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Research Article

The Efficacy of Radiofrequency Bipolar Vascular Sealant (RBVS) on Canine Laparotomy Ovariohysterectomy

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ABSTRACT

Introduction: Radiofrequency Bipolar Vascular Sealant (RBVS) has been used to provide a more comfortable and secure sealing of vessels in laparoscopic surgery for more than a decade. However, RBVS is not often used in open surgery due to its high cost.
Objectives: To illustrate the cost- benefit of using RBVS.
Material and methods: This study compared operation time and blood loss between RBVS and conventional ligation in canine ovariohysterectomy (OVH). Blood loss may contribute to delay of operation time or complex surgery may increase the bleeding chance.
Result and conclusion: the result found that RBVS significantly reduced operation approximately time to one-third of conventional ligation and significantly reduced blood loss to approximately one-half of conventional ligation. Operation time and blood loss were related to canine body weight. In conclusion, RBVS provides benefits in laparotomy OVH including shortened operation time and decreased bleeding.

Key words: Radiofrequency bipolar vascular sealant, Laparotomy ovariohysterectomy, Canine

INTRODUCTION

Conservative method for canine ovariohysterectomy (OVH) in values of ligation of ovarian vessels and uterine cervix using absorbable suture.(Fossum, 2018) The estimated total operation time for OVH procedure varies between 30 and 60 minutes depending on surgeon skill and animal condition. Faster operation time brings about shorter anesthesia recovery time and may reduce postoperative complications due to hypothermia and infection. Several strategies can be adapted to shorten operation time such as good surgery plan and preparation, a skilled surgeon and appropriate instruments. However, to prevent bleeding from ovarian and uterine vessels, circumferential double loop ligation with or without cervical transfixation is usually applied, but these techniques consume more surgical time. Radiofrequency Bipolar Vascular Sealant (RBVS) has been widely used in laparoscopic surgery for more than a decade in human surgery.(Prokopakis et al., 2005) RBVS provides more comfort and secure vessel sealing than suture ligation. The reduction in operative time, blood loss, complications and postoperative pain on using a bipolar vascular sealant were described in hemorrhoidectomy, hysterectomy and thyroidectomy. (Macario et al., 2008) A canine ovariohysterectomy study showed the benefit of using a bipolar vascular sealant, which decreased bursting pressure to 237 mmHg on the uterine body compared with conventional ligation (300 mmHg), but sealing dehiscence was found in uteruses ≥ 9 mm in diameter.(Barrera and Monnet, 2012)

Generally, laparotomy OVH has a lower cost than laparoscopic OVH, but canine patients receive more postoperative pain due to the large incision wound. However, in laparoscopic OVH ovarian vessels and uterine cervix ligation with suture consumes longer operation time (47–175 minutes) than in open laparotomy OVH (25–140 minutes) and postoperative complications such as massive ovarian pedicle bleeding and dehiscence of the abdominal wall more severe from post-laparoscopic OVH complications such as minor splenic or pedicle hemorrhage and intermittent vaginal hemorrhagic discharge. (Davidson et al., 2004) The acute life-threatening complication in OVH is intra-operative ovarian artery bleeding because of the surrounding slippery fat of the ovarian bursa. Bleeding can be intraoperative or delayed up to 12 hours post-operation. Previous studies in reported ovarian artery bleeding in

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1.12% of 1880 bitches undergoing laparotomy OVH (Muraro and White, 2014) and intraoperative bleeding in 6.34% of 142 bitches.(Burrow et al., 2005) The use of RBVS in laparoscopic surgery in both animal and human has been widely reported because of its safety and providing faster operation time compared with using suture ligation.(Vizzielli et al., 2018) However, RBSV in open-abdominal OVH has not been studied, possibly because of the poor cost-effectiveness of the device.

This study aims to compare the time consumption, complications and cost-effectiveness between the bipolar vascular sealant and conservative ligation in canine laparotomy ovariohysterectomy.

MATERIALS AND METHODS

Twenty-six, anestrous female canines (n=26) age ranged from 1 to 10 years, any breeds were enrolled in the study with ethically approved from the Institutional Animal Care and Use Committee; (Reference number 54/2017, Project code 2560 - 05- 052) and agreement from their owners. The animal with abnormal uterine and abdominal condition such as pyometra, peritonitis, ascites and pregnancy were excluded. Canine patients were randomized into two groups, Thirteen canines (n=13) in the control group underwent OVH by conservative ovarian vessels and uterine body ligation with a mid-term absorbable synthetic braided polyglactin 910 suture (Novosyn®, B.Braun, Germany) and thirteen canines (n=13) in the RBVS group has their ovarian vessels and uterine body sealed using a commercial RBVS (Caiman® Aesculap® Germany) with non-articulating jaw of 5mm shaft diameter and 26.5 mm length. Laparotomy and abdominal closure were performed by routine surgery technique. Veterinary surgeons with different skills and experiences were randomly included.

Canines were anaesthetized by general anesthesia protocol. Isoflurane (Forane®, Baxter Healthcare Corporation, USA) was the inhalation anaesthetic agent provided with 100% oxygen through endotracheal intubation. Vital parameters including body temperature (°F), heart rate (bpm), respiratory rate (bpm), oxygen saturation (%), blood pressure (mmHg) and end-tidal carbon dioxide (mmHg) were monitored every 5 minutes until full recovery.

Operation time was calculated from ovarian vessels clamping until all of the uterine apparatus was removed from the abdominal cavity. Blood loss volume was measured by comparing surgical gauze weight before and after surgery. Blood loss percentage was calculated in proportion of the estimated total body blood volume, considering 79 ml per kg of body weight.(Courtice, 1943) The removed ovaries were inspected for the macroscopic structure to imply the ovarian tissue remnant in the abdominal cavity.

$$\text{Blood loss percentage} = \frac{(Blood\ loss\ volume\ (ml) x 100))}{(79 x Body\ weight\ (kg)}$$

Statistical analysis

Mean and standard deviation (SD) of operation time and blood loss was calculated. Comparison between two groups was analyzed by independent t-test. The correlation between factors were evaluated using Pearson's Correlation Coefficient and defined as if between ± 0.68 and ± 1, moderate if between ± 0.36 and ± 0.67 and weak if below ± 0.35. (Taylor, 1990) Prism 8 GraphPad (GraphPad Software, USA) at 95% Confidence interval (CI) was used to analysis.

RESULTS

There was no ovarian tissue remaining in the abdomen and thermal burning of surrounded tissues in both groups. The body weight (BW) of the the control group ranged from 2.80 to 27.00 kg (mean±SD, (10.97±2.382) whereas BW of RBVS group ranged from 1.30-29.00 kg (mean±SD, 11.99±2.835). There was no statistically significant difference of BW in the mean between the two groups (P=0.555) (Figure 1A.) The operation time (from the ovarian vessels clamping to all of the uterine apparatus was removed from the abdominal cavity) of the the control group ranged from 13.03 to 53.27 min (mean±SD, 28.55±3.393), whereas the operation time of RBVS group ranged from 6.28 to 26.26 (mean±SD, 10.93±1.647). Operation time in the RBVS group was significant to shorter than that of the the control group (P=0.0184) (Figure 1B.). The blood loss (% of total body blood volume) of the the control group ranged from 0.66 to 5.5% (mean±SD, 3.06 ± 0.5269), whereas blood loss (% of total body blood volume) of RBVS group ranged from 1.95 to 3.1% (mean±SD, 1.696 ± 0.2482). Blood loss in the RBVS group was significantly lower than that on the control group. (P=0.0143) (Figure 1C.).

The body weight (kg) and operation time (min) had a statistical significantly strong positive correlation (R^2= 0.8197) (P<0.0001) in the control group, whereas the body weight (kg) and blood loss (ml) had a statistical significantly moderate positive correlation (R^2= 0.4564) (P=0.113) in RBVS group (Figure 2A and 2B).

The body weight (kg) and blood loss (ml) had a statistical significantly strong positive correlation (R^2=0.7038) (P=0.0003) in the control group, whereas the body weight (kg) and blood loss (ml) had a statistical significantly weak positive correlation (R^2=0.3396) (P=0366) in RBVS group (Figure 3A and 3B).

The operation time (min) and blood loss (ml) had a statistical significantly moderate positive correlation (R^2= 0.6577) (P=0.0008) in the control group. The operation time (min) and blood loss (ml) also had a statistical significantly moderate positive correlation (R^2= 0.6784) (P=0.0005) in RBVS group (Figure 4A and 4B).

DISCUSSION

Radiofrequency Bipolar Vascular Sealant (RBVS) significantly reduced operation approximately time to one-third of that for conventional ligation and significantly reduced blood loss to approximately one-half of that in conventional ligation. However, very large vessels may pose a limitation on the use of RBVS. Vessels diameter up to 7 mm is recommended for RBVS when using a Caiman 5, non-articulating jaw at 5 mm shaft diameter and 26.5mm length.(Soto-Vega et al.) A porcine study showed the average of successful bursting

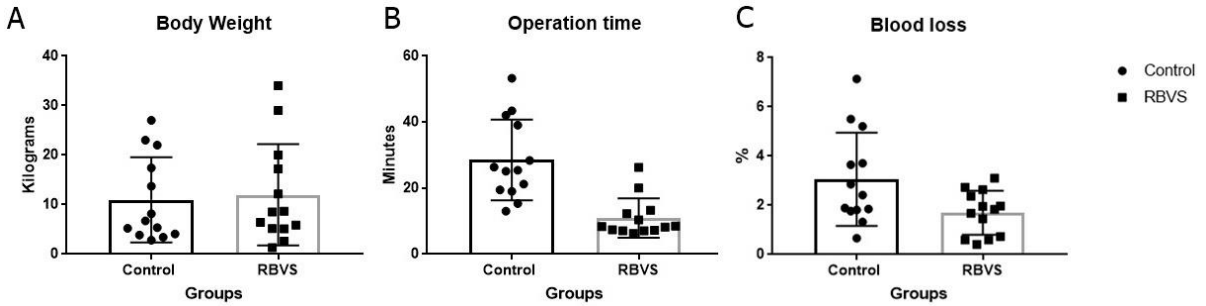

Fig. 1: The comparison of body weight (A), operation time (B) and blood loss (% of total body blood volume) (C) between control and RBVS group in Scatter plot with bar (mean±SD).

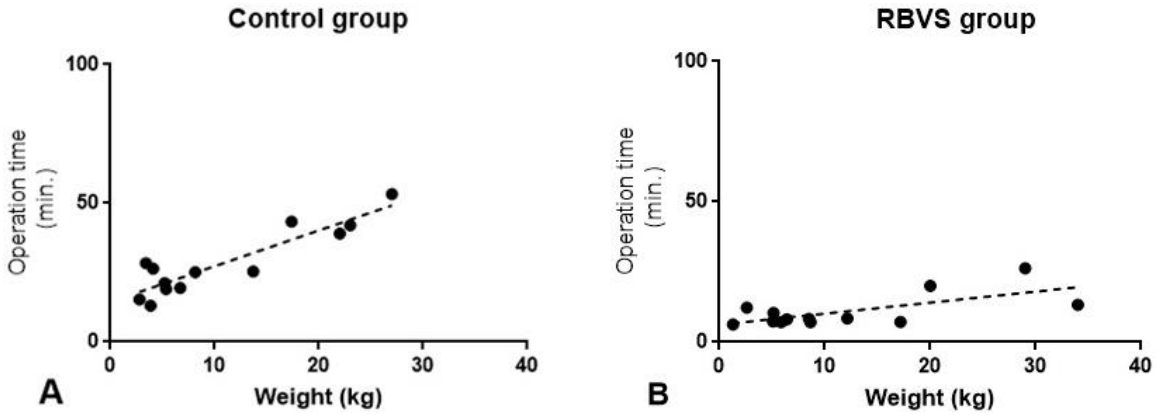

Fig. 2: Correlation between weight (kg) and operation time (min) of the control group (A) and the RBVS group (B).

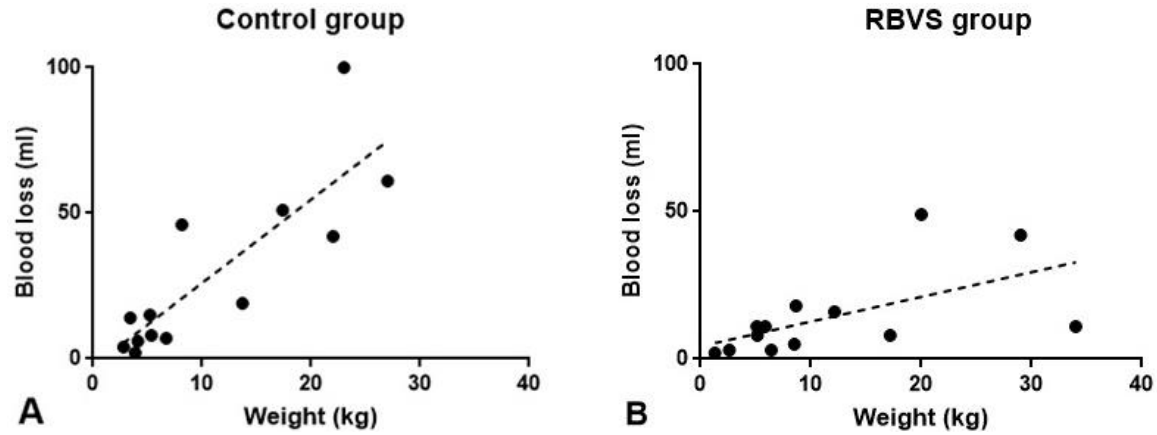

Fig. 3: Correlation between weight (kg) and blood loss (ml) of the control group (A) and RBVS group (B).

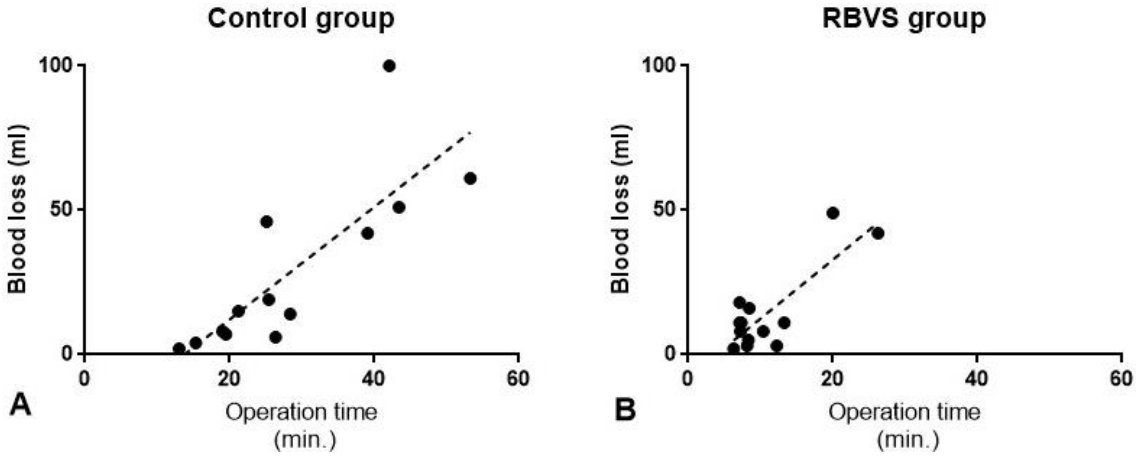

Fig. 4: Correlation Operation time (min) and blood loss (ml) of the control group (A) and RBVS group (B).

pressure of RBVS on three different sizes of vessels including small (2–5 mm), medium (5.1–7 mm), and large (7.1–9 mm) were 1580 mmHg, 1600 mmHg and 1676 mmHg with maximum jaw temperature at 130°C, 120.6°C, and 125°C, respectively.(Okhunov et al., 2018) Thermal spread of RBVS was 108°C -114°C and 2.1-3.0 mm.(Okhunov et al., 2018) In a human laparoscopic malignancy colectomy study, RBVS significantly decreased intraoperative blood loss from an average of 93 to 145ml in other energy devices to an average of 52 to 93 ml. However, hospital stay, complication and morbidity were not significantly different.(Cassini et al., 2017) In this study, there was not remarkable surgical complication, pain and healing defect in both groups.

The strong positive correlation between body weight and operation time in the control group was because body weight is directly related to the size of ovarian vessels/uterine body. In contrast in the RBVS group, body weight was weakly correlated with operation time. Ligation time depends on surgeon skill and tissue characteristic, but RBVS excludes surgeon skill because the device automatically shuts at a pressure of 363 to 536 mmHg with sealing time between 3 and 11 seconds.(Soto-Vega et al., 2018) The moderate positive correlation between body weight and volume of blood loss in both groups was directly related to body weight according to a study of Courtice, which calculated total blood volume from cell-to-plasma ratio (Hematocrit).(Courtice, 1943) In a human study, blood loss was related to operation duration and complexity of surgical procedure (R^2=0.45) because of tissue trauma.(De Caterina et al., 1994) On the other hand, bleeding may prolong operation duration because the surgeon has to spend times for hemostasis.

Although RBVS achieved a reduction in operation time and blood loss and was user-friendly, the cost of using RBVS in laparotomy OVH may affect pet owners. If the RBVS device is estimated to be used by 1000 cases, the cost of RBVS would be approximately 8 times compared with conventional ligation with suture material. However, conventional ligation requires surgeon skill and suture material may cause foreign body reaction.

Conclusions

RBVS significantly reduced both operation time and blood loss in canine laparotomy OVH. Operation time and blood loss were related to canine body weight, whereas blood loss may contribute prolonged operation time or complex surgery may increase the probability of bleeding. RBVS provides more surgical advantages but is also more expensive than conventional surgery.

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