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Minimally Invasive Two-Port Laparoscopic-Assisted Ovariohysterectomy for Treating Hydrometra and Pyometra in Small Dogs

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ABSTRACT

Reports on laparoscopic-assisted ovariohysterectomy for treating hydrometra or pyometra in small dogs are scarce. This study retrospectively reviewed 77 dogs weighing less than 6 kg that underwent a two-port laparoscopic-assisted procedure for mild to moderate uterine disease. Surgical ports were positioned at the umbilicus and midway between the umbilicus and pelvic brim. The uterine horn was exteriorized, and the cervix was ligated and transected. The dogs had a median age of 8.8 years (10 months–16.1 years) and a median weight of 3 kg (1.26–6.0 kg). Clinical presentation varied from lethargy, anorexia, increased thirst, and urination, though 66% of dogs were asymptomatic, with uterine enlargement found incidentally. Histopathology confirmed hydrometra in 51 dogs and pyometra in 26. Median operative time was 32 minutes (15–83), and median hospitalization was zero days (0–3). No intraoperative complications occurred; 18 dogs had temporary postoperative anorexia, and 3 experienced minor incision site infections. All sutures were removed within 7–10 days, and all dogs were healthy at the two-week follow-up. The results indicate that two-port laparoscopic-assisted ovariohysterectomy is a safe, effective, and minimally invasive option for treating mild to moderate hydrometra and pyometra in small dogs.

Keywords: Two port, Laparoscopic surgery, Small breeds, Laparoscopic-assisted surgery, Ovariohysterectomy, dogs, Hydrometra, Pyometra

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Introduction

Female dogs frequently develop reproductive disorders such as hydrometra, mucometra, and pyometra. While hydrometra and mucometra are usually non-urgent, surgical removal of the uterus is often recommended because these conditions can progress to pyometra [1]. Dogs with pyometra may exhibit increased thirst and urination, as well as reduced appetite. Closed pyometra, in particular, can quickly lead to bacteremia or sepsis, representing a critical health risk [2]. Although conservative medical management can yield favorable long-term outcomes in approximately 86% of affected dogs [3,4], surgical intervention remains the standard treatment, with reported postoperative mortality rates of around 1% [5].

Laparoscopic ovariohysterectomy has gained attention in veterinary medicine due to its minimally invasive nature, offering benefits such as smaller incisions, reduced postoperative pain, and fewer surgical site infections compared with traditional open techniques [6–8]. Various approaches have been described, including single-port, two-port, three-port, and transvaginal methods [9–11]. Previous work has demonstrated the feasibility of a three-port laparoscopic ovariohysterectomy in dogs under 5 kg [12], and the two-port method has been suggested to reduce operating time [13]. Despite this, there is no clear consensus on which approach is superior. In human surgery, reduced-port laparoscopic techniques have become popular because they minimize surgical invasiveness [14, 15],

and similar methods, such as two-port laparoscopic adrenalectomy, have been successfully applied in dogs [16]. Most previous studies of laparoscopic ovariohysterectomy for pyometra have focused on medium-sized dogs, often exceeding 20 kg [17–20]. Performing laparoscopic procedures in small dogs with enlarged uteri is technically challenging due to limited abdominal space and visualization.

The current study aimed to evaluate a two-port laparoscopic-assisted ovariohysterectomy, incorporating a wound retractor and ultrasound probe cover, in small dogs (<6 kg) with mild to moderate hydrometra or pyometra. We hypothesized that even in small dogs, laparoscopic-assisted uterine removal could be performed safely, producing outcomes comparable to those reported in larger breeds.

Materials and Methods

Ethical considerations

As this was a retrospective review, formal ethical approval was not required. All procedures were part of routine clinical care. Dog owners were fully informed about the anesthetic and surgical procedures, potential risks, and consented to both the surgery and the use of clinical data for academic purposes.

Study population and data collection

Medical records from 2018 to 2024 were reviewed for dogs weighing less than 6 kg that underwent laparoscopic-assisted ovariohysterectomy for hydrometra or pyometra. Data collected included age, sex, breed, clinical signs, uterine horn diameter measured by ultrasound, duration of surgery, hospital stay, intraoperative observations, complications, histopathological findings, and follow-up results. Dogs with uterine rupture, peritonitis, or extreme uterine enlargement were excluded.

Preoperative assessment

All dogs underwent standard pre-surgical evaluation, including complete blood count, serum chemistry, CRP, coagulation tests, abdominal ultrasound, and thoracic/abdominal radiographs. Food was withheld for at least eight hours before surgery. An intravenous catheter was placed in the cephalic vein, and lactated Ringer's solution was administered throughout the perioperative period.

Anesthesia protocol

Pre-anesthetic medications included intravenous midazolam (0.2 mg/kg), butorphanol (0.2 mg/kg), and atropine (25 µg/kg). Propofol (6 mg/kg) was used to induce anesthesia, followed by endotracheal intubation and mechanical ventilation. Anesthesia was maintained with 2.0–3.0% sevoflurane. Intraoperative hypotension was managed with dopamine (5–10 µg/kg/min CRI), medetomidine (1 µg/kg), or ephedrine (0.1 mg/kg) as needed.

Surgical procedure: Two-Port laparoscopic-assisted ovariohysterectomy

Dogs were positioned in dorsal recumbency, and the abdominal area from the xiphoid process to the pubis was clipped. A urinary catheter was placed. A 3- or 5-mm trocar was inserted at the umbilicus using a modified Hasson technique, and CO_2 insufflation was used to create a pneumoperitoneum with a target pressure of 8 mmHg at a rate of 1.0–1.2 L/min. A 30° laparoscope was used to explore the abdominal cavity.

A second incision was made slightly caudal to the midpoint between the umbilicus and pelvic brim, approximately 5–10 mm larger than the maximal uterine horn diameter. Under laparoscopic guidance, a 5-mm trocar was inserted. In cases where the uterine horn exceeded 10 mm or pyometra was suspected, an XXS or XS wound retractor was applied to the incision to prevent contamination. The retractor was covered with a sterile probe cover to further reduce the risk of infection **(Figure 1)**.

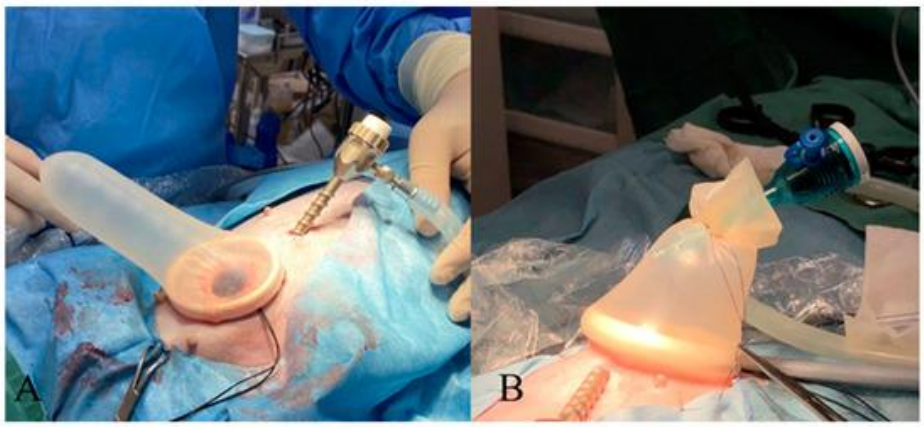

Figure 1. (A) The wound retractor is slipped inside a sterile probe cover. (B) A trocar/cannula is inserted into this cover to create a working port and is anchored with a 3-0 nylon tie

The animal was then rolled from back-lying (dorsal recumbency) into right-side-lying (right lateral recumbency). The surgeon positioned himself/herself on the animal's belly side, and the table was tipped about 10° downward toward the surgeon to improve exposure.

An ultrasonic vessel-sealing and cutting instrument (SONICBEAT, Olympus Co., Ltd., Tokyo, Japan) was passed through the most caudal port. Using this device, the proper ligament of the left uterine horn was grasped and pulled upward against the body wall to bring the ovarian blood vessels and suspensory ligament into clear view.

Outside the abdomen, a 3-0 or 4-0 PDS suture on a 17–22 mm half-circle round needle was loaded into a needle driver and introduced into the peritoneal cavity. This suture was looped around the ovarian proper ligament and tied as a temporary stay suture to keep the uterine horn retracted. The needle was then parked by pushing its tip into the abdominal wall for safekeeping **(Figure 2)**.

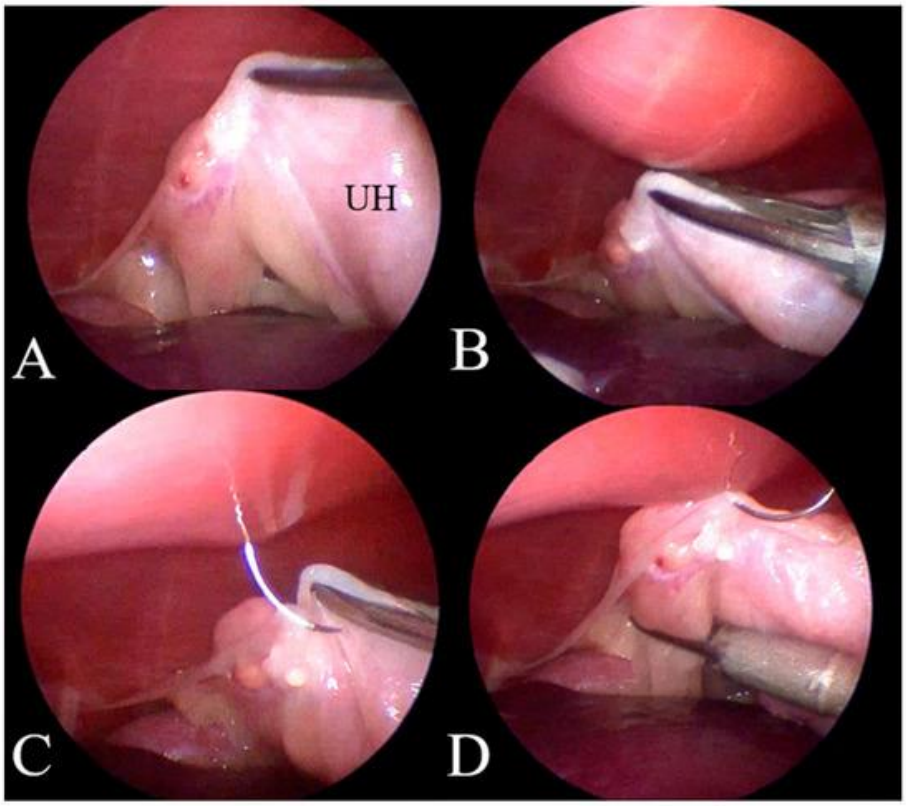

Figure 2. (A) The enlarged uterine horn is lifted by grasping and tensioning the suspensory ligament (UH: uterine horn). (B) The ideal spot on the abdominal wall for needle parking is selected by pressing inward with a finger from the outside. (C) A round-bodied needle carrying 3-0 or 4-0 PDS is introduced into the abdomen with a needle holder; the suture is looped around the proper ligament of the ovary and tied loosely as a stay

suture to keep the horn retracted. (D) While maintaining tension on this stay suture, the ovarian pedicle (artery, vein, and suspensory ligament) is sealed and divided using the ultrasonic energy device, with the needle tip left embedded in the abdominal wall for the time being

The broad ligament was then coagulated and cut with the ultrasonic device, working from caudal to cranial, fully detaching the ovarian pedicle and suspensory ligament (Video S1). Once hemostasis and absence of uterine fluid leakage were confirmed, the animal was repositioned into left lateral recumbency, and the identical steps were repeated on the right side.

On the right, the freed suspensory ligament was grasped with forceps and pulled out through the caudal port. If the second port had been created using a wound retractor inside a probe cover, the cover was simply cut with scissors to allow removal of the uterus. When a standard 5-mm port was in place, the abdominal wall incision was enlarged with scissors or a blade to permit safe exteriorization of the uterus without spillage or rupture.

The cervix was double-ligated with 2-0 or 3-0 PDS and transected using the ultrasonic device (Video S2). The uterine stump was oversewn, returned to the abdomen, and the body wall and subcutaneous layers were closed with continuous PDS. Skin was closed with simple interrupted nylon sutures **(Figure 3)**.

After closing the caudal port, CO_2 insufflation was re-established to inspect the abdomen for bleeding or contamination with uterine contents. The umbilical camera port was then closed in the same layered fashion.

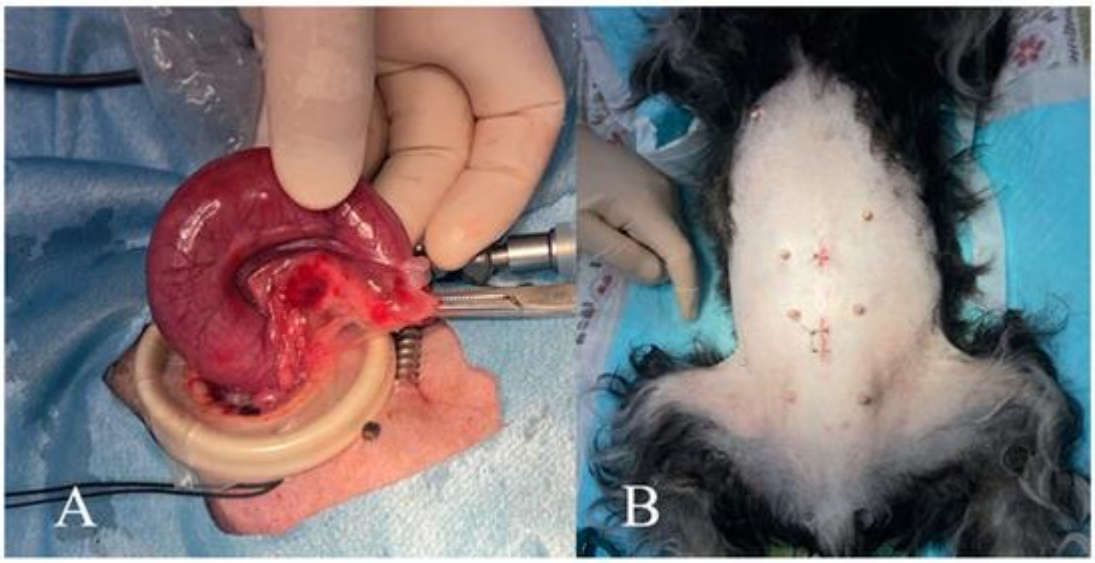

Figure 3. (A) Exteriorized enlarged uterus after removal. (B) Appearance of the surgical wounds at closure

If visualization of the ovarian pedicle or suspensory ligament remained poor despite optimal patient positioning, intra-abdominal pressure was raised to 10–12 mmHg. When exposure was still insufficient, an additional 3–5 mm instrument port was placed on the midline between the xiphoid and umbilicus to allow atraumatic grasping and manipulation of the uterus. In cases where adequate visualization could not be achieved even with these measures, the procedure was converted to conventional open ovariohysterectomy

Postoperative care

At the end of surgery, incision sites were infiltrated with bupivacaine (0.5%, 1 mg/kg) for local analgesia, and meloxicam (0.2 mg/kg SC) was administered. Patients were closely observed for about 5 hours during recovery. In dogs diagnosed with or suspected of pyometra, oral amoxicillin (25 mg/kg twice daily) was prescribed for 1–2 weeks. All removed ovarian and uterine specimens were submitted for histopathology. All animals were re-examined two weeks postoperatively for physical examination and wound assessment. Preoperative hematologic and biochemical abnormalities were rechecked in affected dogs.

Statistical analysis

Data normality was evaluated with the Shapiro–Wilk test. Normally distributed data were compared using Student's t-test; non-normally distributed data were analyzed with the Mann–Whitney U test. Breed distribution

was assessed with the Chi-square test. Categorical variables were compared using Fisher's exact test. To account for multiple comparisons, Bonferroni correction was applied, and statistical significance was set at $p < 0.007$.

Results

Case population

Seventy-seven dogs weighing ≤6 kg and diagnosed with hydrometra (n = 51) or pyometra (n = 26) by abdominal ultrasound were included. Median age was 8.8 years (range 10 months–16.1 years) and median body weight was 3 kg (range 1.26–6.0 kg). Predominant breeds in the hydrometra group were Toy Poodle (n = 25) and Chihuahua (n = 10); in the pyometra group, Chihuahuas (n = 7) and Toy Poodles (n = 6) were most common.

Clinical signs, when present, included lethargy, anorexia, polydipsia, and polyuria; however, 66% of dogs were asymptomatic, with uterine enlargement discovered incidentally during routine examination. Median maximal uterine horn diameter on ultrasound was 10 mm (range 4–30 mm). Median surgical time (skin incision to final suture) was 32 min (range 15–83 min), and median postoperative hospitalization was 0 days (range 0–3 days).

A wound retractor with probe-cover port was used in all pyometra cases and in 12 hydrometra cases. In four dogs, visualization during the initial two-port technique was inadequate: two were managed by adding a third midline port, and two required conversion to open surgery.

No intraoperative complications occurred. Postoperative findings included transient anorexia (≤3 days) in 18 dogs and incisional infection (redness/swelling) in 3 dogs. Sutures were removed 7–10 days after surgery. At the two-week recheck, all dogs were clinically normal, preoperative clinical signs had resolved, and previously abnormal blood parameters had normalized.

Statistical comparisons

Table 1 summarizes the data. Age and body weight were similar between hydrometra and pyometra groups. Uterine horn diameter was significantly larger in pyometra (median 15 mm, range 8–30 mm) than in hydrometra (median 8.5 mm, range 4–25 mm; $p < 0.007$). Operative time did not differ significantly between groups. Hospital stay was significantly longer in pyometra patients (median 0 days, range 0–3) than in hydrometra patients (median 0 days, range 0–1; $p < 0.007$). Surgical-site infection rates were similar, but postoperative anorexia occurred significantly more often in the pyometra group ($p < 0.007$).

Table 1. Summary of variables in dogs with hydrometra and pyometra

Variables	Pyometra (n = 26)	p-Value	Hydrometra (n = 51)
Age (months)	122 (39–192)	p = 0.024	105 (10–194)
Body weight (kg)	3 (1.6–6.0)	p = 0.539	3 (1.26–6.0)
Uterine horn size (mm)	15 (8–30)	p < 0.007	8.5 (4–25)
Surgery time (min)	33.5 (15–64)	p = 0.34	31 (15–83)
Postoperative anorexia	15	p < 0.007	3
Surgical site infection	0	p = 0.547	3
Hospital stay (days)	0 (0–3)	p < 0.007	0 (0–1)

The data are presented as median (minimum−maximum) values. A p-value < 0.007 was considered statistically significant.

Discussion

Laparoscopic techniques are gaining popularity in veterinary practice because they cause less tissue trauma, lower the risk of wound infections, reduce systemic inflammation, and decrease postoperative adhesion formation compared with open surgery [6,8, 21–25]. Earlier work has already shown that laparoscopic ovariohysterectomy is safe and practical in healthy dogs under 5 kg [12]. In human medicine, however, very small patients (neonates and infants) are known to restrict instrument movement and increase technical difficulty [26, 27].

Maintaining an adequate working space during laparoscopy relies on CO_2 pneumoperitoneum. In dogs, pressures above 15 mmHg can impair renal function [28], and insufflation itself may precipitate acute kidney injury in animals with pre-existing chronic renal disease [29]. Elevated intra-abdominal pressure also alters cardiopulmonary dynamics and can be poorly tolerated in patients with heart or lung disease [30]. For these reasons, careful preoperative screening is essential, and insufflation pressure should be kept as low as possible. In this series, all procedures in dogs ≤6 kg were performed at only 8 mmHg, yet exposure remained sufficient to complete ovarian pedicle ligation in nearly every case despite the confined working space.

Devitt *et al.* originally described a two-port ovariectomy method in which a suture needle is passed transabdominally through the uterine horn and exteriorized to provide traction [8]. Subsequent reports, however, highlighted the risk of needle fracture with that approach [31]. To avoid this complication, we parked the needle tip inside the abdominal wall after placing the stay suture around the proper ligament of the ovary—an easy and safe maneuver in small dogs because the thin body wall allows clear visualization of the needle at all times.

All ovarian pedicles and suspensory ligaments were divided without intraoperative bleeding. Ultrasonic energy devices reliably seal and transect vessels up to 5 mm in diameter [21, 32] and, compared with traditional clip placement or hand-tied ligatures, are particularly advantageous in miniature patients where vascular structures are small and space is limited [33–35]. They also appear to cause less postoperative discomfort than suture ligation [21, 36]. Even in pyometra cases with inflamed and somewhat dilated vessels, the ultrasonic device performed effectively. Median surgical time in the current study was only 32 minutes—substantially shorter than the 85, 57, and 107 minutes previously reported for single-, two-, and three-port laparoscopic techniques in pyometra [18–20]. The combination of smaller tissue mass and the efficiency of ultrasonic sealing likely accounts for this difference.

Mortality after conventional open ovariohysterectomy for pyometra ranges from 3–20%, with overall complication rates around 20% (sepsis being responsible for approximately 12%) [4]. Reported conversion rates to open surgery have been as high as 8–14% in multi- and single-port laparoscopic series, usually because of uterine rupture or contamination [19, 20]. In contrast, the two-port glove-port technique has been associated with no ruptures or conversions [18]. Our results compare favorably: conversion to laparotomy was required in only 2.5% of cases (due to inadequate visualization), and an extra port was needed in another 2.5%. No intraoperative spillage of uterine contents occurred, largely because traction was applied exclusively to the proper ligament of the ovary, avoiding direct grasping of the fragile, distended uterine wall.

In four dogs, limited exposure occurred when marked ovarian-end distension of the horn obscured the pedicle. Although table tilt toward the surgeon can improve access in laparoscopic-assisted procedures [37], gravity may pull a heavy uterine horn ventrally and actually worsen visualization in some cases. Adding a third midline instrument port usually resolved the problem, but when it did not, prompt conversion to open surgery was performed. Most dogs with uncomplicated pyometra are hospitalized 1–2 days after traditional surgery [4]; in the present cohort, the majority were discharged the same day, reflecting the minimally invasive nature of the technique and the absence of major complications.

Despite the significantly greater uterine distension seen in pyometra compared with hydrometra, operative times remained short and comparable between the two groups. Surgical-site infection rates were similar, but pyometra patients experienced more postoperative anorexia and required slightly longer hospitalization, underscoring the need for continued medical support even after minimally invasive surgery. In contrast, the majority of hydrometra cases were discharged the same day, supporting the routine use of this two-port laparoscopic-assisted technique for that condition.

Wound retractors are advised for incisions >10 mm to reduce the risk of wound contamination or, in oncology cases, tumor seeding [38]. The probe-cover port technique—placing a sterile ultrasound probe cover over a wound retractor—provides a low-cost substitute for commercial single-port platforms [39] and has already been shown to shorten surgical time in canine ovariohysterectomy [40]. In the current series, a small incision of at least 10 mm was always required for uterine exteriorization; consequently, XXS- or XS-sized wound retractors were used in every case to protect the abdominal wall. Standard size-5 surgical glove wrists (≈67 mm) do not fully seal the outer ring of an XXS retractor (65 mm), which can lead to CO_2 leakage. By using a 35-mm sterile rubber ultrasound probe cover stretched over the retractor ring, a reliable gas-tight seal was achieved without leakage. Although this setup accommodates only one cannula (unlike the five possible with a glove), its semi-transparent material facilitates instrument handling and markedly lowers cost, offering a practical new option for very small retractors.

In hydrometra, the uterine lumen contains sterile fluid [2], so a wound retractor is not strictly required; the caudal port can simply be enlarged for uterine removal. Ideally, the decision to use a retractor should be made preoperatively based on ultrasonographic measurement of uterine diameter and confirmation of pyometra versus hydrometra.

This study has several limitations. It was retrospective, included only mild-to-moderate cases of pyometra, and excluded dogs with uterine rupture, peritonitis, or severe distension—conditions that remain indications for open surgery. All procedures were performed by a single experienced surgeon, which may limit generalizability. The

ultrasound probe cover modification may not be universally available. Although Bonferroni correction reduced the risk of type I errors, it increased the chance of type II errors and reduced statistical power. The relatively small sample size and retrospective design highlight the need for larger prospective studies to further validate the safety and efficacy of two-port laparoscopic-assisted ovariohysterectomy in small-breed dogs with mild-to-moderate hydrometra or pyometra.

Conclusions

Two-port laparoscopic-assisted ovariohysterectomy is a safe, rapid, and effective technique for dogs weighing ≤6 kg with mild-to-moderate hydrometra or pyometra.

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Conflict of Interest: None

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Ethics Statement: None

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