Laparoscopic Colopexy in Dogs

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(Received 11 December 2012/Accepted 11 April 2013/Published online in J-STAGE 25 April 2013)

ABSTRACT. Colopexy was accomplished in eight healthy mixed-breed dogs by use of a 3-portal laparoscopic technique without major intra-operative and postoperative complications. A permanent adhesion between the colon and the abdominal wall was observed. Concentrations of acute-phase C-reactive protein (CRP) were measured in serum as a marker of systemic inflammation postoperatively, and no relevant increase in CRP concentrations was found.

KEYWORDS: C-reactive protein, canine, colon, colopexy, laparoscopic.

Rectal prolapse is a common condition in dogs with intestinal parasites and severe diarrhea [1]. Straining to defecate or urinate can cause rectal prolapse. It can also occur in association with dystocia, prostatic disease, perineal hernia, rectal neoplasia and rectal foreign bodies [18]. Prophylactic colopexy is performed to prevent occurrence in dogs predisposed to it. Colopexy, a permanent adhesion created between the descending colon and the left abdominal wall to prevent rectal prolapse, is an effective preventative measure [18, 21].

Colopexy has been achieved through celiotomy in dogs [4, 13, 19]. Interest in minimally invasive techniques has increased; laparoscopy is a minimally invasive technique that permits observation of the abdominal organs, especially the organs that are sometimes challenging to directly observe in open surgery [1, 15], and compared with traditional open surgery, it has many advantages, such as a minimal incision [25], less pain [10] and fewer postoperative complications [7]. Laparoscopic-assisted colopexy has been reported in dogs [15, 22]. Under laparoscopic observation, the colon was exteriorized and sutured to the abdominal wall, which was incised to a length of approximately 5 cm during colon exteriorization. We are unaware of a reported method for laparoscopic colopexy in dogs.

A generalized state of immune suppression was induced by surgical trauma, which potentially increases the risk of infections [8]. Acute-phase cytokines (APPs) have been utilized to provide a more objective, quantitative measure of operative trauma [2]. Thus, the purpose of the study reported here was to describe a laparoscopic technique for colopexy in 8 healthy dogs and investigate the systemic inflammatory response to the surgical procedure.

MATERIALS AND METHODS

Animals: The study was approved by the Animal Ethics Committee of the Northeast Agricultural University (Harbin, China). Adult mix-breed dogs (n=8), aged 0.8 to 5 years and weighing from 15 to 25 kg, were used in this study. All dogs were determined to be healthy on the basis of results of physical examination and a complete blood count (CBC).

Surgical preparation: Prior to the procedure, food and water were withheld for 12 and 6 hr, respectively, to empty the gastrointestinal tract. Ampicillin sodium (20 mg/kg, IM) was administered preoperatively. Each dog was pre-medicated with atropine (0.04 mg/kg) subcutaneously, and approximately 15 min later, the dog was administered intramuscularly ketamine (20 mg/kg) and xylazine (1.5 mg/kg), respectively. Dogs were positioned in dorsal recumbency with all 4 legs tied. The ventral abdomen (from the xiphoid to the pubis and to each inguinal fold) was shaved, aseptically prepared and draped for surgery. Anesthesia monitoring consisted of electrocardiogram, saturation of oxygen, indirect arterial blood pressure, respiratory rate and rectal temperature and was recorded prior to the induction of anesthesia, 10 min after the creation of a pneumoperitoneum and then every 20 min until the procedure was finished; arterial blood gases were also determined.

Surgical procedure: A Veress needle was inserted perpendicularly to the peritoneal cavity on the midline, 1–2 cm cranial to the umbilicus, while the surgeon and 1 assistant elevated the ventral abdominal wall using 2 towel clamps. An aspiration and injection test was performed to verify the position of the needle within the abdominal cavity using a 5-ml syringe containing 5 ml of sterile saline (0.9% NaCl) solution. Then, the Veress needle was connected to an automatic high-flow CO₂ insufflator (Olympus, Hamburg, Germany) to insufflate the abdominal cavity to an intra-abdominal pressure of 10 mmHg with carbon dioxide. The standard 3-cannula laparoscopy technique was used (Fig. 1). Once a pneumoperitoneum was created, the insufflator was closed, and the Veress needle was removed and replaced with the first trocar-cannula (10/11 mm, blunt,
triangular, guarded) unit. Once the first cannula was in place, the blunt trocar was removed, and the insufflator was connected to the cannula to maintain an intra-abdominal pressure of 10 mmHg. A rigid laparoscope (0°, 10 mm in diameter, 330 mm long, Olympus) with an attached videoendoscopic camera and light source (Olympus) was introduced into the peritoneal cavity through the first cannula. A brief exploration of the abdominal cavity was performed to ensure that the insertion of the trocar had not caused any lesions to the viscera. Then, the laparoscope was angled caudally to identify the colon. The other 2 trocar-cannulas were placed under laparoscope guidance. The 2nd trocar-cannula (5/5.5 mm, sharp, triangular, unguarded) unit was located 5 to 8 cm caudal to the first cannula and 8 to 12 cm to the right of the ventral middle region. The 3rd trocar-cannula (10/11 mm, sharp, triangular, unguarded) unit was located 12 to 16 cm caudal to the 1st cannula and 8 to 12 cm to the right of the ventral middle region.

A laparoscopic left-curved preparation forceps (330 mm long, 30°, left-curved jaws, Olympus) was introduced through the 2nd cannula, and the antimesenteric section of the descending colon was grasped when it was placed in its anatomical position. A small gauze sponge was inserted into the abdominal cavity through the third cannula, the gauze sponge was grasped by a second left-curved preparation forceps introduced through the 3rd cannula, and the areas to be sutured on the serosa of the colon and on the peritoneum were then lightly abraded. The gauze sponge was pulled out of the peritoneal cavity using the second left-curved preparation forceps through the 3rd cannula.

USP 2–0 polyglycolic acid sutures (swaged, taper point 1/2 circle needle, 38 mm) were used for the colopexy. The needle was formed into a 3/8 circle curve and inserted through the 3rd cannula with a 10-mm laparoscopic needle driver (330 mm long, Olympus). The intracorporeal suturing technique was used to perform the colopexy. The needle and suture material were grasped by the laparoscopic needle driver, passed through the rectus abdominis muscle in a dorsal to ventral direction and then passed through serosal and muscularis layers of the colon in a transverse direction (Fig. 2). The intra-abdominal pressure was decreased to 6 mmHg to reduce tension between the ventral body wall and the colon. Beginning caudally, a simple interrupted suture was placed. The intra-abdominal pressure was returned to 10 mmHg and maintained. The other 5 sutures were placed by use of the same technique (Fig. 3).

Carbon dioxide was evacuated from the abdominal cavity by opening the cannulas. The laparoscopic cannulas were removed after the abdomen was decompressed. Skin incisions for all portals were closed; the 10 mm portals were closed in 2 layers, and the 5 mm portal was closed in 1 layer. The dogs recovered from anesthesia unequivocally. Operative time and intraoperative and postoperative complications were recorded. Operative time was defined as the time between the initial stab incision and closure of the last portal.

Postoperative care and monitoring: Ampicillin sodium (20 mg/kg, IM) was administered three times a day for 5 days after surgery. Feeding with paste food was indicated. Postoperative monitoring consisted on subjective assessment of the dog (general attitude and appetite) and inspection of the skin incisions (swelling, heat and pain). Objective evaluation of its general health was based on a physical examination (rectum temperature) once daily for 7 days and blood examination (white blood count and C-reactive protein).

Blood examination: Peripheral blood samples were obtained prior to anesthesia, 6 hr after the procedure and on days 1, 3, 5 and 7 after surgery. WBC was measured by hematology analyzer. Serum CRP levels were measured by enzyme-linked immunosorbent assay. Peripheral blood samples were collected with a vacuum collection tube in the early morning before food and allowed to clot at room temperature for about 30 min. Then, the tubes were centrifuged for 10 min at 3,000 × g, and the obtained serum stored at −80°C until analysis.

Postmortem and histologic examination of colopexy sites: A month after surgery, dogs were euthanatized to evaluate the colopexy sites. The adhesions and surrounding colon and abdominal wall muscle were collected and placed into 10% neutral buffered formalin for histologic examination. 

Open colopexy: A ventral midline was performed from the level of the umbilicus to 8–10 cm caudal to the umbilicus. The descending colon was located and exteriorized. A 3–4 cm longitudinal incision was made along the antimesenteric border of the descending colon through only the serosal and muscular layers without mucosal penetration, and a similar incision was made on the left abdominal wall 2.5 cm from the linea alba through the peritoneum and underlying muscle. Each edge of the colonic and abdominal wall inci-
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Laparoscopic colopexy in dogs was performed using a laparoscopic technique. The surgical procedure involved minimal incisions and resulted in a shorter surgical time compared to open colopexy. No complications were observed during the procedure, and bowel movement was normal during the study.

Statistical analysis: Standard statistical methods were used for the analysis of all results. Data are reported as means ± SD. Statistical differences were determined by one-way ANOVA. The significance level was established as P<0.05. Statistical analysis of data was performed with computer software (SPSS, SPSS Inc., Chicago, IL, U.S.A.).

RESULTS

Surgical procedure: We successfully performed colopexy in 8 healthy dogs using a laparoscopic technique. Laparoscopic colopexy in dogs resulted in only two 10-mm incisions and one 5-mm incision in the body wall, and the total length of all incisions was approximately 2.5 cm. Mean surgical time defined as the time from the initial stab incision to closure of the last portal was 64 min and ranged from 58 to 74 min. Mean surgical time of open colopexy was 40.75 min and ranged from 36 to 49 min. No complications occurred during insertion of the trocar-cannula units. The hemorrhage was negligible during suture of the colon and abdominal wall. Leakage from the colon and infection did not occur clinically. Bowel movement was normal during the study.

There was an increase in blood pressure after insertion of the trocars, and a further increase occurred during suture of the colon and abdominal wall; it subsequently decreased, but remained higher than the baseline after closure of the portals. The mean heart rate did not differ between the registered phases. The intraoperative saturation of oxygen was always>90% and tended to be from 93.63 ± 2.97 to 96.87 ± 0.25. However, hyperthermia ranged from 36.00 ± 1.00 to 38.93 ± 0.25 during laparoscopy. The mean arterial pH was 7.32 (± 0.07), ranged from 7.26 to 7.41 and decreased during laparoscopy. The rectal temperature returned to within the reference range at 24 hr after surgery, and arterial pH returned to within the reference at the end of the operation.

WBC: The highest white blood count during the postoperative period was 25.77 × 10^9/l (SD, 11.25 × 10^9) at day 1, and ANOVA revealed significant differences in WBC between time points. Mean WBC was significantly higher than the baseline value (median ± SD, 11.73 ± 4.19 × 10^9/l) at 6 hr (24.73 ± 6.09 × 10^9/l, P<0.05) and 1 day (P<0.05) postoperatively and were not significantly different at 3 days (median ± SD, 11.70 ± 5.10 × 10^9/l, P=0.995), 5 days (11.93 ± 5.26 × 10^9/l, P=0.970) and 7 days (11.70 ± 3.77 × 10^9/l, P=0.995) postoperatively.

CRP concentration: The highest serum CRP concentration during the postoperative period was 1.39 mg/dl (SD, 0.08) at day 1, and the mean CRP was significantly higher than the baseline value (median ± SD, 0.85 ± 0.26 mg/dl) at 1 day (P<0.05) and 3 days (1.29 ± 0.23 mg/dl, P<0.05) postoperatively and not significantly different at 6 hr (median ± SD, 0.98 ± 0.15 mg/dl, P=0.463), 5 days (0.98 ± 0.33 mg/dl, P=0.467) and 7 days (0.87 ± 0.18 mg/dl, P=0.917) postoperatively. The concentration returned to the pre-surgical level by seven days postsurgery. The CRP concentrations in open colopexy at the six stages were 0.85 mg/dl (SD, 0.23), 1.41 mg/dl (SD, 0.20), 2.51 mg/dl (SD, 0.60), 1.88 mg/dl (SD, 0.32), 1.31 mg/dl (SD, 0.16) and 0.94 mg/dl (SD, 0.21), and the mean CRP level increased significantly at days 1 and 3 after surgery (P<0.05). There were statistically significant differences in serum CRP levels between laparoscopic co-
lopopexy and open colopexy at 6 hr, 1 day and 3 days after surgery ($P<0.05$) (Fig. 4).

Postmortem and histologic examination of colopexy sites: Necropsy revealed firm adhesions between the serosal surface of the descending colon and the abdominal wall in all dogs (Fig. 5). A tight focal fibrous adhesion connecting the colon and parietal peritoneum was present. No other abdominal abnormalities were found. The adhesions were characterized by a thick band of well-organized fibrous connective tissue. This mature connective tissue moderately to markedly infiltrated the adjacent abdominal wall muscle (Fig. 6). The fibrous connective tissue was composed of collagen fibers and fibroblasts (Fig. 7).

DISCUSSION

Laparoscopic colopexy has been reported in humans and horses [3, 5, 11, 24]. In the present study, we successfully performed laparoscopic colopexy in 8 dogs without intraoperative or immediate postoperative complications. The laparoscopic colopexy procedure is simple, safe and effective, and compared with the traditional abdominal cavity

![Fig. 5. Necropsy revealed firm adhesions between the serosal surface of the descending colon and the abdominal wall. C, colon; Bw, body wall; white arrow, the adhesions.](image)

![Fig. 6. Histological evaluation of the adhesion, surrounding colon and abdominal wall (hematoxylin and eosin, 10 × 4). Bw, body wall; Iw, intestinal wall; Ec, enteric cavity; As, the adhesion site.](image)

![Fig. 7. Histological evaluation of adhesion site (hematoxylin and eosin, 10 × 10). Cf, collagen fibers; F, fibroblasts.](image)
approach, it confers benefits related to observation of the colon, postoperative complications, such as infection and abdominal wall hernia and return of bowel function.

Prolapse of the rectum causes significant discomfort because of the sensation of the prolapse itself and the mucus that it secretes and because it tends to stretch the anal sphincters. The specific goals of management of rectal prolapse are to eradicate the external prolapse of the rectum, improve bowel function and reduce the risk of recurrence. Treatment of rectal prolapse includes conservative treatments and surgery, and the former always proves inefficient; thus, surgery is the primary choice. Colopexy is a surgical technique to permit a permanent adhesion between the colon and the abdominal wall, fixing the colon in place, and includes incisional colopexy and nonincisional colopexy. Some believe that the incisional method would provide a more permanent colopexy [23], and some have suggested that both methods are equally effective in preventing rectal prolapse [21]. In the present study, the nonincisional method was adopted, and a gauze sponge was used to promote consistent surgical adhesions with light abrasion of conjunctive tissue.

When performing colopexy, the colon was lightly advanced forward in the abdomen while avoiding excess tension on the colon. Laparoscopic intracorporeal suturing skills were required; 6 simple interrupted sutures were placed within the body cavity during laparoscopic colopexy. The key point regarding sutures was not penetrating the lumen of the colon, as this can result in infection at the colopexy site and failure to form an adhesion between the colon and the abdominal wall. Thus, each suture penetrated only the serosal and muscularis layers of the colon. In the present study, necropsy revealed firm adhesions between the serosal surface of the descending colon and the abdominal wall in all dogs subjected to the nonincisional suture technique with skilled laparoscopic intracorporeal suturing. The laparoscopic colopexy technique described here should be evaluated further in clinical cases of rectal prolapse in dogs.

In small animal veterinary practice, colopexy is often performed in combination with other surgical procedures depending on the therapeutic purpose, the most common case being resolution of perineal hernias. For the treatment of perineal hernias, the use of cystopexy and colopexy has been described [9]. Although the combined surgery is reasonable, sole colopexy is practical, not only for perineal hernias but also for rectal prolapse. Maute et al. [16] believed that colopexy, vasopexy, cystopexy and castration were elective therapies for the treatment of perineal hernia. Rectal prolapse is a common disease in dogs and cats, and colopexy is an efficient method to solve it [21, 23]. For the reason of combined surgery is more practical, laparoscopic colopexy combined with other surgical procedures should be evaluated further.

The combination of laparoscopic and conventional accesses has been described in dogs for performance of colopexy [15]. In that report, laparoscopic-assisted colopexy attached the colon and the abdominal wall successfully. But, compared with the laparoscopic technique, laparoscopic-assisted colopexy was more or less invasive, as it resulted in 5-cm-long skin wound. In our laparoscopic colopexy technique, the total length of all incisions was 2.5 cm. Laparoscopic intracorporeal suturing skills were required during attachment of the colon and the abdominal wall, and these are different from the in vitro suturing skills used in laparoscopic-assisted colopexy. Intracorporeal suturing represents a newly acquired skill for most surgeons [17], and it has been used in laparoscopic tube cystostomy in dogs [26]. It is a skill that requires practice to perform efficiently; thus, the surgical time required to complete the laparoscopic colopexy may have decreased with additional experience.

Determinations of APPs are increasingly common in monitoring of the postoperative period [6]. APPs, such as haptoglobin, CRP and serum amyloid A, provide valuable diagnostic information in the monitoring of systemic inflammation [20]. In the present study, serum CRP concentrations increased significantly compared with baseline values at day 1, were higher than the baseline values at days 3 and 5 surgery and returned to baseline at day 7. Laparoscopic colopexy serum CRP levels were significantly lower than those with open colopexy at 6 hr, 1 day and 3 days after surgery. CRP is one of the proteins quickly released in the bloodstream during the acute phase response, and it is recognized as one of the essential clinical examination items in human medicine [12, 15]. The upregulation of CRP 1 day after surgery and return of CRP to baseline levels at 7 days after surgery in the present study indicate that tissue inflammation associated with the overall surgical procedure was short-lived, as reported in other laparoscopic techniques in dogs [14, 15], and the statistically significant lower postoperative serum CRP levels in laparoscopic colopexy compared with open colopexy also support use of this procedure.

In the present study, we used necropsy and histological examination to evaluate the colopexy sites, and they both revealed firm adhesions between the descending colon and the abdominal wall. We also investigated the systemic inflammatory response to the surgical procedure and compared the CRP values under this technique with those under conventional open colopexy. For the first time, our study not only proved the feasibility and efficiency of laparoscopic colopexy but also evaluated the systemic inflammatory response to the surgical procedure.

REFERENCES