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Case Report Rapport de cas

Bilateral intracorporeally sutured inguinal herniorrhaphy using 3-dimensional laparoscopy in a dog

Maureen A. Griffin, Ingrid M. Balsa, Philipp D. Mayhew

Abstract — A 7-month-old, intact male, mixed breed dog with bilateral inguinal hernias underwent general anesthesia for laparoscopic bilateral inguinal herniorrhaphy *via* a 3-port approach. A 3-dimensional laparoscopic system was used to perform the procedure immediately following prescrotal open castration. Intracorporeal suturing with polypropylene was performed, and 2 cruciate sutures were placed to close each inguinal ring. The caudal aspect of each inguinal ring was left slightly open so as not to disrupt the passage or patency of vessels and nerves. No intra- or post-operative complications occurred. One year after surgery, the dog has no evidence of recurrence of the inguinal hernias.

Key clinical message:
This case report demonstrates a novel minimally invasive approach to inguinal herniorrhaphy in a dog with no reported complications and a good long-term outcome. Intracorporeally sutured inguinal herniorrhaphy is feasible in dogs with good results, although additional cases are needed to gain experience with this technique in dogs with varying presentations of inguinal hernias.

Résumé — Herniorraphie inguinale bilatérale suturée intra-corporellement par laparoscopie tridimensionnelle chez un chien. Un chien de race mixte, mâle, intact, âgé de 7 mois, avec une hernie inguinale bilatérale, fut mis sous anesthésie générale pour une herniorraphie inguinale bilatérale laparoscopique *via* une approche à trois voies. Un système laparoscopique tridimensionnel a été utilisé pour effectuer la procédure immédiatement après la castration préscrotale ouverte. Une suture intracorporelle avec du polypropylène a été réalisée et deux sutures croisées ont été effectuées pour fermer chaque anneau inguinal. L'aspect caudal de chaque anneau inguinal a été laissé légèrement ouvert afin de ne pas perturber le passage ou la fonctionnalité des vaisseaux et des nerfs. Aucune complication per- ou postopératoire n'est survenue. Un an après la chirurgie, le chien ne présente aucun signe de récidive des hernies inguinales.

Message clinique clé :
Ce rapport de cas démontre une nouvelle approche minimalement invasive de la herniorraphie inguinale chez un chien sans complications signalées et un bon résultat à long terme. Une herniorraphie inguinale suturée de manière intracorporelle est réalisable chez les chiens avec de bons résultats, bien que des cas supplémentaires soient nécessaires pour acquérir de l'expérience avec cette technique chez les chiens présentant des présentations variables de hernies inguinales.

(Traduit par Dr Serge Messier)

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Inguinal herniorrhaphy in dogs is typically performed *via* an open surgical approach, either directly over the inguinal ring or alternatively on the ventral abdominal midline to allow for concurrent abdominal exploration. Herniorrhaphy involves appropriate reduction of herniated contents (with possible additional treatment/excision of those contents depending on viability) and creation of a secure closure of the defect using strong, healthy, surrounding native tissues if possible (1). In humans, laparoscopic techniques, including laparoscopic intracorporeally sutured herniorrhaphy, are commonly used for treatment of inguinal hernias and are associated with good outcomes and low recurrence rates (2,3). To date, few reports of minimally invasive inguinal herniorrhaphy exist in dogs and are limited to experimental models of the disease. One experimental study on 12 beagle dogs (11 females, 1 male) with indirect inguinal hernias used laparoscopic closure of the abdominal opening of the patent processus vaginalis *via* staple application. Seven of these dogs were euthanized 7 to 14 wk after surgery, and no recurrence of herniation was detected at the time of euthanasia; however, long-term follow-up data were not obtained (4).

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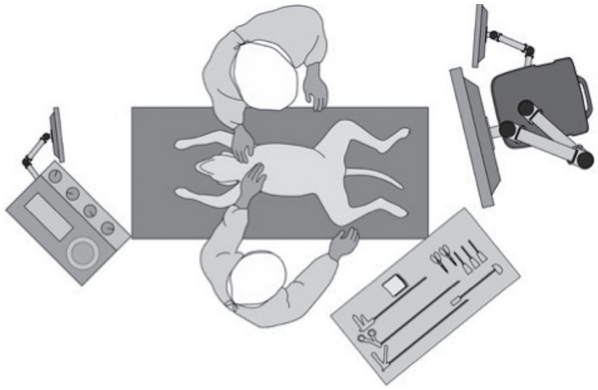

Figure 1. Intraoperative schematic of operating room setup with the tower and monitor at the caudal aspect of the dog and the surgeon and assistant on opposite sides of the dog.

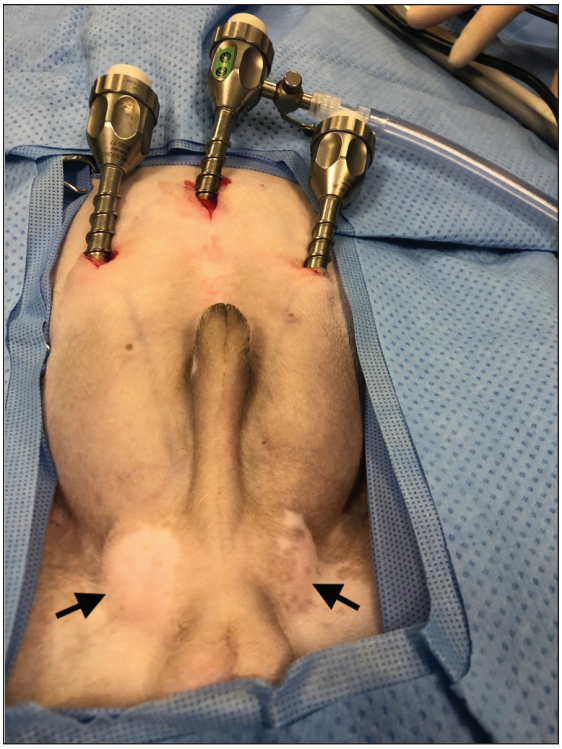

Figure 2. Intraoperative view of 3-port (6 mm) placement. Arrows demonstrate the insufflated bilateral inguinal hernias.

Two other experimental studies on healthy, male, mixed breed dogs without inguinal hernias were done using a natural orifice transluminal (transgastric) endoscopic approach for bilateral inguinal herniorrhaphy using several implant systems: AlloDerm (Lifecell; Branchburg, New Jersey, USA) and Bioglue (CryoLife; Keneesaw, Georgia, USA) (5,6). All dogs in these studies were euthanized immediately after or 14 d following the procedure, and evaluation afterwards showed adequate placement and coverage of the implants (5,6). No long-term data were available, and these treatments were not performed on dogs with naturally occurring disease (5,6).

To date, there are no documented reports of laparoscopic intracorporeally sutured herniorrhaphy for treatment of inguinal hernias in dogs. Minimally invasive surgery in dogs is commonly associated with multiple benefits including reduced post-operative pain, faster return to function, smaller and more cosmetic incisions, and potentially reduced morbidity including reduced surgical site infection (7–11). In addition, 3-dimensional (3D) laparoscopy has been used increasingly in human minimally invasive surgery and provides improved precision, hand-eye coordination, and depth perception compared with traditional laparoscopy (12).

The authors theorize that a laparoscopic intracorporeally sutured inguinal herniorrhaphy technique in dogs may provide these benefits and allow adequate exposure, permanent herniorrhaphy, and good outcomes with low risk of recurrence. Furthermore, the authors postulate that the use of a 3D telescope during inguinal herniorrhaphy provides similar benefits to those reported in human surgery.

Case description

A 7-month-old, intact male, mixed breed dog was presented to our institution for evaluation and treatment of bilateral inguinal hernias as well as castration. The dog was adopted from a shelter 5 mo prior to presentation and was noted to have bilateral inguinal hernias at that time. No previous history was known, and the hernias were presumed to be congenital. The dog was systemically healthy with no vomiting, diarrhea, coughing, or sneezing, a normal appetite and energy level, and normal urination and defecation. On physical examination, the dog weighed 3.7 kg and had a body condition score of 4/9. His vital parameters were within normal limits (temperature: 38.4°C, heart rate: 140 beats/min, panting). The bilateral inguinal hernias were ~2 to 4 cm in diameter and the contents were readily reducible. The dog had bilaterally descended scrotal testes. The remainder of his examination was unremarkable.

Results of pre-anesthetic laboratory tests were within normal limits. An abdominal ultrasound showed bilateral inguinal hernias with fat and a segment of jejunum extending through the left inguinal ring. The remainder of the abdominal ultrasound findings were unremarkable. Based on the presumed congenital nature of the hernias, the cardiovascular stability of the patient and the lack of vital sutures in the hernias, laparoscopic repair of the hernias was deemed reasonable.

The dog underwent general anesthesia: premedication with hydromorphone (Dilaudid; Fresenius Kabi USA, Lake Zurich, Illinois, USA), 0.05 mg/kg body weight (BW), IM, and dexmedetomidine (Dexdomitor; Zoetis, Parsippany, New Jersey, USA), 3.0 µg/kg BW, IM. Anesthesia was induced with propofol (Diprivan; Fresenius Kabi USA), 2.0 mg/kg BW, IV, and midazolam HCl (Hospira; Lake Forest, Illinois, USA), 0.2 mg/kg BW, IV, and was maintained with sevoflurane (Ultane; Abbott Laboratories, Chicago, Illinois, USA) in 100% oxygen. The dog was positioned in dorsal recumbency, and the ventral abdomen and preputial regions were clipped, prepared for aseptic surgery, and draped. The dog's urinary bladder was voided before surgery. Upon positioning the dog in dorsal recumbency, no herniated contents were palpable in the inguinal sites due to the easily reducible nature of the hernias. The dog was placed in a

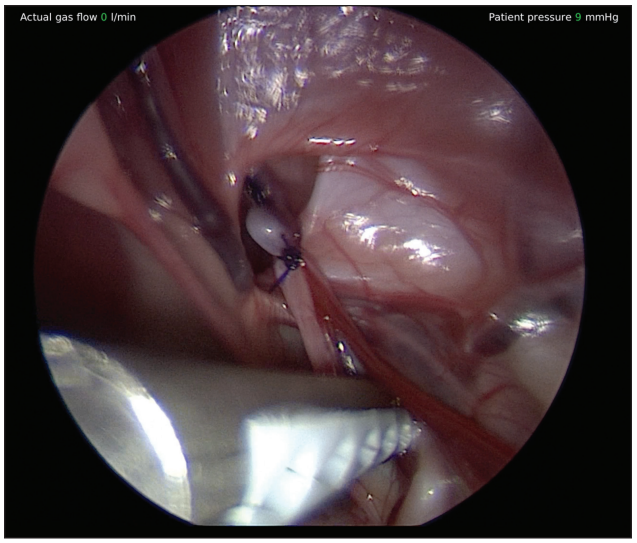

Figure 3. Laparoscopic manipulation of the vas deferens to reduce into abdominal cavity prior to herniorrhaphy. Suture ligations from open prescrotal castration are visible.

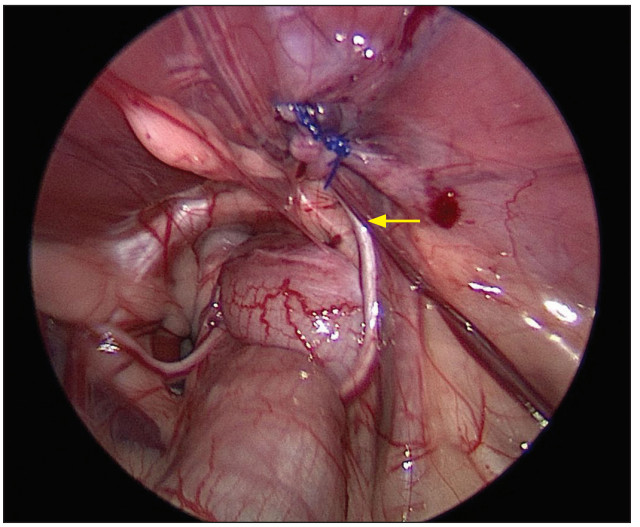

Figure 4. Repair of right inguinal hernia with Prolene cruciate sutures as described. Arrow – vas deferens and testicular vessels.

Trendelenburg position, and the laparoscopy tower and monitor were positioned at the dog's caudal aspect (Figure 1).

A routine prescrotal open castration was performed bilaterally. The 2 surgeons were then positioned at each lateral aspect of the dog facing the monitor caudally, and both surgeons wore 3D glasses throughout the procedure. A 3-port technique was used. A 6-mm telescope portal was established 2 cm cranial to the umbilicus using a modified Hasson technique with a threaded trocarless cannula (Endotip; Karl Storz, Tuttlingen, Germany). The peritoneal cavity was insufflated to 8 to 10 mmHg. The abdomen was briefly explored with a 4-mm 3D Storz telescope (TipCAM 1 S 3D LAP; Karl Storz). A second 6-mm Endotip cannula was placed in the left lateral abdominal wall slightly caudal to the umbilicus and approximately 10 to 15 cm cranial to the left inguinal ring region under visual guidance. A third 6-mm Endotip cannula was inserted in similar fashion in the right lateral abdominal wall. Abdominal insufflation resulted in concurrent insufflation of both inguinal regions (Figure 2).

Right-angle laparoscopic forceps (Karl Storz) were placed through each of the lateral ports, and the vas deferens with adjacent testicular vasculature was grasped and retracted cranially. The spermatic cord sutures placed in the prescrotal region were visible through each inguinal ring but could not be released into the abdomen due to additional tissue attachments superficial to the deep inguinal ring (Figure 3).

Laprascopic atraumatic grasping forceps were removed and laparoscopic needle drivers (Microline Surgical, Beverly, Massachusetts, USA) were inserted into each lateral cannula. Approximately 10 cm of 2-0 Prolene suture on a CT-2 needle (Ethicon; Johnson & Johnson, New Brunswick, New Jersey, USA) was passed transabdominally. Closure of the right inguinal hernia was performed first. Intracorporeal suturing was performed in a cruciate pattern beginning at the cranial aspect of the deep inguinal ring, engaging the rectus abdominis fascia medially and inguinal ligament laterally. To obtain greater purchase through strong fascial tissues, suture bites were deepened to incorporate components of the external inguinal ring (external abdominal oblique aponeurosis) on both the lateral and medial aspects. The CT-2 needle proved large and cumbersome to manipulate in the working space. Therefore, after the first cruciate suture, 2-0 Prolene on an RB-1 needle (Ethicon; Johnson & Johnson) was used for all remaining intracorporeal suturing. Ideal suture length to facilitate knot tying was approximately 15 cm. After all bites were taken with the needle for each suture, the needle was cut from the suture with a laparoscopic hooked scissors (Karl Storz), and the needle was passed transabdominally and removed from the abdomen. Two cruciate sutures were placed to close the right inguinal hernia. No further defect was palpable in the inguinal region and subcutaneous insufflation of the hernia no longer occurred. The same procedure was performed for the left inguinal hernia closure. The external pudendal vessels and genitofemoral nerve were readily visible at the caudal aspect of each inguinal canal, and these regions were not sutured closed in order to maintain patency of those structures (Figure 4).

The pneumoperitoneum was subsequently relieved. The port sites were closed with 2-0 PDS (Ethicon; Johnson & Johnson) in an interrupted pattern in the linea and abdominal musculature. The subcutaneous tissue and skin were closed with 3-0 Monocryl (Ethicon; Johnson & Johnson) in a buried cruciate pattern.

No intraoperative complications were noted and appropriate herniorrhaphy was confirmed after surgery. The total procedure time was 172 min. The dog was administered hydromorphone (Dilaudid; Fresenius Kabi USA), 0.05 mg/kg BW, IM, and meloxicam (Metacam; Boehringer Ingelheim, Duluth, Georgia, USA), 0.1 mg/kg BW, PO, once after surgery. The dog was hospitalized for monitoring overnight, no evidence of recurrence of herniation or complications were noted. The dog was discharged

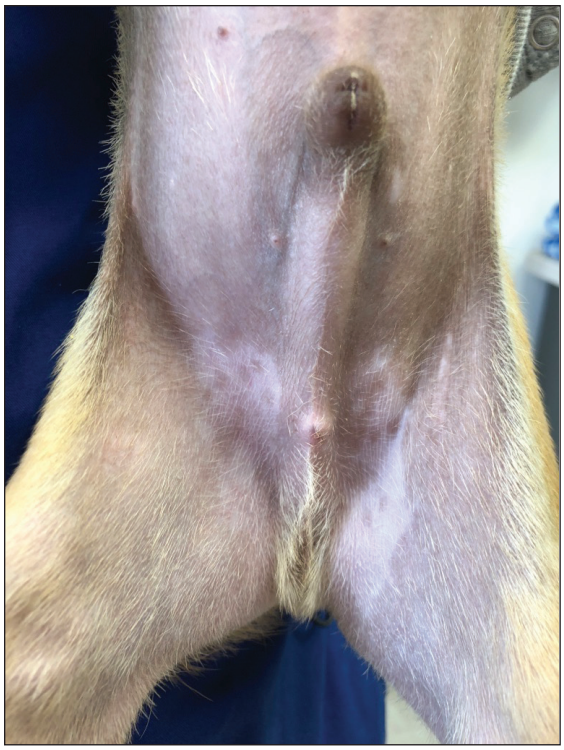

Figure 5. Physical examination performed 2 wk after surgery did not reveal evidence of failure of herniorrhaphy or recurrence of inguinal hernias.

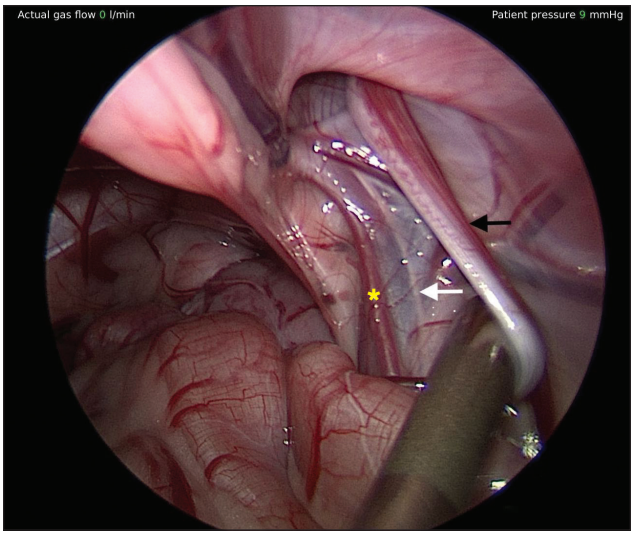

Figure 6. Intraoperative laparoscopic view of the right inguinal ring/hernia. Black arrow – vas deferens and testicular vessels; yellow asterisk – external pudendal vessels; white arrow – genitofemoral nerve.

1 d after surgery with instructions for restriction of activity for 10 to 14 d, E-collar use, and general and incisional monitoring. He was discharged with meloxicam 0.1 mg/kg BW, PO, to be given once daily for 7 d.

The dog was re-presented to our hospital 2 wk after surgery for incision recheck. He was reported to be doing well with a good energy level and appetite and no signs of systemic illness. On physical examination, his vital parameters were within normal limits (temperature: 37.5°C, heart rate: 112 beats/min, respiratory rate: 24 breaths/min). His incisions appeared healed with no evidence of complications. Upon palpation of the inguinal hernia sites, there was no evidence of failure of the repair or recurrence of herniation (Figure 5).

Communication with the dog's owner at 9 wk after surgery revealed no evidence of hernia recurrence or systemic illness. Nearly 1 y after surgery, communication with the dog's owner similarly reported no evidence of hernia recurrence or systemic illness.

Discussion

This report represents the first documented case of laparoscopic intracorporeally sutured inguinal herniorrhaphy in a clinical dog. Results of the case demonstrate that this technique is technically feasible, and the authors felt that it provided excellent visualization of the caudal abdominal structures including the inguinal ring and its contents (Figure 6). In addition to placing the dog in Trendelenberg position, placement of a urinary catheter to maintain a deflated urinary bladder would enhance the exposure to the caudal abdomen in dogs if needed for visualization. The procedure resulted in excellent short- and long-term outcomes, as the dog appeared comfortable and was discharged 1 d after surgery with no intra-operative or post-operative complications. One year after surgery, the dog is doing well with no evidence of hernia recurrence.

Based on the findings and results of this case, laparoscopic intracorporeal inguinal herniorrhaphy may be considered as a minimally invasive option for treatment of inguinal hernias in dogs. This technique can be performed on intact male dogs following castration and for repair of bilateral hernias. In this case, open castration was elected to potentially allow for manipulation of the vas deferens, testicular artery, and pampiniform plexus at the level of the inguinal ring to improve exposure during intracorporeal suturing. For patients with unilateral inguinal hernia, port placement may be altered to allow triangulation around the inguinal ring. In general, a 3-port technique will be required to allow for placement of a camera as well as 2 instruments with adequate triangulation and working space. As with all minimally invasive procedures, case selection is important and the authors suggest that this technique, at least in the early part of the learning curve, is likely best suited for dogs with congenital inguinal hernias that are readily reducible. In addition, this technique should be limited to dogs with no or minimal systemic clinical signs, no trauma history, and small to moderately sized hernia sacs (13). In more complicated cases, adhesions or devitalized tissues may complicate the minimally invasive approach.

Additional cases are required to gain knowledge and experience in the minimally invasive treatment of this condition in female dogs, previously castrated dogs, and dogs of varying body weight and conformation. As with many minimally invasive techniques, a learning curve is likely to be encountered during initial cases of laparoscopic intracorporeal inguinal herniorrhaphy that are pursued. For example, in this procedure, the suture length and needle conformation were altered in ways that were deemed advantageous in optimizing efficiency. It is likely that with additional cases, the surgical time will decrease with

similarly good outcomes (i.e., a low recurrence rate) and low complication rates. Additional techniques and equipment could also be considered. For instance, the authors chose to perform an interrupted cruciate pattern with a nonabsorbable monofilament suture; however, nonabsorbable barbed suture may also be acceptable and could help to facilitate intracorporeal suturing for inguinal herniorrhaphy in some cases. Barbed suture was not used in this case due to lack of availability of nonabsorbable barbed suture at our institution. The authors recommend the use of nonabsorbable suture for congenital and chronic hernias. Additionally, there was concern that with the short length of the hernia there would be an insufficient number of suture bites with the barbed suture to create a secure herniorrhaphy. Another technique that may be of benefit during intracorporeally sutured inguinal hernias involves partial release of the pneumoperitoneum during tightening of the herniorrhaphy suture to achieve a tension-free environment. However, this must be balanced by the relative loss of working space that will occur when pneumoperitoneum pressure is decreased.

An additional consideration with any herniorrhaphy involves techniques that may contribute to or enhance the durability and longevity of the repair. In some studies on minimally invasive inguinal hernia repair in children, the laparoscopic approach was associated with a greater recurrence rate compared with open surgery (14). It is theorized that laparoscopic closure may not cause as much tissue damage and scar formation as the open surgical technique, such that the minimally invasive repair may rely on the sutures themselves (rather than scarification with tissue fibrosis/adhesions) to prevent recurrence (15). In support of this theory, in a rabbit model, sharp peritoneal trauma at the time of minimally invasive repair resulted in a greater percentage of repairs that remained intact after removal of the sutures at 2 and 4 wk after surgery (87.5 compared to 25% and 100 compared to 12.5%, respectively) (15). Therefore, the addition of minor sharp trauma to the inguinal ring at the time of laparoscopic herniorrhaphy may be considered in future cases to maintain the herniorrhaphy in the event that the sutures themselves fail.

A 3D laparoscopic camera was used for this procedure. At the time of the writing, 4-mm 30° and 10-mm 0° or 30° 3D laparoscopic cameras were available to the authors. Given the small size of the dog, the 4-mm 30° camera was selected. For case documentation purposes, images were taken with a 2-dimensional (2D) laparoscope. Studies on minimally invasive surgery in humans have demonstrated improved surgical precision, hand-eye coordination, and depth perception with 3D than with 2D laparoscopy (12). However, the use of 3D laparoscopy in veterinary patients has rarely been reported. One study in dogs evaluated the effects of 3D (relative to 2D) laparoscopy for intracorporeally sutured gastropexies in dogs (16). Although this study reported no significant difference between 2D and 3D laparoscopy with respect to surgical time or surgeon workload, there were no reported disadvantages with use of the 3D telescope and results may or may not be transferrable to other minimally invasive procedures in veterinary medicine (16). Similar to findings in human studies, the 3D feature in this study enhanced depth perception and thereby surgical precision and efficiency, although these findings were subjective in nature. Additional cases of intracorporeal inguinal herniorrhaphy in dogs using both 2D and 3D cameras are needed to further assess any benefit of this technology for this procedure.

In conclusion, this report marks the first documented case of a dog with bilateral inguinal hernias that underwent laparoscopic intracorporeally sutured herniorrhaphy and concurrent castration. Results demonstrate a possible low risk for surgical complications and the potential for good long-term outcomes without recurrent herniation. Additional cases are needed to gain more experience with this technique in dogs with varying presentations of this disease.

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