UNIVERSITI PUTRA MALAYSIA

A COMPARATIVE STUDY ON POST-OPERATIVE WOUND HEALING IN CATS THAT UNDERWENT VENTRAL MIDLINE VERSUS FLANK OVARIOHYSTERECTOMY

AINA INSYIRAH BINTI ROSZIZUL KAHAIRI

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AINA INSYIRAH BINTI ROSZIZUL KAHAIRI

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It is hereby certified that we have read this project paper entitled "A comparative study on post-operative wound healing in cats that underwent ventral midline versus flank ovariohysterectomy", by Aina Insyirah Binti Roszizul Kahairi and in our opinion it is satisfactory in terms of scope, quality, and presentation as partial fulfilment of the requirement for the course VPD 4999 – Final Year Project.

WAN MASTURA SHAIK MOHAMED MOSSADEQ

DVM (UPM), MSc (GUELPH), PhD (UPM)

Senior Lecturer,

Faculty of Veterinary Medicine,

Universiti Putra Malaysia

(Supervisor)

KU NURUL ATIQAH KU AZIR

DVM (UPM)

Veterinary Officer,

I-Vet Petcare Seksyen 23,

Shah Alam, Selangor

(Co-Supervisor)

DEDICATION

This study is dedicated to my parents and my family, my friends and also my cats (Bebe & Eli) for giving me the courage and strength to complete this study.

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Alhamdulillah, praise to Allah for blessing me with the time, energy, and health to complete the Final Year Project for this programme. These past few weeks have been nothing but a fun, life-long lesson. This project has truly broadened my perspective on the research aspect in the veterinary field.

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Oleh

Aina Insyirah Binti Roszizul Kahairi

No. Matrik : 188767

Penyelia: Dr. Wan Mastura Shaik Mohamed Mossadeq

Penyelia Bersama: Dr. Ku Nurul Atiqah Ku Azir

ABSTRAK

Ovariohysterectomy (OHE) adalah prosedur di mana pensterilan haiwan betina dilakukan dengan membuang rahim dan ovari secara pembedahan. Walaupun OHE adalah prosedur pembedahan biasa di kebanyakan klinik veterinar, kelebihan pendekatan ini berbanding semua pendekatan lain masih boleh diperdebatkan. Kajian ini dilakukan untuk membandingkan kadar penyembuhan luka pada kucing betina yang menjalani OHE melalui pendekatan garis tengah ventral (n = 25) atau OHE melalui pendekatan lambung (n = 25). Semua kucing (purata berat badan 2.81 ± 0.85 kg) dipantau setiap hari untuk kemungkinan berlakunya komplikasi selepas OHE sehingga hari discaj. Keadaan tapak insisi pada kedua-dua kumpulan diperhatikan setiap hari sepanjang tempoh kajian. Data klinikal dikumpulkan sebaik sahaja selesai OHE dan semasa temu janji pemeriksaan semula pada hari ke-7 selepas OHE. Hasil kajian menunjukkan bahawa kadar penyembuhan luka jauh lebih tinggi ($P < 0.05$) pada kucing yang menjalani OHE melalui pendekatan insisi lambung lateral berbanding OHE melalui pendekatan insisi garis tengah ventral. Selanjutnya, tapak insisi pada 3 daripada 25 (12%) ekor kucing yang menjalani OHE melalui pendekatan insisi lambung menunjukkan kesembuhan penuh. Sebaliknya, 2 dari 25 (8%) ekor kucing yang menjalani OHE melalui pendekatan insisi garis tengah ventral mengalami kegagalan sutur. Oleh itu, disimpulkan bahawa selain dari kemudahan pemerhatian klinikal pasca pembedahan, OHE melalui pendekatan insisi lambung lebih unggul daripada pendekatan insisi garis tengah ventral disebabkan komplikasi minimum yang timbul dan kadar aktiviti penyembuhan luka yang lebih baik.

A COMPARATIVE STUDY ON POST-OPERATIVE WOUND HEALING IN CATS THAT UNDERWENT VENTRAL MIDLINE VERSUS FLANK OVARIOHYSTERECTOMY

By

Aina Insyirah Binti Roszizul Kahairi

Matric No. : 188767

Supervisor: Dr. Wan Mastura Shaik Mohamed Mossadeq

Co-Supervisor: Dr. Ku Nurul Atiqah Ku Azir

ABSTRACT

Ovariohysterectomy (OHE) is a procedure in which sterilization of a female animal is performed by surgically removing the uterus and ovaries. Although OHE is a common surgical procedure in most veterinary clinics, the superiority of this approach over all other approaches is still debatable. This study was conducted to compare the wound healing rates in female cats that underwent OHE via the ventral midline approach (n=25) to OHE via the lateral flank approach (n=25). All cats (mean body weight of 2.81 ± 0.85 kg) were monitored daily for possible occurrence of complications post-OHE until the day of discharge. The condition of the incision site in both groups was observed daily throughout the period of study. Clinical data was collected immediately after the completion of OHE and during the re-examination appointment on day-7 post OHE. Results from the study indicated that the rate of wound healing was significantly higher ($P < 0.05$) in cats that underwent OHE via the lateral flank approach as compared to OHE via the ventral midline approach. Furthermore, 3 out of 25 (12%) cats that underwent OHE via the flank approach displayed a completely healed incision site. In contrast, 2 out of 25 cats (8%) that underwent OHE via the ventral midline approach succumbed to suture breakdowns. Hence, it is concluded that aside from the ease of post-surgery clinical observation, OHE via the lateral flank approach is superior to the ventral midline approach due to the minimal complications elicited and better rate of wound healing activity observed.

1.0 INTRODUCTION

1.1 Study Background

Ovariohysterectomy (OHE) in cats is usually performed via the ventral midline approach compared to the flank approach. Majority of practicing veterinarians in Malaysia adopt the ventral midline approach for OHE because it is the only approach that has been taught and applied in practical classes in most teaching hospitals. In addition, the ventral midline approach is often preferred by surgeons due to the ease of access to the uterus (Faisal et al., 2014).

A wound may be defined as a breakdown or loss of cellular and anatomical or functional continuity of living tissues. Wound healing on the other hand, is a biological process that is caused by trauma (whether intentional or accidental) and is often followed by scar formation (Kumar et al., 2013). Clean wounds that are properly debrided aseptically often heal without complications. However, different rates of wound healing may be observed depending on the size of the wound, and the location of the wound (Mickelson et al., 2016). Moreover, the skills and the experience of the surgeon play an important role in determining the overall outcome of the wound. Nevertheless, it is vital that the surgical wounds post-spay heal properly to avoid excessive hemorrhage from the skin and subcutaneous tissues, infections and leakage from the mammary tissues (McGrath et al., 2004).

1.2 Justification

The flank approach in small animals has yet to gain widespread recognition in the United States, mostly due to the differences in surgical ideology, anaesthesia protocols, and post-operative management. Although smaller animals with a narrow body conformation enables easier access to the ovaries and uterus, the variation in body size and wider body conformation in larger animals however, results in the difficulty in accessing the contralateral ovary (McGrath et al., 2004). The flank approach, although not commonly practiced, offers many advantages including avoidance of evisceration even in the presence of wound dehiscence, less surgical trauma, and shorter surgical time (Coe et al., 2016). Nevertheless, this approach has just gained interests amongst veterinarians who work with animal shelters, due to the ease of monitoring the animal's incision site post-OHE from afar (Reece et al., 2012). Smith (2014) reported that regardless of the benefits and disadvantages of both approach, the choice of either technique is often made based on a veterinarian's personal choice and previous training. This study aims to elucidate the correlation between the anatomical site of the incision to the rate of wound healing in cats that underwent ventral midline or flank OHE approach.

1.3 Objective

To determine the correlation between the anatomical site of the incision to the wound healing rate post-OHE

1.4 Hypotheses

Null hypothesis

The mean of wound healing rate for both approaches is the same

Alternative hypothesis

The mean of wound healing rate for both approaches is not the same

2.0 LITERATURE REVIEW

2.1 Ovariohysterectomy (OHE)

The onset of puberty in female cats may be as early as 12 weeks, and a single female cat may produce 40 kittens per year. However, neutering during the early stages of life has been shown to dramatically reduce the risk of mammary tumours development in dogs and cats (Smith et al., 2014). In addition, Roberts et al. (2015) stated that between 75% and 97% of cats in Australia need to be neutered to stabilise their numbers in the population. Therefore, neutering is often performed on cats as a form of population control (Murugesan et al., 2020). Neutering (spay) or sterilization of female animals is performed by surgically removing the uterus and ovaries through a procedure known as ovariohysterectomy (OHE).

2.2 Ventral midline versus lateral flank approach for OHE

OHE in cats are regularly performed via ventral midline or lateral flank approach. A ventral midline spay is performed by making a surgical incision through the linea alba of the patient (cats) placed on dorsal recumbency; whereas a flank spay is performed with the patient placed on left lateral recumbency (Coe et al., 2006). The ventral midline incision is made on the ventral abdominal midline at the middle of umbilicus and the anterior brim of the pubis. In contrast, the flank incision is made parallel to the last rib, cranial to the wing of ilium and just ventral to the transverse spinous processes (Bushby, 2014). In addition, the closing suture for the midline incision of this approach must include the external rectus fascia. On the other hand, the

closing suture for the flank incision must include the transverse abdominal muscle as well as the internal and external abdominal oblique muscles (Griffin et al., 2016).

2.3 Stages of wound healing in cats

The duration of wound healing depends on several factors such as the host factors (e.g. age, body condition, nutritional intake, concurrent disease) and the local wound factors (e.g. tissue perfusion, tissue viability, infection, presence of hematoma and/or seroma, mechanical factors such as tension, motion, wound debris) (Mickelson et al., 2017). The wound healing process can be divided into the inflammatory, proliferative, maturation and remodelling stages; following the same fundamental patterns of healing (i.e. first intention vs. second intention) (Volk, 2013).

2.3.1 Inflammatory phase

The inflammatory phase or also referred to as lag phase or preparatory phase, occurs immediately in response to injury (Pavletic, 2018). During this phase, the vasoconstriction process which lasts for 5-10 minutes will be followed by the vasodilation process during which, blood clotting mechanism occurs. This process involves adhesion of platelets to the vascular endothelium. These platelets secretes vasoactive mediators as well as chemotactic factors to recruit leukocytes. The host's leukocytes or white blood cells will migrate into the site of tissue damage (wound) through the basement membrane of the vessel wall by diapedesis within 30 minutes in order to resolve the inflammation. During the initial stage, the peripheral blood is predominated by neutrophils until these cells undergo apoptosis and are replaced by

the monocytes (Winkler, 2020). The predominant monocytes also secrete a number of growth factors deemed necessary for wound healing. Thus, the combined activities such as increased blood flow and fluid extravasation in addition to blockage of lymphatic drainage (Mickelson et al., 2017) during this stage results in the classic signs of inflammation such as redness, swelling, heat and pain. The inflammatory or lag period in experimental wounds typically lasts about 5 days.

2.3.2 Proliferative phase

In a non-complicated wound, the early reparation of the affected site occurs 3-5 days after the initial injury while the formation of early granulation tissues requires approximately 4 days to be completed. The four key processes associated with this phase which occur in a consecutive manner are neovascularisation, fibroplasia and collagen deposition, epithelialisation, and wound contraction (Pavletic, 2018).

The blood capillaries which operate on the principle of oxygen gradient are attracted to the presence of low oxygen tension at the centre of the wound. The capillaries migrate to the site of damage to supply blood to this area in order to balance the oxygen gradient through a process known as the neovascularisation stage. The fibroblasts that play an important role in wound healing by synthesizing the extracellular matrix and collagen to form a framework for tissues are dependent on the activity or growth of blood capillaries. Thus, both of these structures proliferate together to form the granulation tissue. The granulation tissue formed appears to be both very friable as well as resistant to infection possibly due to the extensive capillary invasion (Winkler, 2020).

The epithelialization process however, begins within hours of the initial tissue damage. During this stage, the basal epithelial cells flatten and migrate from the wound edges to the centre of the open wound by sliding over the fibrin deposits or basal lamina. The migration of epithelial cells underneath the wound clot and over the granulation tissues results in the separation of the scab from the wound via secretion of proteolytic enzymes.

Generally, the wound contraction process takes place five to nine days after the initial injury. During contraction, the existing tissue at the wound edges is drawn inward and the surrounding skin expands, reducing the total wound size. The mechanism continues until the wound edges touch, high tension is produced or until the myofibroblasts become insufficient (Mickelson et al., 2017).

2.3.3 Maturation and remodelling phase

The collagen remodelling process is initiated during the transition from granulation tissue to scar maturation (Kumar et al., 2013). Reinforcement and remodelling of the newly formed collagen is a vital element of this process. The density of blood vessels returns to normal as the scar matures and the number of fibroblasts is decreased by apoptosis (Kawasumi, 2012). By aligning with the body's tension lines, collagen fibres remodel and gain strength via cross-linking (Mickelson et al., 2017). This mechanism allows tensile strength to continue to increase steadily over a long time (as long as 2 years). However, most wounds persist 15%-20% weaker than the original tissue (Winkler, 2020).

2.4 Anatomical and physiological aspects of wound healing

Compared to the flank approach in OHE, the ventral midline approach was reported to have higher chances of the wound being inflamed or infected due to its location on the ventral side, complications arising from the wound inflicted and the difficulty of the owners to observe the wound (Babu et al., 2018). However, Coe et al. (2006) stated that the presence of discharge at the site of wound was significantly higher in cats that were spayed via the flank approach. The higher incidence of a discharge following a flank approach may have been due to the higher fat and muscle thickness incised during this approach; however, the greater flank site visibility may play a role in increasing the owner's likelihood of detecting a presence of discharge at the incision site post-spay. On the other hand, Swaffield et al. (2019) reported that severe swelling and discharge observed in cats post-spay via the ventral midline approach may be recognised as one of the signs of post-operative complication. Hence, the anatomical location of the incision site plays a notable role on the nature of post-operative complications observed.

3.0 MATERIALS AND METHODS

3.1 Study design

This study was carried out on 50 healthy adult female cats (body weight mean ± SD of 2.81 ± 0.85 kg) of Domestic Short Hair and Domestic Long Hair breeds that were admitted for OHE.

A total of 25 cats that were admitted to I-Vet Petcare underwent ventral midline OHE while a separate group of cats (n=25) admitted to Serv-U Veterinary Clinic underwent flank OHE. Each group was further subdivided into five (5) subgroups; subgroup A1, A2, A3, A4, A5; with a total of 5 cats per subgroup. Cats in subgroup A1, A2, A3, A4, A5 underwent ventral midline OHE on Monday, Tuesday, Wednesday, Thursday, and Friday respectively. All cats were monitored immediately post-OHE until the day of discharge. The other subgroup B1, B2, B3, B4, B5 also consisted of 5 cats per subgroup. Cats in the B1, B2, B3, B4, B5 group underwent flank OHE on Monday, Tuesday, Wednesday, Thursday, and Friday on the following week. All cats in this group were also monitored immediately post-OHE until the day of discharge. Clinical data was collected immediately after the completion of OHE, at the time of discharge, and on day-7 (post-operative re-examination appointment).

The healed incision site was measured with the aid of a ruler and is photographed. Images of the incision site were taken with the owner's consent for record purposes. Informed written consent forms were obtained from the owners of all animals under study at both clinics. All procedures were performed by the practicing veterinarians at the respective clinics.

The approval from the Institutional Animal Care and Use Committee (IACUC) Universiti Putra Malaysia was granted for this project (UPM/IACUC/AUP-U013/2020).

3.2 Statistical analysis

Data were analysed statistically using Independent t-test (IBM SPSS Statistics software version 25) and expressed as mean ± SEM. A value of $P<0.05$ is considered as statistically significant.

3.3 Pre-operative, anaesthetic protocol and post-operative medication

General physical examination was performed on all cats upon admission to the clinic. Only vaccinated cats are allowed for admission to these clinics. All cats were kept in individual cages for ease of monitoring i.e. mentation and were fasted 6-8 hours prior to the surgery. Next, they are premedicated with xylazine (Ilium Xylazil-20®) at 2mg/kg, intramuscularly (IM), and induced with ketamine (Ilium Ketamil®) at 20mg/kg, IM. Immediately after the surgery, all cats were given amoxicillin (Amoxi 20%®) at 20mg/kg, subcutaneously (SC). Upon discharge (Day 2), cats at I-Vet Petcare were dispensed with metronidazole (Metronidazole 200®) at 10mg/kg, *per os* (PO), and Beazyme at 1 tablet per cat whereas cats at Serv-U Vet Care were dispensed with amoxicillin (Almox®) at 10mg/kg, PO, and Beazyme at 1 tablet per cat. The dispensed medications were indicated for 5 days after the surgery.

3.4 Surgery

OHE was performed in all the animals through either the ventral midline or flank approach as per standard surgical procedure following the anaesthetic protocol

previously mentioned. All cats were prepared routinely for ventral midline and flank approach.

3.4.1 Ventral midline approach

The cat was placed in dorsal recumbency on the surgery table. The skin and subcutaneous fat were incised 2-3 cm in the midline area midway between the second and last mammary, exposing the rectus abdominis muscles using blade #15 through the linea alba and the parietal peritoneum to access the peritoneal cavity (Coe et al., 2006). The ovary and uterus were identified using a spay hook and exteriorised. The right ovarian pedicle was ligated with 3-0 polyglycolic acid suture, severed using three clamp pedicle technique and released after inspection for any occurrence of haemorrhage. The same procedure was repeated for the left ovarian pedicle. The uterine body was exteriorised and clamped using the three clamp pedicle technique. An encircling ligature with same suture material was placed cranial to cervix. Then, the uterine body was severed and released after inspection for any occurrence of haemorrhage. The same suture material was used to oppose the linea alba and subcutaneous tissue using the simple interrupted pattern. Finally, the skin was sutured using horizontal mattress pattern.

3.4.2 Flank approach

The cat was placed on right lateral recumbency on the surgery table. An approximately 2-3 cm incision was made two finger-widths behind the last rib and one finger-width below the transverse process (McGrath et al., 2014). The muscle fibres underneath the skin were then bluntly dissected using a curved mayo scissors until it reaches the peritoneal cavity. The ovarian vessels were clamped using the three-clamp

pedicle technique and were auto-ligated. The uterine body was exteriorised and an encircling ligature with 3-0 polyglycolic acid suture was placed cranial to cervix and the uterine body was severed by using the three clamp pedicle technique. The stump was then released after inspection for any occurrence of haemorrhage. The peritoneum, transverse, internal and external oblique muscles, followed by subcutaneous tissues were closed individually using simple interrupted suture pattern using the same suture material. Finally, the skin was closed intradermally using the same suture.

3.5 Clinical observation of the wound

The wound healing rate (WHR) was reported to be one of the best parameters for quantifying the wound healing progress in clinical settings (Meyers et al., 2020). The observation of WHR includes establishment of clinical markers during a wound follow-up such as the reduction or increment of the size of wound inflicted on the animals.

In this study, assessment of the wound was performed using the direct observation of the characteristics of the wound surface method. The clinical appearance of the wound was documented at two time points; at 24 hours and 7 days post-surgery.

Percentage of Wound Healing Rate (WHR) was calculated using the formula below

$$\text{WHR} = \frac{(\text{Initial wound area} - \text{Final wound area})}{\text{Initial wound area}} \times 100$$

Where, WHR equivalent to 100% implies total healing and a WHR equivalent to 0% is indicative of no healing at all. A WHR > 0% represents a decrease in wound area and WHR <0% represents an increase in wound area (Meyers et al., 2020).

3.6 Post-surgery monitoring

The incision sites were measured directly using a ruler after the skin was closed. Apart from that, the cats' crucial parameters i.e. mentation, appetite, bowel, urination, and surgical wound were also monitored from day-1 until day-7 post-surgery. The second data collection was conducted 24 hours post-surgery. Any significant changes in the length and the characteristic of the wound was observed and recorded. After the cats were discharged, owners were asked to monitor their cats at home, and were reminded to bring their cats to the clinic seven days after the surgery for the purpose of post-operative re-examination. Owners who were not available for a revisit were contacted by the researcher via the telephone and were asked to photograph and describe their cat's wound appearance via Whatsapp©, a cross-platform messaging app.

4.0 RESULTS

Animals from both groups remained healthy with good mobility, responsiveness and normal breathing throughout the experiment. Results from the study indicated that the wound healing rate in the flank-approach (72.5 ± 3.3%) (CI, 95%) or group (B) is significantly different ($P<0.05$) compared to the ventral midline approach (Group A) (59.9 ± 3.5 %)(CI, 95%) (Figure 4.1).

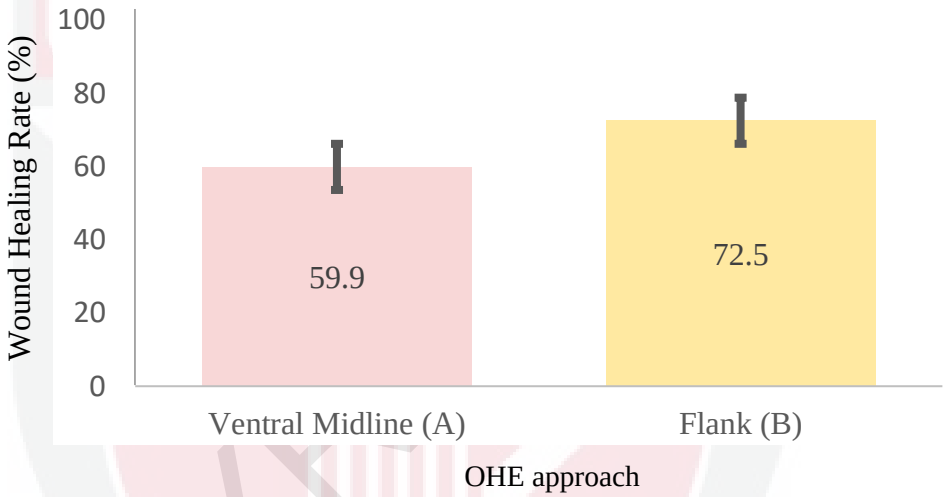

Figure 4.1 Wound healing rate of cats that underwent ventral midline versus flank OHE

Figure 4.2 Physical appearance of wound from a cat in group A (Day 2)

Figure 4.3 Physical appearance of wound from a cat in group B (Day 2)

All cats in group A (ventral midline group) (Figure 4.2) and group B (flank group) (Figure 4.3) showed no presence of swelling and discharge at the respective suture site on the day of discharge (Day 2). However, there was as presence of hardened serosanguinous discharge surrounding the suture site in 1 out of 25 cats from group A (Figure 4.4) during the post-operative re-examination appointment (Day 7), whereas none of the cats in group B showed any signs of discharge around the incision site at Day 7. There were scab formations on the incision site of cats in group B as early as 3 days (Figure 4.5) post-OHE compared to group A which formed about 7 days post-surgery (Figure 4.6).

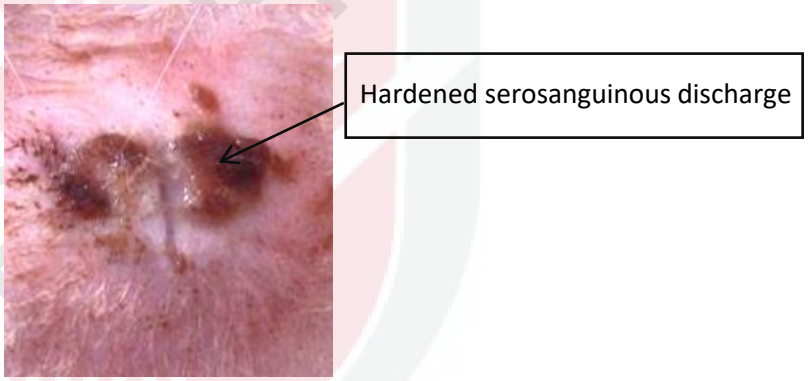

Figure 4.4 Hardened discharge observed surrounding the incision site of a cat from group A at Day 7

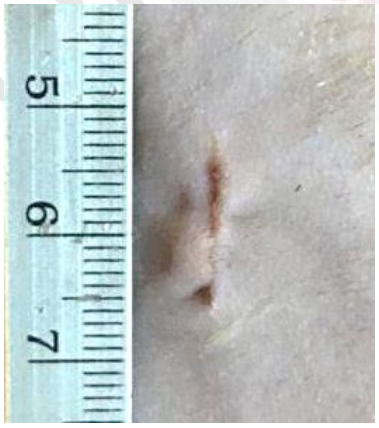

Figure 4.5 Formation of scab on a cat from group B at Day 3

Figure 4.6 Formation of scab on a cat from group A at Day 7

On day 7 post-spay reassessment visit, 2 out of 25 cats (8%) from group A had a suture breakdown as shown in Figure 4.7 (i) and (ii) with no other complications whereas none of the cats in group B had any suture breakdown. However, 3 out of 25 cats (12%) from group B showed a completely healed incision site as shown in Figure 4.8 (i-iii).

Figure 4.7 (i), (ii) Examples of suture breakdown in cats from group A

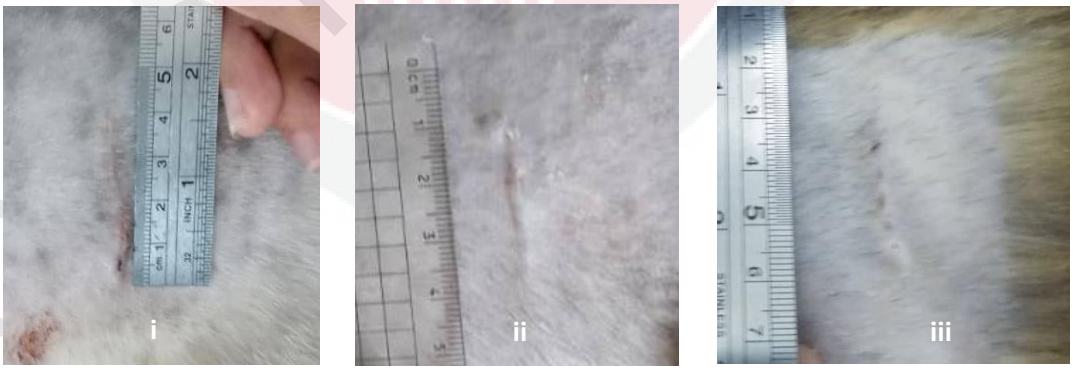

Figure 4.8 (i), (ii), (iii) Total wound healing at Day 7 (Group B)

5.0 DISCUSSION

Results from this study indicated that the mean wound healing rate of the flank OHE approach is significantly different from the ventral midline OHE approach. This result is similar to those found by Faisal et al. (2014). The differences of wound healing rates seen in both approches may be due to several factors. It is known that the incision of the ventral midline OHE approach is performed on the linea alba, which lacks vascularity and is in constant pressure from the abdominal organs that pushes down on the incision site due to gravitational pull. In addition, the anatomical location of the ventral midline OHE creates a highly accecible wound site for cats to lick on during the recovery process which further exacerbate the condition. This factor may contribute to the slow healing process in this approach as compared to the flank approach (Acharya et al., 2016). Moreover, due to the same factor, cats in the ventral midline group are more predisposed to wound contamination as the wound site may be in direct contact with dirty floorings as compared to cats in the flank-OHE group.

Reece et al. (2012) stated that the flank approach is a technique that is more preferred to the ventral midline approach since smaller incisions are required and the risk of abdominal hernia is lowered if the body closure fails. Even though the initial incision length for cats in group A (0.96cm ± 0.163 cm) of this study was lesser than of group B (2.168cm ± 0.536cm), the wound healing rate in the flank approach was still higher than the ventral midline approach.

Cats in shelters that underwent ventral midline OHE at the age of less than 12 weeks old had significantly higher post-operative wound complications compared to cats that underwent OHE via the flank approach (Roberts et al., 2015). However, there

was no significant difference observed in older cats, indicating that the differences may be due to the different post-surgery activity of younger versus older cats (Gates, 2019). However, the exact age of most cats used in this study is not known to the clinic or the owner. Therefore, a comparison in terms of the possible contribution of the age factor in wound healing activity cannot be made at present.

During the observation period, 2 cats out of 25 cats (8%) from group A had suture breakdowns, The causal factors may likely be due to the choice of suture pattern used during skin closure i.e. horizontal mattress versus intradermal suture pattern for cats in group B. However, other factors such as the suture material, number of throws per knot, and surgeon experience may all influence the likelihood of the knot remaining secure (Miller, 2016). Most surgeons tend to use intradermal patterns to close the skin as it can minimise self-induced trauma and discard the need for appointments for suture removal (Sylvestre et al., 2002). In addition, leaving suture materials in the incision site can be troublesome as it can result in significant tissue reactions which can take weeks to months to resolve until the foreign material is removed (Gates, 2019).

6.0 LIMITATIONS AND RECOMMENDATIONS

The significance difference of wound healing rate in both approaches observed in the present study may be due to the contribution of several factors such as the different practices adopted by both clinics, whereby metronidazole was dispensed at I-Vet Petcare whereas amoxicillin was dispensed at Serv-U Veterinary Clinic. However, it is unknown whether different prophylactic oral antibiotics could affect the wound healing rate of each approach at this point.

A proper client education is crucial to ensure that a satisfactory woud healing rate in the cats during the recovery period is achieved. Owners of the newly spayed cats need to be reminded to administer medications dispensed for their cat(s) and monitor the recovery process in these animals daily without fail. In addition, other common problems faced by owners such as the difficulties in administering oral medications to their cats need to be addressed by the clinician earlier or at the point of discharge. Furhtermore, it is important to educate the owners that placing any contraception such as Elizabethan Collar or bandages on the cat at home in an effort to accelerate the recovery process may produce adverse reactions and unwanted complications.

Nevertheless, the aforementioned factors may contribute dircetly or indirectly to the wound healing activities observed in these cats. However, variables such as these may be minimised if the cats are warded and closely-monitored throughout the duration of the study.

Furthermore, the efficacy and quality of this study can be improved further by increasing the sample size to 80 cats. This study was limited in terms of sample size as both clinics involved in the study were not able not reach their target caseloads for

OHE each day due to the Recovery Movement Control Order (RMCO) imposed as a result of COVID-19 pandemic thus forcing most pet owners to stay indoors and minimise their expenses due to their financial constraints.

7.0 CONCLUSION

In conclusion, although the incision used for the flank approach was longer in length than the ventral midline approach, the results obtained from this study indicated that there is a significant difference in the wound healing rate observed in cats that underwent OHE via the flank approach as compared to ventral midline approach. This is partly due to the surgeon's experience and skill, anatomical location of the incision site, accessibilty of the animal to the wound, and wound contamination from dirty surfaces. Other factors that may contribute to the results such as the age and different practices adopetd at the point of discharge were not explored at present. In summary, results obtained from this study indicated that OHE-performed via the flank approach produces a better wound healing rate, ease of monitoring and produces lesser complications than the conventional procedure.

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APPENDIX I (a) and (b)

All values of WHR were numbered as percentage, log, and expressed as mean ± standard deviation, and standard error (Appendix 1 a and b) which are then analysed using Independent T-Test in SPSS software.

	Groups	N	Mean	Std. Deviation	Std. Error
Wound Healing Rate (%)	Ventral midline	25	59.9072	16.69471	3.33894
	Flank	25	72.5492	17.42734	3.48547
Wound Healing Rate (log)	Ventral midline	25	4.0501	0.31253	0.06251
	Flank	25	4.2539	0.25900	0.05180

Appendix 1. a Semi-quantitative evaluation of wound healing rate of 2 groups (A and B).

	F	Sig.	t	df	Sig. (2-tailed)	Mean diff.	95% Confidence Interval of the Difference	
							Lower	Upper
Wound Healing Rate (%)	0.138	0.712	-2.619	48	0.012	-12.642	-22.347	-2.937
Wound Healing Rate (log)	0.530	0.470	-2.511	48	0.015	-0.204	-0.367	-0.041

Appendix 1. b Result of Independent T-Test analysis.