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Comparative evaluation of electrocoagulation and endo-clip haemostasis techniques in laparoscopic ovariohysterectomy in female dogs

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The study was conducted on 12 female dogs of varying ages and body weights, randomly allocated into two groups (6 animals in each group) based on the haemostasis technique used during laparoscopic ovariohysterectomy. In group I, electrocoagulation was performed, and in group II, endo-clip application was done. The mean total surgical duration for laparoscopic ovariohysterectomy was 39.33±0.80 min in group I and 51.17±0.75 min in group II, indicating a shorter operative time with the electrocoagulation technique. Both haemostasis techniques were found to be effective and feasible in nulliparous and lean animals. However, in pluriparous and overweight (fatty) female dogs, only the electrocoagulation technique provided consistently reliable outcomes, suggesting that it may be more suitable in such cases due to better tissue handling and haemostatic efficacy.

Key words: *Dogs, Electro-coagulation, Endo-clips, Laparoscopy, Ovariohysterectomy*

In recent times, non-invasive or minimally invasive OVH procedure is becoming more popular in companion animals due to occurrence of least complications. Laparoscopic sterilisation is a quick and safe alternative to open OVH, laparoscopy lowers the intensity and length of postoperative sickness by minimising bowel handling and serosal drying, hence minimising postoperative adhesion formation. Furthermore, the smaller, less painful incisions and faster postoperative healing provide benefits over traditional open surgery (Wildt and Lawler, 1985). Haemorrhage is one of the OVH consequences, and it can come from a variety of places, primarily the ovarian pedicles, uterine veins and broad ligament (Howe, 2006). Laparoscopic surgery requires a clear, bloodless field, as bleeding- even when managed with suction and irrigation- can impair visibility, prolong surgery, and hinder haemostasis assessment (Austin *et al*., 2003; Hancock *et al*., 2005; Salvi *et al*., 2023). Keeping in view the importance of haemostasis, the present investigation was undertaken to compare electrocoagulation and endo-clip haemostasis techniques in laparoscopic OVH in female dogs.

Materials and Methods

The present study was conducted on 12 female dogs of different ages and body weights presented for elective sterilization. The study was approved by Institutional Animal Ethical Committee of CVAS, Bikaner, RAJUVAS (CVAS/IAEC/2023-24/19, dated 19.07.2023). Apparently, healthy female dogs were selected for ovariohysterectomy, and all the dogs were subjected to a series of diagnostic tests, including a review of their medical history, clinical symptoms, physical examination, haematology, and serum biochemistry. The animals in the oestrus or pregnancy were excluded from the study after history and ultrasonographic examination. Selected female dogs were randomly assigned into two equal groups (n=6 in each group) based on the use of different haemostasis techniques: group I- laparoscopic OVH using electro-coagulation, and group II- laparoscopic OVH using endo-clips.

All the animals undergoing surgery were kept off-feed and off-water for 12 hr and 6 hr, respectively. Enema was administered 2 hr before surgery, and the urinary bladder was catheterised and emptied prior to the induction of anaesthesia. The ventral abdomen of the patient was clipped from the xiphoid up to the pubis, and the surgical site was prepared aseptically. Pre-anaesthetic mediation included administration of xylazine HCl (1 mg/kg body wt., i.m.), which was followed 10 min later by ketamine HCl (5 mg/kg body wt., i.m.) as the induction anaesthetic agent. Anaesthesia was maintained by inhalant anaesthetic, 1.5% isoflurane, in both groups.

Each dog was spayed using a similar laparoscopic OVH technique, except for the use of differing ovarian pedicle and uterine body haemostasis techniques. The laparoscopic OVH procedure was performed using a standard 3-port laparoscopy technique. In group II, one paramedian port on one side was upsized to a 10 mm pyramidal-tip trocar-cannula assembly to accommodate the 10 mm endoscopic clip applicator.

In group I, a 5 mm Maryland grasping forceps was inserted through the right working port to grasp the proper ligament of the right ovary and elevated ventrally. The ovarian ligament was lifted so that traction was placed on the suspensory ligament. The

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5 mm bipolar electro-cautery was introduced from the left paramedian port. The suspensory ligament and ovarian vascular pedicle were cauterised using bipolar electrocautery (Fig. 1) and it was transected using laparoscopic scissors on the ovarian end. The same procedure was repeated on the contralateral side. The cervix was identified visually, and the uterus and associated uterine arteries were cauterised using bipolar electrocautery (Fig. 2) and transected using laparoscopic scissors closed approximately 1 cm proximal to the cervix. The uterine horns and body were separated from the broad ligament by simultaneous electro-cauterisation with laparoscopic scissors and mild traction using grasping forceps.

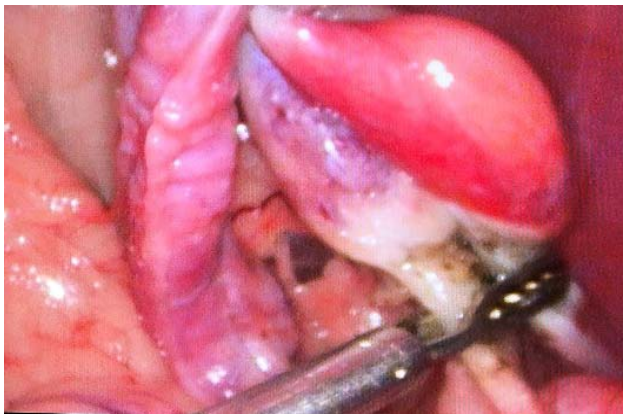

Fig. 1: Cauterisation of the ovarian pedicle using bipolar electrocautery - group I.

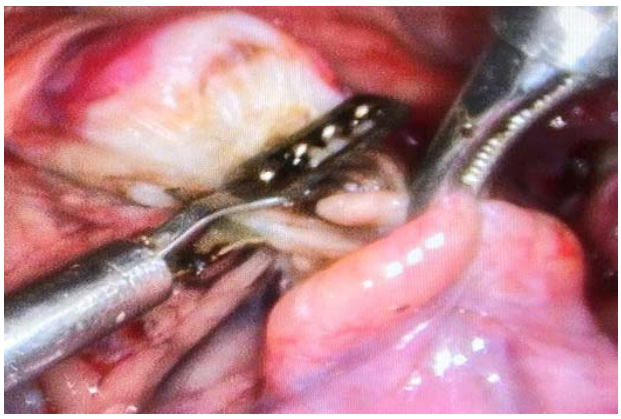

Fig. 2: Cauterisation of the uterine body using bipolar electrocautery - group I.

In group II, haemostasis of the ovarian pedicles and uterine body was achieved using the endo-clip technique (Holey, 2010). The right ovary was first identified, and the proper ligament was atraumatically grasped and elevated ventrally using Maryland grasping forceps inserted through the working port designated for 5 mm instruments. An endoscopic clip applicator was introduced through the working port accommodating 10 mm instruments to apply appropriately sized metal clips (medium, medium-large, or large). One distal clip and two proximal clips were placed along the ovarian pedicle, extending from the suspensory ligament to the cranial border of the mesovarium (Fig. 3). The pedicle was then sharply transected between the clips using laparoscopic scissors. The same procedure was repeated on the contralateral side after tilting the animal to improve access to the left ovary.

The uterine body and associated uterine arteries, located cranial to the cervix, were similarly secured using three rows of clips (Fig. 4), followed by transection between the clips with laparoscopic scissors. The resected genital tract was exteriorized through the working port using laparoscopic grasping forceps, ensuring gentle tissue handling and preventing contamination. Upon completion, all instruments,

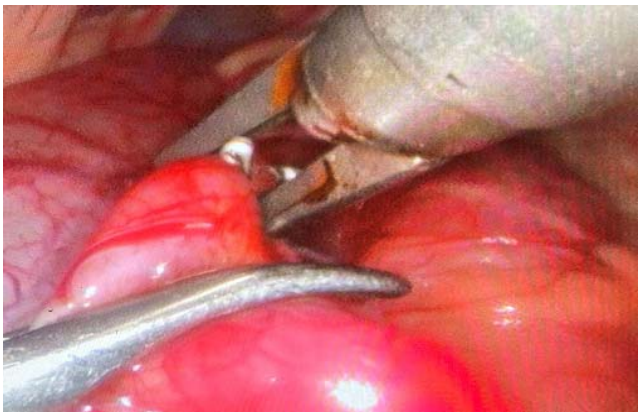

Fig. 3: Application of endo-clips to the ovarian pedicle using an endoscopic clip applicator - group II.

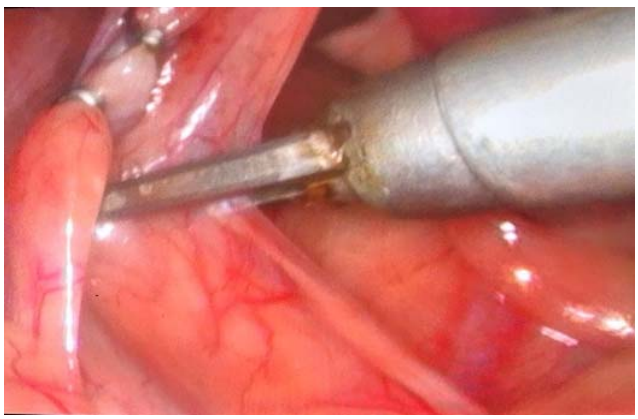

Fig. 4: Application of endo-clips to the uterine body using an endoscopic clip applicator - group II.

including the laparoscope, graspers, and all three port cannulas, were removed. The pneumoperitoneum was released, and the port-site incisions were closed using simple interrupted sutures with sterile silk No. 1.

Postoperatively, ceftriaxone–tazobactam (antibiotic) was administered intramuscularly (25 mg/kg body wt.) twice daily for five days, along with meloxicam (analgesic anti-inflammatory drug, 0.25 mg/kg body wt.) once daily for three days. The surgical site was dressed on alternate days with 5% povidone-iodine solution. The skin sutures were removed on 10th

postoperative day in all dogs.

Postoperatively, different physical (body condition and parity), physiological (rectal temperature, heart rate and respiratory rate), haematological and biochemical (haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count, differential leukocyte count, aspartate aminotransferase, alanine aminotransferase, blood urea nitrogen, serum creatinine, serum cortisol and blood glucose) parameters, pain score (modified University of Melbourne pain scale system) and surgical parameters (duration of surgery, peri and post-operative complications) were recorded.

The data were analysed using paired 't' test and one way Analysis of Variance, and significance was considered at $P<0.05$.

Results and Discussion

The mean duration of surgery for laparoscopic OVH (including various surgical steps measured from Veress needle insertion to final port closure) was 39.33±0.80 min in group I and 51.17±0.75 min in group II. The time from Veress needle insertion to CO, insufflation for pneumoperitoneum was 5.67±0.33 min in group I and 4.50±0.22 min in group II. Placement of three laparoscopic ports took 5.50±0.43 min and 5.00±0.26 min in group I and II, respectively. Resection of the right ovarian pedicle required 9.50±0.43 min in group I and 14.00±0.45 min in group II, while the left ovarian pedicle was resected in 7.50±0.22 min and 11.67±0.49 min, respectively. The mean time required to resect the uterine body was 6.50±0.22 min in group I and 11.50±0.43 min in group II. Exteriorization of the utero-ovarian complex took an equal time of 3.17±0.31 min in both groups. Finally, port closure for all three ports was completed in 1.50±0.22 min in group I and 1.33±0.21 min in group II.

The mean surgical time for Veress needle insertion and establishment of pneumoperitoneum was relatively higher in group I compared to group II, although the difference was not statistically significant. The mean surgical times for port placement, exteriorization of the utero-ovarian complex, and port closure were slightly more in group I, but the differences between the groups were not statistically significant. In contrast, the mean times required for resection of the right ovarian pedicle, left ovarian pedicle, and uterine body were significantly shorter in group I as compared to group II. Significantly prolonged duration of surgery in group II was primarily attributed to the use of the endo-clipping technique, which required frequent instrument exchanges. Specifically, the process of introducing the endoscopic clip applicator, retracting it for reloading, and then introducing scissors to sever the clipped tissue had to be repeated multiple times, thereby increasing the overall duration of the procedure. Similarly, Valocky *et al.* (1999) also found that electrocoagulation required less time than endo-clipping method for laparoscopic ovariectomy. Holey (2010) reported marginally longer duration of procedure in endo-clipping compared to electrocoagulation technique in laparoscopic OVH, and average time required for both techniques was longer than the present study. Niranjana *et al.* (2013) found that the duration of surgery was less in electrocauterization with three ports on the ventral midline group, followed by clip application with two ports on paramedian and one port on midline group of laparoscopic OVH. The surgical time can be minimized in laparoscopic surgery by familiarisation of laparoscopic instruments (Wildt and Lawler, 1985).

The mean number of clips used in group II animals for haemostasis of the right ovarian pedicle, left ovarian pedicle, uterine body, and total clips applied were 3.83±0.48, 3.67±0.33, 6.33±0.72 and 13.83±0.70, respectively. Mayhew and Brown (2007) reported that, in some dogs, a large number of surgical clips were required (median: 31; range: 19-40). Most dogs required two clip cartridges (19 clips per cartridge), while one dog required three. They noted that the use of additional cartridges significantly increased the cost of disposables. The authors suggested that combining clip application for major vessels with monopolar or bipolar cauterisation for surrounding tissue could reduce the number of clips used and potentially shorten the surgical time, although such a combined approach was not evaluated in their study.

In group I, minor intraoperative bleeding was observed during coagulation of uterine body in one animal; however, bleeding was controlled by re-cauterisation. Difficulty in grasping of ovaries was also observed due to distended intestine and excessive fat deposition in two dogs. In group II, minor and moderate intraoperative bleeding episodes were observed during endo-clipping of the ovarian pedicle and uterine body in one case each. They occurred due to difficulty in manoeuvring the endoscopic clip applicator, as the smaller clips were inadequate for the large-sized pedicle and uterine body in two animals. However, haemorrhage was successfully controlled by repositioning and properly applying the clips. Additionally, minor intraoperative bleeding was noted in two animals after sectioning the ovarian pedicle and uterine body, attributed to improper occlusion and inadequate vessel compression by the clips. This bleeding was also effectively managed by re-clipping the affected structures. In one animal from group II, the spleen was accidentally punctured during insertion of the umbilical trocar-cannula assembly; however, the resulting haemorrhage was minor and was controlled by applying pressure with laparoscopic forceps at the puncture site. In one

pluriparous animal from group II, difficulty was encountered in applying endoscopic clips due to slippage on the ovarian pedicle and uterine body, attributed to the large size of the pedicle relative to the clips and excessive fat deposition.

Similarly several researchers in earlier studies have reported complications during the surgical procedure. Mayhew and Brown (2007) observed splenic laceration caused from an accidental trocar injury, haemorrhage during sharply sectioned the pedicle between clips and slippage of the extracorporeally tied modified Roeder knots resulted in substantial haemorrhage from the ovarian pedicle. Hardie *et al.* (1996) found damage of internal organs due to improper placement of cannula. Shirodkar *et al*. (2008) noted minor emission of blood in endo-loop suturing technique of laparoscopic ovariectomy. Brun *et al.* (2000) recorded haemorrhage with death of one animal and another animal requiring shifting to exploratory celiotomy to control haemorrhage during laparoscopic OVH. Dharmaceelan *et al.* (2000) observed accidental electrocauterisation of a small portion of peritoneum during laparoscopic ovariectomy. Kumar *et al.* (2023) found spleen puncture, difficulty in cauterization of ovarian pedicle in fatty animals, and moderate ovarian pedicle bleeding during laparoscopic OVH. Niranjana *et al.* (2013) noticed slight bleeding from the pedicle after applying two endo-clips and transection of the ovarian pedicle, thus another endo-clip was applied to the right ovarian pedicle to ensure haemostasis. Further they observed that in the prepubertal dog, the ovarian pedicle was smaller in size, and hence clip application was easier and it did not warrant electro-cauterization; and in dogs which had whelped, the diameter of the blood vessel was larger and minor blood vessels originating from large ovarian pedicle required electro-cauterization after endo-clip application for ensuring complete haemostasis.

Postoperatively, two animals of group I exhibited suture dehiscence on the fourth day, indicating localised wound healing complications. In contrast, no postoperative complications were observed in animals of group II. Kumar *et al.* (2023) similarly documented cases of skin wound dehiscence and exudation at the lateral working port site following laparoscopic OVH, highlighting the possibility of minor port-site complications even in minimally invasive procedures. Conversely, Austin *et al.* (2003) reported postoperative swelling at the right paramedian port site due to omental herniation through the abdominal wall, which was attributed to incomplete closure of the rectus sheath- an issue that was initially underestimated during surgery.

The mean postoperative pain scores recorded at 24 hr, 48 hr, and 96 hr in group I were 2.00±0.26, 1.83±0.31 and 1.33±0.21, respectively, and in group II the respective scores were 2.33±0.33, 2.17±0.31 and 1.67±0.21. In both groups, the mean pain scores showed a non-significant decrease from 24 hr to 48 hr, followed by a significant reduction at 96 hr, indicating progressive recovery. Devitt *et al.* (2005) reported consistently higher pain scores in dogs undergoing conventional OVH compared to those undergoing laparoscopic OVH. Additionally, 9/10 dogs in the conventional group required supplemental analgesic medication, whereas none of the dogs in the laparoscopic group required additional pain relief. Similarly, Case *et al.* (2011) observed higher pain scores in female dogs subjected to three-port laparoscopic ovariectomy compared to those undergoing two- or one-port procedures. The authors also noted that non-nociceptive stress factors such as environmental noise and unfamiliar individuals could influence the accuracy of subjective pain scoring methods.

By 48 hr postoperatively, the mean rectal temperature, heart rate, and respiratory rate were non-significantly higher than the preoperative values in both groups. However, by 96 hr, these parameters had nearly returned to baseline levels, with all values remaining within the normal physiological range throughout the observation period.

The postoperative mean values of haemoglobin (Hb), packed cell volume (PCV), total erythrocyte count (TEC), monocyte count, lymphocyte count and eosinophil count were non-significantly lower than preoperative levels up to 48 hr, but returned to the preoperative level by 96 hr in both groups. However, all haematological parameters remained within the normal range throughout the study.

In the present study, a significant increase in the mean aspartate aminotransferase (AST) level was observed at 48 hr postoperatively, though the values returned close to preoperative levels by 96 hr. Mean alanine aminotransferase (ALT), blood urea nitrogen (BUN), serum creatinine, serum cortisol and blood glucose levels were non-significantly elevated at 48 hr postoperatively, with values nearing baseline by 96 hr in both groups.

Ranganath and Kumar (2007) also reported a significant elevation in AST levels in bitches undergoing the left flank method of OVH, as compared to those operated via the laparoscopic approach, likely due to greater muscle trauma. Kumar *et al.* (2023) reported that serum cortisol concentrations peaked at 30 min postoperatively, followed by a gradual decline, reaching preoperative levels by 10th day in animals undergoing both laparoscopic and open OVH. Cortisol concentration is widely recognised as a physiological indicator of stress and pain in dogs (Devitt *et al.*, 2005).

Based on the results of this study, it was concluded that both haemostasis techniques, electrocoagulation and endo-clips techniques, were effective and feasible, and hence can be recommended

for laparoscopic ovariohysterectomy in female dogs irrespective of body condition and parity. However, the laparoscopic ovariohysterectomy in female dogs with electro coagulation technique is quicker and safer than endo-stapling technique. Endo-clips technique was associated with higher rate of complications and thus not recommended particularly in pluriparous and fatty female dogs. Neither of the haemostatic methods affected the physiological and haemato-biochemical parameters significantly.

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