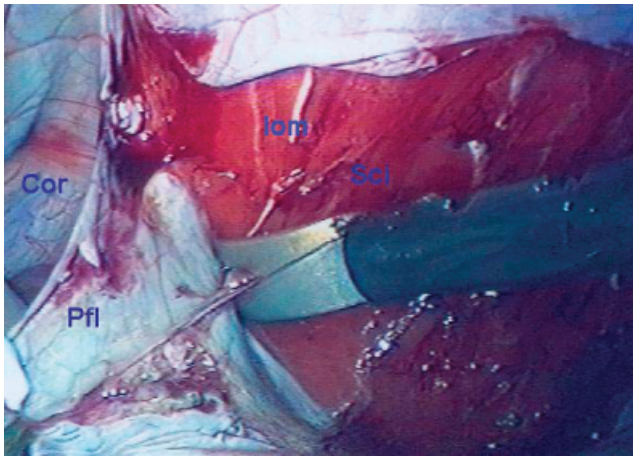

Fig 2. Right vaginal ring. Laparoscopic view in dorsal recumbency showing dissection of the peritoneal flap. Sci, scissors; Pfl, peritoneal flap; Cor, testicular cord; Iom, internal oblique muscle after peritoneal flap removal.

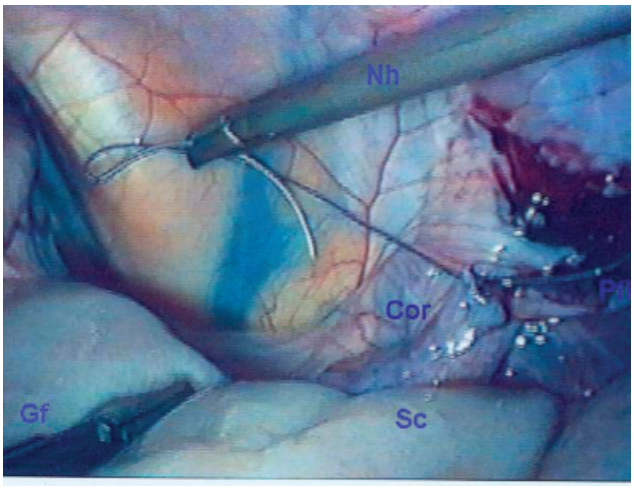

Fig 3. Passage of the needle medial to the vaginal ring to attach the flap. Pfl, flap; Co, testicular cord; Sc, small colon; Nh, needle holder; Gf, grasping forceps.

contralateral side. The flap was inverted, moved dorsomedially to cover the vaginal ring, and attached medially and laterally to the parietal wall, 2 cm dorsal to the ring. Two simple intracorporeal sutures using 3 metric braided lactomer 9–1 (Polysorb- Tyco/Vetoquinol: Magny-Vernois, Lure Cedex, France) were used in 6 cases (Figs 1, 3, and 4) whereas laparoscopic helicoidal staples (Protack- Tyco/Vétoquinol) were used in 7 cases (Fig 5). With the latter technique, it was sometimes necessary to create one more instrument portal on each side, between the laparoscope and the first instrument portal to position the stapling device perfectly perpendicular to the tissue. Flap security was tested manually before closure (Fig 6). If necessary, an additional suture or staple was added. Incisions were closed in 1 layer using 2 simple interrupted skin sutures.

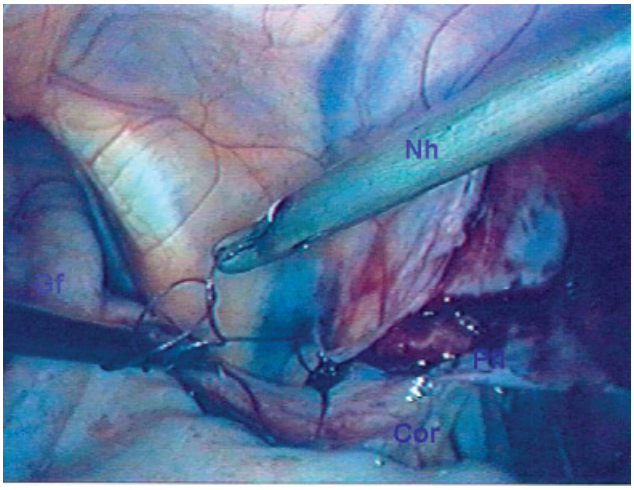

Fig 4. Tying the intra-corporeal knot. Pfl, flap; Co, testicular cord; Nh, needle holder; Gf, grasping forceps.

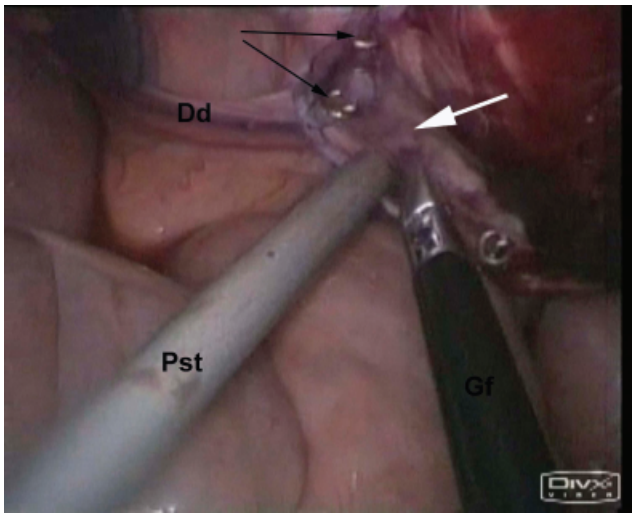

Fig 5. Right vaginal ring. Fixation of the peritoneal flap using helicoidal staples. Dd, Deferent duct; Gf, grasping forceps; Pst, protack stapling device; Note the position of the flap (large white arrow) and the helicoidal staples (black arrows).

After recovery, parenteral antibiotics were continued for 24 hours and anti-inflammatory drug treatment for 3 days. Each horse or pony was hospitalized for a minimum of 7 days, after which the first group (n = 9) had standing laparoscopy to visualize the vaginal rings and perform castration by the technique of Rijkenhuizen.[5] The PFH was considered anatomically effective if the entry to the vaginal ring was not visible. Flap adherence was assessed manually by probing with Babcock forceps, the site of peritoneal defect was observed, and any adhesions noted (Fig 7). Endoscopic images of each vaginal ring were recorded. The horse or pony was monitored clinically for 8 days before hospital discharge.

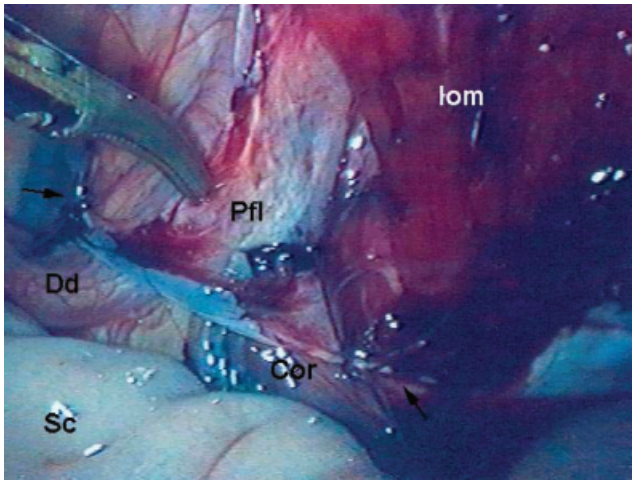

Fig 6. View of flap covering the vaginal ring just after suture. Dd, deferent duct; Pfl, flap; Co, testicular cord; Iom, internal oblique muscle; Arrows, points of attachment.

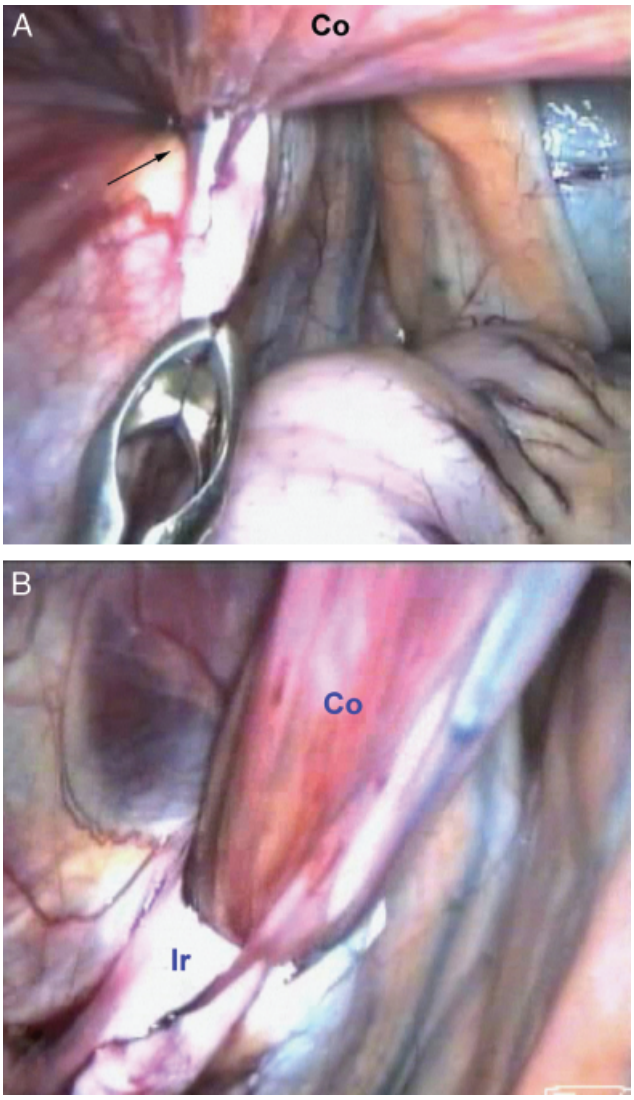

Fig 7. (A) Laparoscopic view of the right inguinal region during standing laparoscopy, 2 weeks after peritoneal flap hernioplasty, Co, testicular cord; Bc, babcock forceps; Arrow, Inguinal ring covered by the flap. Note the remodeling of the tissue and the absence of any adhesions. (B) Same view after traction on the spermatic cord. Co, testicular cord. Note complete obturation of the inguinal ring (Ir).

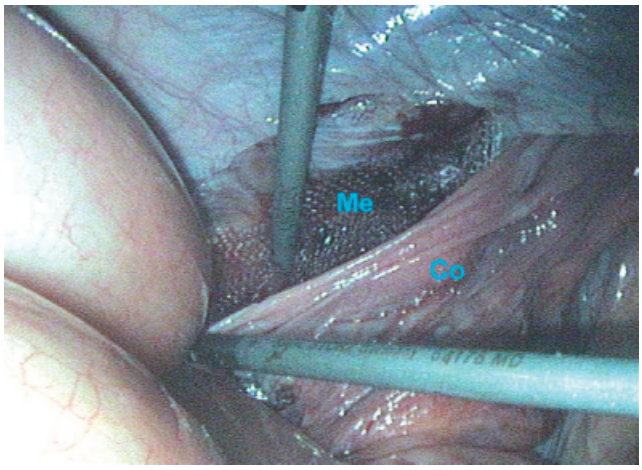

Fig 8. Retroperitoneal non-absorbable mesh implantation. Co, testicular cord; Me, mesh. Diagram 1a: Visualisation of left vaginal ring ("internal inguinal ring") under standing coelioscopy. Normal vaginal ring. Diagram 1b: Enlarged vaginal ring. Diagram 2a, 2b: Coelioscopic diagram on dorsal recumbency. Right inguinal ring: dissection of the peritoneal flap. Diagram 2c: Coelioscopic diagram on dorsal recumbency. Right inguinal ring: Fixation of the flap over the inguinal ring.

Clinical Cases

Case 1. An 11-year-old Dutch Warmblood stallion was admitted with acute abdominal pain associated with an inguinal hernia. The herniated content was reduced digitally under general anesthesia. The intestinal tract and vaginal ring were assessed by diagnostic laparoscopy. Although the intestine was viable, bilaterally enlarged vaginal rings were observed, so bilateral hernioplasty by Fischer's technique[6] using a nonabsorbable mesh implant was performed (Fig 8). Three months later, the stallion was referred for chronic recurrent colic. On repeat laparoscopy, bilateral intestinal adhesions were observed to the mesh implant sites. The adhesions were dissected free and a stapled PFH performed after dissection of the peritoneum and mesh removal. Postoperative management included 1 month of hand walking before return to training.

Case 2. A 4-year-old Westphalian Warmblood stallion was admitted with a history of left inguinal herniation, small intestinal resection, hemicastration, and vaginal ring closure. The right vaginal ring was enlarged ($\sim$ 15 cm on rectal palpation); therefore, a stapled PFH was performed on the right side.

Case 3. An 8-year-old Hanoverian stallion was admitted with acute signs of abdominal pain and inguinal herniation. The stallion had a history of recurrent left-sided inguinal incarceration with secondary intestinal strangulation obstruction, which had last been reduced under general anesthesia 4 weeks earlier. Bilateral inguinal closure was achieved by stapled PFH.

Case 4. A 5-year-old French Warmblood stallion was admitted with a strangulated left inguinal hernia and a request for surgical closure of both vaginal rings. The stallion had a history of herniation on 2 previous occasions, both of which had resolved spontaneously. Both vaginal rings were enlarged on rectal examination; bilateral PFH was performed using intracorporeal sutures.

RESULTS

Observation of the vaginal rings in the 30° Trendelenburg position was excellent and no problems with general

anesthesia, positioning, or abdominal distension occurred. We were able to cover all vaginal rings with the dissected peritoneal flap, which did not tear and there was no hemorrhage of consequence. Mean surgical time was 45 minutes per ring and surgical time decreased with experience so that it became possible to close each ring in 25 minutes. Tying the intracorporeal knots proved easy after practice and was made easier by good instrument triangulation. Intracorporeal suturing allowed stronger, more secure attachment of the peritoneal flap, but was technically more challenging and took longer compared with staples. No postoperative complications were observed; however, long-term repeat laparoscopy was not performed.

On 7 days recheck laparoscopy in the experimental equids, the vaginal ring had been effectively and completely covered in all except horse 1, where there was only partial coverage probably because of surgical inexperience. In the others, the vaginal ring was no longer visible and it was impossible to enter the inguinal canal. The peritoneal defect over the flap source was covered with scar tissue. The flap was usually weakly adhered to the spermatic cord and this adhesion was easy to break down by applying traction to the cord. Beneath the flap adhesion, the spermatic cord appeared normal. No adhesions were observed between the viscera, the flap, or its donor bed.

There was no recurrence of inguinal hernia in the 4 clinical cases (follow-up, 6 months to 4 years). Three stallions (1–3) were being used for breeding with normal fertility and 1 (4) had returned to high-level show jumping. Horses 1, 3, and 4 had rectal palpation and it was impossible to insert a finger into the inguinal canal. No morphologic changes were noted in the scrotal area.

DISCUSSION

Closing the vaginal ring without castration is recommended for breeding stallions that have had inguinal herniation, whether they have been reduced surgically or not.[7] The size of the vaginal ring may be correlated with the probability of inguinal herniation. In the 6 stallions described by Mariën,[7] all had enlarged and flaccid rings, as did in our cases. We have noted variation in the size and shape of the vaginal rings during standing laparoscopy. Larger, flaccid funnel-shaped rings have been observed and it is our impression that these horses may have an increased risk of inguinal herniation.

Congenital inguinal herniation has been observed in foals. Typically, spontaneous, gradual reduction occurs as the foal grows so that by 12 months of age the hernia has disappeared. This condition is genetically linked and many breed organizations forbid breeding from affected horses.[8] Nonetheless, in severe cases, it is sufficient to simply close the vaginal ring by celioscopic stapling after reduction of the herniated viscera.[9] In adult horses, because of the higher intra-abdominal forces that may occur, this approach may be insufficient[6,9] and techniques that improve resistance to muscular forces associated with movement and intra-abdominal pressure may be necessary.[9] Fischer et al[6] reported an adaptation of human surgical technique called transabdominal preperitoneal mesh repair (TAPP) for herniorrhaphy in 2 stallions in Trendelenburg position, under general anesthesia. Polypropylene mesh was positioned under a peritoneal flap, collapsing the neck of the vaginal tunic and decreasing the size of the vaginal ring, and secured in position with laparoscopic staples. Tissue ingrowth into the mesh leads to scarring and prevents re-herniation. In our experience, mesh placement was time consuming and the mesh had to be positioned very close to the spermatic cord to be effective. The TAPP technique is reportedly successful in prevention of direct hernias in man by resisting high intra-abdominal pressure. It may be less well adapted to the anatomy of the inguinal area in horses where indirect hernias are more frequent and where reinforcement of the peri-inguinal area seems unnecessary.

Adhesions after hernioplasty are described in men, although TAPP and total extraperitoneal (TEP) hernioplasty techniques decrease this risk (2.79% for TAPP, 0.57% for TEP techniques).[10] In our clinical cases, the first horse had the TAPP technique. It was technically difficult to totally cover the mesh with peritoneum and the horse developed adhesions postoperatively. Further dissection of the peritoneum laterally might have improved this coverage. Although PFH was successful in this horse, dissection of the flap was more difficult during the second surgery.

Recently, a simpler technique that involves insertion of polypropylene mesh (rolled into a cylinder and stabilized with 2 sutures) into the vaginal canal during standing laparoscopy has been reported.[7] After insertion of the mesh into the inguinal canal, the proximal or both proximal and distal sutures are cut using laparoscopic scissors allowing the mesh to unfurl and fill the canal. The proximal part of the mesh is then secured to the parietal peritoneum using endoscopic staples. Subsequent granulation tissue is supposed to obliterate the inguinal canal.

In both mesh techniques, polypropylene is in close contact with the spermatic cord. In men, testicular[11] and infertility with or without atrophy of the testis[12] are reported after mesh implantation. This may be caused by ischemic orchitis, immunologic reactions, or surgical trauma to the spermatic cord. Although good local tolerance has been reported in horses, sterility may potentially occur similarly because of mesh contact with the spermatic cord whereas there is no mesh implant using

PFH. Thus, foreign body reaction or irritation of the spermatic cord should not occur with PFH. Surgical compression and irritation could occur after scar formation and wound contraction, although this has not been observed clinically.

Leaving an area of denuded abdominal wall may cause adhesions, although we did not observe this on 7-day repeat laparoscopy. Others have described the closing of the vaginal ring in standing normal horses by apposition of the cranial and caudal edges, either by endoscopic staples or sutures[13,14] but long-term outcome has not been described.

The Trendelenburg position, in combination with CO_2 pneumoperitoneum, is associated with deleterious cardiovascular effects that are more apparent in heavier horses undergoing positive pressure ventilation. Blood gas analysis and arterial pressure monitoring are therefore mandatory during these procedures.[15] We observed cardiovascular depression as described previously. Withholding food decreases visceral weight on the diaphragm improving ventilation and is also important for enhancing observation of the inguinal region in the Trendelenburg position. For bilateral herniorrhaphy in large and very heavy horses, use of stapling instruments could be beneficial in reducing surgical time and minimizing the time needed in Trendelenburg position.

Laparoscopic herniorrhaphy in recumbent horses is feasible by closing the vaginal ring with a peritoneal flap. We found the procedure simple and effective, especially using staples. We believe the technique may reduce inflammation and irritation of the spermatic cord, which could otherwise jeopardize subsequent fertility. Successful use of this technique in standing horses would further reduce the risks and costs associated with general anesthesia.

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