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A Comparative Study on Midline and Right Flank Ovariohysterectomy with Special Reference to Postoperative Changes During Wound Healing in Cats

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ABSTRACT

Ovariohysterectomy is the most common surgical procedure performed in dogs and cats, which prevents the risk of development of mammary tumor and pyometra. Although there is no standard surgical approach to the ovariohysterectomy of dogs, some prefer the midline over the flank approach. This study compared postoperative hematological, hormonal, and wound healing responses in cats undergoing ventral midline versus lateral flank ovariohysterectomy. Thirty clinically healthy female cats were randomly divided into two equal groups, with Group I subjected to midline ovariohysterectomy and Group II to flank ovariohysterectomy. Blood samples were collected on Day 0 (preoperative) and on postoperative Days 1, 3, and 7 for complete blood count and serum cortisol and estrogen estimation, and wound healing was assessed clinically. Both approaches produced significant postoperative changes; however, the midline group showed significantly higher total leukocyte counts, neutrophil percentages, and serum cortisol levels, along with lower lymphocyte percentages, hemoglobin concentration, and packed cell volume during the early postoperative period ($p < 0.05$), indicating greater surgical stress and inflammatory response. Serum estrogen concentrations decreased significantly in both groups following ovariohysterectomy, with a more pronounced decline in the midline group. Clinically, wound healing was uneventful in most cases except one case of evisceration and one case of wound breakdown in midline ovariohysterectomy, but cats undergoing flank ovariohysterectomy demonstrated milder inflammatory reactions, earlier normalization of hematological and hormonal parameters, and without evisceration and wound breakdown. Overall, lateral flank ovariohysterectomy was associated with reduced postoperative stress and faster recovery compared to the ventral midline approach.

Keywords: Ovariohysterectomy, Midline approach, Right flank approach, Postoperative changes, Cat.

INTRODUCTION

Ovariohysterectomy (OVH), commonly referred to as spaying, is one of the most frequently performed elective surgical procedures in feline veterinary practice. The procedure involves the complete surgical removal of both ovaries and the uterus and is routinely undertaken to prevent unwanted reproduction, control stray animal populations, and reduce the incidence of reproductive tract disorders. In female cats, ovariohysterectomy has been shown to significantly decrease the risk of uterine diseases such as pyometra and markedly reduce the incidence of mammary neoplasia, particularly when the procedure is performed before sexual maturity(Kustritz, 2007). As a result, ovariohysterectomy is widely recognized as a fundamental component of preventive veterinary medicine and animal welfare programs.

Although ovariohysterectomy is considered a routine procedure, it is a major surgical intervention that results in tissue trauma and physiological stress. Surgical injury initiates a cascade of local and systemic responses, including activation of inflammatory pathways, release of stress hormones, and metabolic alterations. These responses are essential for tissue repair; however, excessive or prolonged reactions may negatively affect wound healing and postoperative recovery. Postoperative complications such as pain, inflammation, delayed wound healing, infection, and wound dehiscence are commonly reported and may compromise animal welfare if not properly managed(Mathews et al., 2015).

The severity of postoperative responses is influenced by several factors, including anesthetic protocol, surgical duration, tissue handling, surgeon expertise, and the surgical approach used to access the reproductive organs. Among these variables, the surgical approach is of particular importance because it directly determines the extent of tissue disruption, inflammatory response, and postoperative pain. In feline ovariohysterectomy, two primary surgical approaches are commonly practiced: the ventral midline approach and the lateral flank approach.

The ventral midline approach involves an incision through the linea alba, providing direct access to the abdominal cavity and reproductive organs. This approach is widely used due to its familiarity among surgeons, excellent visualization of anatomical structures, and ease of extension if complications occur. It is particularly advantageous in pregnant or obese animals, where greater exposure may be required(Fossum, 2012). However, the midline approach may involve increased manipulation of abdominal tissues and prolonged exposure of viscera, which can contribute to heightened postoperative inflammation and discomfort.

In contrast, the lateral flank approach involves a skin and muscle incision made on the lateral aspect of the abdomen, typically on the left side. Through this incision, the ovaries and uterus are exteriorized and removed. The flank approach is often preferred in free-roaming or feral cats because the incision site is less accessible to licking and contamination, potentially reducing the risk of wound complications. Additionally, some studies have suggested that the flank approach may be associated with reduced postoperative pain and faster wound healing compared with the midline approach(McGrath et al., 2004).

Despite these potential advantages, the flank approach has certain limitations. Visualization of abdominal structures may be restricted, and the technique requires greater surgical skill. Furthermore, the flank approach may be less suitable in cases involving uterine enlargement, pregnancy, or abdominal pathology. Postoperative complications can occur following both surgical approaches, emphasizing that technique selection should consider both clinical outcomes and physiological responses(Pollari et al., 1996).

Wound healing is a complex and dynamic biological process involving a sequence of overlapping phases, including hemostasis, inflammation, proliferation, and tissue remodeling. Each phase is tightly regulated by interactions among inflammatory cells, cytokines, growth factors, and extracellular matrix components. Proper coordination of these processes is essential for timely wound closure and restoration of tissue integrity(Gurtner et al., 2008). Surgical trauma disrupts tissue continuity and initiates an inflammatory response that is necessary for wound repair.

Inflammation represents a critical early phase of wound healing, characterized by vasodilation, increased vascular permeability, and infiltration of immune cells. Inflammatory cytokines play a central role in coordinating this response. Among these cytokines, interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) are rapidly released following tissue injury and serve as key mediators of leukocyte recruitment and activation. While controlled cytokine activity promotes healing, excessive or prolonged inflammation may impair fibroblast function, delay collagen deposition, and increase the risk of wound complications(Eming et al., 2007).

The magnitude of the inflammatory response is closely related to the extent of tissue trauma and surgical manipulation. Surgical approaches that minimize tissue damage may therefore result in a more favorable inflammatory profile and improved wound healing outcomes. Assessment of inflammatory mediators provides an objective measure of the physiological impact of surgery and may offer valuable insight beyond clinical observation alone.

In addition to inflammatory mediators, surgical procedures activate the hypothalamic–pituitary–adrenal (HPA) axis, leading to increased secretion of stress hormones, particularly cortisol. Cortisol plays a vital role in maintaining cardiovascular stability, glucose metabolism, and immune regulation during stress. However, sustained elevation of cortisol can suppress immune function, inhibit fibroblast proliferation, and impair collagen synthesis, thereby delaying wound healing(Kiecolt-Glaser et al., 2010). Measurement of cortisol concentrations is therefore widely used as an indicator of surgical stress and postoperative recovery.

Studies conducted in canine patients have demonstrated that the surgical approach can significantly influence postoperative pain, inflammatory responses, and stress hormone levels. (Howe, 2006) reported that minimally invasive techniques and reduced tissue trauma were associated with improved postoperative outcomes. Although direct extrapolation of canine data to feline patients is limited, these findings suggest that surgical technique may play a crucial role in modulating postoperative physiological responses.

Cats differ from dogs in several important aspects, including pain expression, stress sensitivity, and behavioral responses to injury. Felines are known to mask signs of pain and discomfort, making clinical assessment alone unreliable for evaluating postoperative recovery. Subtle behavioral changes may be the only indicators of distress, and these can be easily overlooked (Robertson & Taylor, 2004; Taylor & Robertson, 2004). Consequently, objective biochemical markers are particularly valuable in feline patients for assessing postoperative stress, inflammation, and wound healing.

Despite the widespread performance of ovariohysterectomy in cats, research focusing on postoperative biochemical changes related to wound healing remains limited. Most available studies emphasize clinical outcomes such as wound appearance, complication rates, and behavioral pain scores, with relatively little attention given to underlying inflammatory and endocrine mechanisms. This lack of biochemical data represents a significant gap in feline surgical research and limits the evidence-based selection of surgical techniques.

Understanding postoperative biochemical responses has important clinical implications. Identification of a surgical approach that minimizes inflammatory responses and stress hormone release may lead to improved wound healing, reduced postoperative pain, shorter recovery periods, and enhanced animal welfare. Such information is particularly valuable in high-volume spay programs, where optimizing surgical efficiency and outcomes is essential.

Therefore, the present study aims to comparatively evaluate postoperative biochemical changes associated with wound healing in female cats undergoing ventral midline and lateral flank ovariohysterectomy. By assessing inflammatory and stress-related biochemical markers and correlating these findings with clinical indicators of wound healing, this research seeks to provide objective evidence regarding the physiological impact of each surgical approach. The findings of this study are expected to contribute to improved surgical decision-making and postoperative management strategies in feline veterinary practice.

MATERIALS AND METHODS

The present study was conducted as a prospective, experimental, comparative study to evaluate postoperative changes associated with wound healing in cats undergoing ovariohysterectomy through two different surgical approaches, namely the ventral midline approach and the lateral flank approach. The study aimed to compare inflammatory and tissue repair-related biochemical parameters between the two groups during the postoperative period.

Study Location and Duration

The study was carried out at the Department of Surgery and Theriogenology, Sylhet Agricultural University, over a period of one year, from June 2024 to June 2025. All surgical procedures, sample collections, and postoperative monitoring were performed under aseptic conditions.

Ethical Considerations

The study was conducted in accordance with the ethical guidelines for animal experimentation and was approved by the Institutional Animal Ethics Committee (IAEC) of Sylhet Agricultural University. Informed consent was obtained from all animal owners prior to inclusion in the study.

Animals and Experimental Design

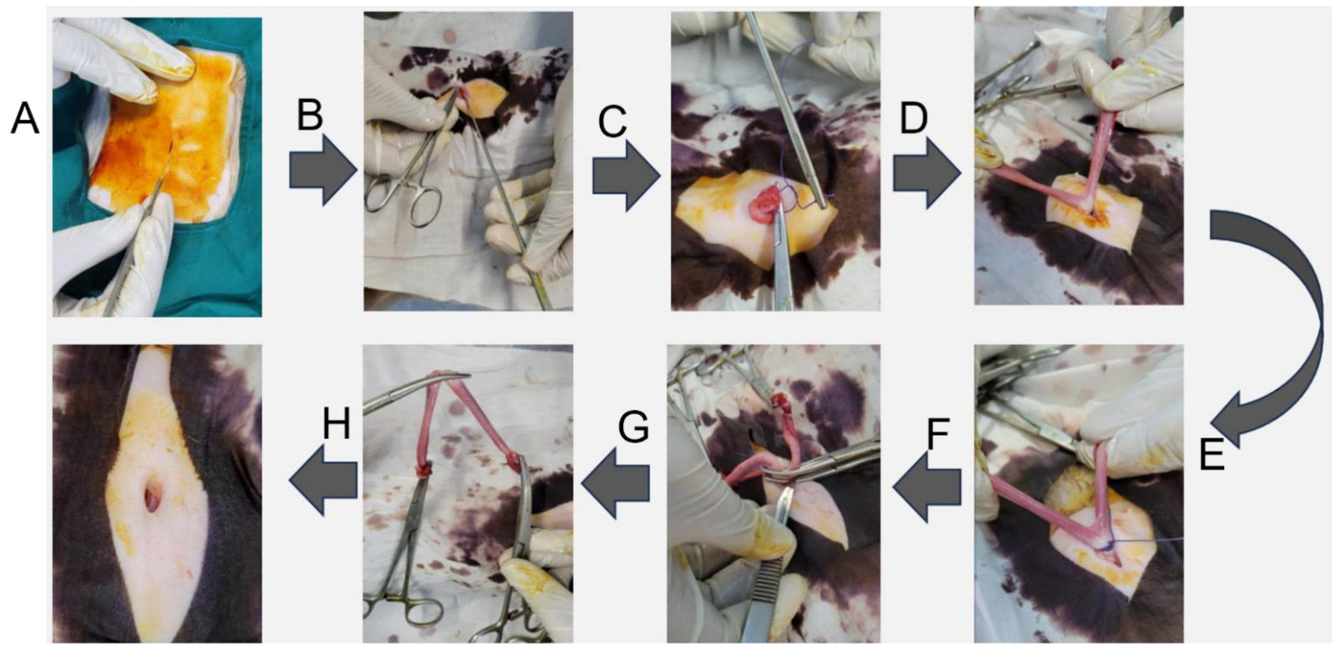
A total of 30 clinically healthy, sexually intact female domestic cats (*Felis catus*) were selected for the study. Cats were presented for elective ovariohysterectomy by their owners. The age of cat ranged from 6 months to 2 years. The body weight ranged between 2.0 kg and 4.0 kg. Clinically healthy cats were selected by physical examination. Normal hematological and biochemical parameters prior to surgery were also recorded. The selected cats were randomly divided into two equal groups: Group I (Midline Group): Cats undergoing ovariohysterectomy through the ventral midline approach and Group II (Flank Group): Cats undergoing ovariohysterectomy through the lateral flank approach. Each group consisted of 15 animals. All cats were fasted for 12 hours prior to surgery, while water was withheld for 6 hours. A thorough clinical examination was performed, including assessment of temperature, heart rate, respiratory rate, mucous membrane color, and capillary refill time. Baseline blood samples were collected preoperatively for hematological and biochemical analysis. The surgical site was prepared by shaving and aseptically scrubbing with povidone-iodine and alcohol. All animals were anesthetized following a standardized anesthetic protocol to minimize variability: Atropine sulfate (0.04 mg/kg, subcutaneously) was used as premedicant 10 min before sedative use. Xylazine hydrochloride (1 mg/kg, intramuscularly) was used as a sedative. Anesthetic, Ketamine hydrochloride (10 mg/kg, intramuscularly) was used 5 min after the sedative use for induction. Additional xylazine and ketamine were required to maintain surgical anesthesia. Vital parameters such as heart rate, respiratory rate, and reflexes were monitored throughout the surgical procedure.

Surgical Procedures

Ventral Midline Ovariohysterectomy (Group I)

Cats in Group I were positioned in dorsal recumbency. A skin incision of approximately 2–3 cm was made along the ventral midline, caudal to the umbilicus. The subcutaneous tissue was bluntly dissected, and the linea alba was incised to enter the abdominal cavity. Both ovaries and the uterus were exteriorized sequentially. The ovarian pedicles and uterine body were ligated using absorbable suture material (e.g., polyglactin 910). The abdominal wall was closed routinely in layers: linea alba, subcutaneous tissue, and skin (Figure 1).

Figure 1: Surgical Procedure of Ovariohysterectomy. A) Incision on ventral midline, B) Exteriorize the uterine horn, C) Ligation of the anterio-ovarian artery, D) Detachment and exposure of the ovaries and uterus, E) Ligation in front of the cervix of the uterus, F) Removal of the uterus including the ovary, G) Removed uterus including ovaries, and H) Completion of the ovariohysterectomy.



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Lateral Flank Ovariohysterectomy (Group II)

Cats in Group II were positioned in lateral recumbency. A 2–3 cm skin incision was made in the left flank region, caudal to the last rib and ventral to the lumbar transverse processes. The abdominal muscles were bluntly separated to enter the peritoneal cavity. The ovary on the incision side was exteriorized first, followed by the contralateral ovary and uterus. Ligation and removal of reproductive organs were performed similarly to the midline approach. The muscle layers, subcutaneous tissue, and skin were closed routinely.

Postoperative Care

All cats received identical postoperative management: Ceftriaxone (35 mg/kg, intramuscularly, once daily for 5 days) as an antibiotic and Meloxicam (0.2 mg/kg on day 1, followed by 0.1 mg/kg for 2 days) as an analgesic were used. Daily inspection and topical antiseptic application were performed for wound healing. Cats were housed individually and monitored daily for appetite, activity, wound condition, and signs of complications.

Blood Sample Collection

Blood samples (approximately 2 mL) were collected from the cephalic vein at the following time points: Day 0, (Preoperative baseline), Day 3 Postoperative, Day 7 Postoperative, and Day 14 Postoperative. Blood samples were divided into EDTA tubes for hematological analysis and Plain tubes for serum biochemical analysis. Serum samples were separated by centrifugation and stored at −20°C until analysis.

Hematological Analysis (CBC)

CBC parameters analyzed include Total leukocyte count (TLC), Neutrophil percentage, Lymphocyte percentage, Hemoglobin (Hb), Packed cell volume (PCV), and Platelet count. CBC was performed using an automated hematology analyzer.

Biochemical Marker Following Midline and Flank Ovariohysterectomy

C-reactive Protein (CRP)

Serum CRP concentration was measured using Immunofluorescence Assay according to the manufacturer's instructions. C-reactive protein (CRP) is a sensitive, non-specific biomarker produced by the liver during the healing process.

Total Protein (TP)

Serum total protein concentration was measured using the Biuret method according to the manufacturer's instructions. Total protein is crucial for tissue repair.

Hormonal Assay

Cortisol

Serum cortisol concentration was measured using a commercial ELISA kit according to the manufacturer's instructions. Cortisol levels were used as an indicator of surgical stress and inflammatory response, which directly influences wound healing.

Estrogen

Serum estrogen levels were quantified using ELISA. Estrogen concentration was monitored due to its known role in collagen synthesis, angiogenesis, and epithelial regeneration.

Clinical Evaluation of Wound Healing

Wound healing status was assessed based on reduction in inflammatory leukocyte counts, normalization of cortisol levels, postoperative decline in estrogen following ovariohysterectomy and absence of wound complications on clinical inspection.

Postoperative wound healing was clinically assessed based on Swelling, Redness, Discharge, Pain on palpation, and wound dehiscence. A standardized wound scoring system was used to compare healing progression between groups.

Statistical analysis

One-way "ANOVA" using Post Hoc tests was done with a 95% confidence interval to compare the mean value of observed parameters among all experimental groups. $P \leq 0.05$ and $P \leq 0.01$ between the two groups were considered significant and highly significant, respectively. A sample size of N=15 per group was selected based on established rules of thumb for pilot studies (Julious, 2005), which suggest N=12 to 15 per group is sufficient for assessing feasibility and estimating standard deviations for future power calculations. The outcome assessors were blinded to group allocation. All the statistical analysis were performed using computerized IBM SPSS Statistics software version 20 (UK).

RESULTS

Hematological Changes Following Midline and Flank Ovariohysterectomy

Total Leukocyte Count

Total leukocyte count did not differ significantly between groups before surgery. Following ovariohysterectomy, TLC increased significantly in both groups; however, the midline ovariohysterectomy group showed a significantly higher leukocyte count on postoperative Days 1, 3, and 7 compared to the flank group ($p < 0.05$), indicating a stronger and more prolonged inflammatory response (Table 1).

Table 1. Comparison of Total Leukocyte Count (TLC, ×10³/µL) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	8.12 ± 0.31	8.05 ± 0.28	0.72
Day 1	14.85 ± 0.54**	11.92 ± 0.47	0.001
Day 3	12.40 ± 0.48**	9.85 ± 0.39	0.003
Day 7	9.65 ± 0.36*	8.42 ± 0.30	0.02

All of the results are expressed as the mean ± SEM. * indicates $P \leq 0.05$ and ** indicates $P \leq 0.01$. A P value of ≤ 0.05 between the two groups was considered significant and a P value of $P \leq 0.01$ between the two groups was considered highly significant

Neutrophil Percentage

Neutrophil percentage increased significantly following surgery in both groups; however, animals subjected to midline ovariohysterectomy exhibited significantly higher neutrophil percentages on postoperative Days 1, 3, and 7 compared to the flank group ($p < 0.05$), indicating a more prolonged inflammatory response (Table 2).

Table 2. Comparison of Neutrophil Percentage (%)(Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	55.4 ± 1.9	54.8 ± 1.7	0.81
Day 1	78.6 ± 2.1**	69.3 ± 1.8	0.001
Day 3	70.2 ± 2.0**	60.1 ± 1.6	0.002
Day 7	60.8 ± 1.8*	56.0 ± 1.5	0.04

All of the results are expressed as the mean ± SEM. * indicates $P \leq 0.05$ and ** indicates $P \leq 0.01$. A P value of ≤ 0.05 between the two groups was considered significant and a P value of $P \leq 0.01$ between the two groups was considered highly significant

Lymphocyte Percentage

Lymphocyte percentage decreased significantly after surgery in both groups; however, the midline ovariohysterectomy group showed significantly lower lymphocyte values on postoperative Days 1, 3, and 7 compared to the flank group ($p < 0.05$), indicating greater postoperative stress and delayed immune recovery (Table 3).

Table 3. Comparison of Lymphocyte Percentage (%)(Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	35.6 ± 1.8	36.2 ± 1.6	0.77
Day 1	16.2 ± 1.4**	24.8 ± 1.7	0.001
Day 3	22.5 ± 1.6**	30.9 ± 1.8	0.002
Day 7	30.4 ± 1.7*	34.8 ± 1.6	0.03

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Hemoglobin Concentration

Hemoglobin concentration decreased significantly following surgery, with a greater reduction observed in the midline group on postoperative Days 1 and 3 ($p < 0.05$), suggesting higher surgical trauma compared to the flank approach (Table 4).

Table 4. Comparison of Hemoglobin Concentration (Hb, g/dL) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	11.8 ± 0.4	11.9 ± 0.3	0.88
Day 1	10.2 ± 0.3*	11.1 ± 0.3	0.02
Day 3	10.6 ± 0.3*	11.4 ± 0.3	0.03
Day 7	11.1 ± 0.3	11.8 ± 0.3	0.06

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Packed Cell Volume

Packed cell volume showed a significant postoperative decline in both groups, with significantly lower values in the midline ovariohysterectomy group on Days 1 and 3 ($p < 0.05$), indicating comparatively greater blood loss and tissue trauma (Table 5).

Table 5. Comparison of Packed Cell Volume (PCV %)(Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	35.2 ± 1.1	35.6 ± 1.0	0.79
Day 1	30.8 ± 1.0**	33.9 ± 0.9	0.01
Day 3	32.1 ± 1.0*	34.6 ± 0.9	0.03
Day 7	34.0 ± 1.0	35.2 ± 0.9	0.09

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

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Platelet Count

Platelet count increased transiently following surgery in both groups; however, a significantly higher platelet count was observed in the midline group on postoperative Day 1 ($p < 0.05$), reflecting a stronger acute hemostatic response (Table 6).

Table 6. Comparison of Platelet Count ($\times 10^3/\mu L$) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	305 ± 15	310 ± 14	0.83
Day 1	360 ± 18*	330 ± 16	0.04
Day 3	340 ± 16	320 ± 15	0.08
Day 7	315 ± 14	308 ± 13	0.67

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Biochemical Changes Following Midline and Flank Ovariohysterectomy

Serum C-reactive Protein Concentration

Serum C-reactive Protein Concentration decreased in both groups. But no significant differences were detected between two groups (Table 7).

Table 7. Comparison of Serum C-reactive Protein Concentration (mg/L) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	4.3667 ±0.41	4.46 ±0.53	0.64
Day 1	4.33 ±0.23	4.16 ± .33	0.38
Day 3	4.20± 0.17	3.90 ± 0.26	0.44
Day 7	3.10 ± 0.20	2.73 ± 0.17	0.72

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Serum Total Protein Concentration

Serum Total Protein Concentration increased in both groups. But no significant differences were detected between two groups (Table 8).

Table 8. Comparison of Serum Total Protein Concentration (g/dL) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	5.96 ± 0.26	5.86 ± 0.34	0.65
Day 1	6.36 ± 0.27	6.76 ± 0.14	0.23
Day 3	7.0 ± 0.17	7.5 ± 0.11	0.30
Day 7	7.36 ± 0.20	7.76 ± 0.08	0.30

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Serum Cortisol Concentration

Serum cortisol levels were comparable at baseline and increased postoperatively in both groups; however, significantly higher values were observed in the midline ovariohysterectomy group on postoperative Days 1, 3, and 7 ($p < 0.05$), indicating greater surgical stress (Table 9).

Table 9. Comparison of Serum Cortisol Concentration (ng/mL) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	32.5 ± 1.8	31.9 ± 1.6	0.74
Day 1	68.7 ± 2.9**	54.3 ± 2.4	0.001
Day 3	55.6 ± 2.5**	39.8 ± 2.1	0.002
Day 7	42.3 ± 2.0*	34.1 ± 1.7	0.03

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was

considered highly significant

Serum Estrogen Concentration

Serum estrogen concentrations decreased significantly following ovariohysterectomy in both groups, with a more pronounced postoperative decline observed in the midline group compared to the flank group ($p < 0.05$) (Table 10).

Table 10. Comparison of Serum Estrogen Concentration (pg/mL) (Mean ± SEM) between Two Groups

Time point	Midline OHE	Flank OHE	*p*-value
Day 0	42.8 ± 2.1	43.2 ± 2.0	0.81
Day 1	21.4 ± 1.6**	26.8 ± 1.7	0.01
Day 3	15.9 ± 1.4*	19.6 ± 1.5	0.02
Day 7	10.8 ± 1.2*	13.5 ± 1.3	0.03

All of the results are expressed as the mean ± SEM. * indicates P ≤ 0.05 and ** indicates P ≤ 0.01. A P value of ≤ 0.05 between the two groups was considered significant and a P value of P ≤ 0.01 between the two groups was considered highly significant

Physiological Changes in Wound Healing Following Midline and Flank Ovariohysterectomy

Postoperative wound healing progressed through the typical physiological phases in both midline and flank ovariohysterectomy groups; however, distinct differences were observed in the magnitude and duration of local and systemic responses between the two surgical approaches.

Hemostatic Response

Immediately following surgery, both groups exhibited effective hemostasis characterized by clot formation at the incision site. Animals undergoing midline ovariohysterectomy demonstrated more pronounced hemostatic activity, as evidenced by increased local tissue reaction and higher early postoperative platelet responses. In contrast, the flank ovariohysterectomy group showed rapid clot stabilization with comparatively reduced local tissue disruption.

Inflammatory Response

A postoperative inflammatory response was observed in both groups, particularly during the early postoperative period. The midline ovariohysterectomy group exhibited a more intense and prolonged inflammatory response, characterized by elevated leukocyte and neutrophil counts, increased local swelling, and delayed reduction of inflammatory indicators. In comparison, the flank ovariohysterectomy group showed a milder inflammatory response with earlier normalization of leukocyte profiles and reduced local tissue edema.

Proliferative Phase Indicators

Progression to the proliferative phase of wound healing was observed in both groups during the subsequent postoperative days. Animals subjected to flank ovariohysterectomy demonstrated earlier signs of tissue regeneration, including faster reduction in wound inflammation, improved tissue approximation, and earlier epithelialization. In contrast, the midline group showed delayed progression, with prolonged granulation tissue formation and slower wound contraction.

Remodeling and Wound Maturation

During the later postoperative period, wound remodeling and scar formation were evident in both groups. The flank ovariohysterectomy group exhibited earlier wound stabilization and more uniform scar maturation. Conversely, animals in the midline group demonstrated delayed scar maturation and prolonged tissue remodeling, indicating slower recovery of wound tensile strength.

Wound Complications

In both groups, very few complications were raised. Mild Wound discharge and swelling were observed in one case out of 15 cases in the Flank OHE group, whereas mild wound discharge, excessive licking, evisceration, and wound breakdown were observed in one out of 15 cases in the Midline OHE group (Table 11).

Table 11. Comparison of Wound Complications between Two Groups

Gross wound appearance	None		Mild		Severe	
	Flank OHE	**Midline OHE**	**Flank OHE**	**Midline OHE**	**Flank OHE**	**Midline OHE**
Discharge	-	-	1	1	-	-
Excessive licking	-	-	-	1	-	-
Swelling	-	-	1	-	-	-
Dehiscence	-	-	-	-	-	-
Wound complications						
Evisceration	-	-	-	1	-	-
Hernia	-	-	-	-	-	-
Wound breakdown	-	-	-	1	-	-

Total Pain Score

In both groups, mild pain was observed on day 0, severe pain on day 1, and moderate pain on day 3. On day 7, there was no pain in the flank OHE group, whereas mild pain was recorded in the midline OHE group (Table 12).

Table 12: Comparison of Total Pain Score Recorded at Different Time Intervals (day) Postoperatively using Simple Descriptive Scale (SDS) between Two Groups

Groups	Total score at different time intervals (days)			
	0	**1**	**3**	**7**
Flank OHE	1	3	2	0
Midline OHE	1	3	2	1

The Simple Descriptive Scale (SDS) is a subjective pain assessment tool used to measure postoperative pain intensity, often categorized on a 0–3 scale: 0 (No pain), 1 (Mild pain), 2 (Moderate pain), and 3 (Severe pain). Studies evaluating postoperative pain at day intervals (0–7 days).

DISCUSSION

Hematological Parameters Following Midline and Flank Ovariohysterectomy

Hematological parameters serve as valuable systemic indicators of surgical trauma, inflammatory response, stress, and the overall physiological environment influencing wound healing. In the present study, comparative evaluation of complete blood count (CBC) parameters revealed distinct postoperative hematological patterns between animals subjected to midline ovariohysterectomy and those undergoing the flank approach. These differences reflect variations in tissue injury, inflammatory burden, and recovery dynamics associated with the two surgical techniques.

Total leukocyte count is a well-established marker of inflammation and tissue injury. In this study, TLC values were comparable between groups at baseline, confirming similar preoperative health status. A significant postoperative increase in TLC was observed in both groups, particularly on postoperative Day 1, which is consistent with the expected acute inflammatory response following surgical intervention. Surgical trauma leads to the release of pro-inflammatory cytokines such as interleukin-1, interleukin-6, and tumor necrosis factor-α, which stimulate leukocyte mobilization from bone marrow reserves into circulation(Guyton, 2006).

However, the magnitude and duration of leukocytosis were significantly greater in the midline ovariohysterectomy group compared to the flank group. This prolonged leukocytic response suggests greater tissue trauma and sustained inflammatory stimulation associated with the midline approach. The ventral midline incision involves manipulation of the linea alba, peritoneum, and abdominal viscera, which can provoke a more intense inflammatory cascade. In contrast, the flank approach generally involves less visceral exposure and reduced surgical handling, resulting in a milder inflammatory response.

Earlier normalization of TLC values in the flank group indicates faster resolution of inflammation, a key prerequisite for progression from the inflammatory to the proliferative phase of wound healing. Persistent leukocytosis, as observed in the midline group, may delay fibroblast activity and collagen deposition, thereby prolonging the healing process(Fossum, 2012).

Neutrophils constitute the first line of cellular defense during acute inflammation and play a critical role in early wound decontamination. In the present study, neutrophil percentages increased significantly following surgery in both groups, peaking during the early postoperative period. This neutrophilia is a characteristic response to surgical stress and tissue injury, and reflects demargination and bone marrow release mediated by stress hormones and inflammatory cytokines(Weiss & Wardrop, 2011).

Animals subjected to midline ovariohysterectomy exhibited significantly higher neutrophil percentages for a longer duration compared to the flank group. Prolonged neutrophilia indicates sustained inflammatory signaling and delayed transition toward wound resolution. Excessive or prolonged neutrophil activity may contribute to increased production of reactive oxygen species and proteolytic enzymes, which can impair tissue regeneration if not adequately regulated.

Conversely, the flank ovariohysterectomy group demonstrated a more rapid decline in neutrophil percentages toward baseline values, suggesting timely resolution of acute inflammation. This finding supports the concept that reduced surgical trauma facilitates a more controlled inflammatory response, promoting favorable wound healing conditions(Slatter, 2003).

Lymphocytes play an essential role in immune regulation and tissue repair. In the present study, lymphocyte percentages decreased significantly during the immediate postoperative period in both groups, a phenomenon commonly associated with surgical stress and corticosteroid-mediated immunomodulation. Stress-induced lymphopenia occurs due to redistribution of lymphocytes to lymphoid tissues and apoptosis mediated by glucocorticoids(Guyton, 2006).

The decline in lymphocyte percentage was significantly more pronounced and prolonged in the midline ovariohysterectomy group. This suggests greater stress-induced immunosuppression associated with the midline approach. Prolonged lymphopenia may compromise immune surveillance and delay wound healing by impairing macrophage activation and growth factor regulation.

In contrast, animals in the flank group exhibited earlier recovery of lymphocyte percentages, indicating faster restoration of immune homeostasis. This immune stability is advantageous for wound healing, as lymphocytes contribute to the regulation of fibroblast proliferation and angiogenesis during later healing phases(Fossum, 2012).

Hemoglobin concentration is an indirect indicator of blood loss, hemodilution, and tissue oxygen-carrying capacity. In this study, postoperative hemoglobin levels declined in both groups, particularly during the early postoperative period. Such reductions are commonly attributed to intraoperative blood loss, fluid therapy–induced hemodilution, and surgical trauma.

The midline ovariohysterectomy group exhibited a significantly greater decline in hemoglobin concentration on postoperative Days 1 and 3 compared to the flank group. This finding suggests increased blood loss or greater tissue trauma associated with the midline approach. Adequate hemoglobin levels are essential for oxygen delivery to healing tissues, and reduced oxygenation can impair collagen synthesis and angiogenesis, thereby delaying wound healing(Rosenberger et al., 2009).

The flank group demonstrated better preservation and faster recovery of hemoglobin levels, indicating reduced surgical insult and improved postoperative physiological stability.

Packed cell volume closely parallels hemoglobin concentration and provides further insight into blood volume status and erythrocyte dynamics. In the present study, PCV values declined significantly following surgery, with a more pronounced decrease observed in the midline ovariohysterectomy group. This reduction is consistent with intraoperative blood loss and postoperative fluid shifts.

The significantly lower PCV values in the midline group during the early postoperative period further support the conclusion that this approach is associated with greater surgical trauma. Reduced PCV may compromise oxygen delivery to the wound site, thereby negatively affecting healing efficiency. In contrast, the flank group maintained relatively higher PCV values, reflecting improved hemodynamic stability and a more favorable healing environment.

Platelets play a crucial role not only in hemostasis but also in wound healing through the release of growth factors such as platelet-derived growth factor (PDGF) and transforming growth factor-β (TGF-β). In the present study, platelet counts increased transiently following surgery in both groups, particularly on postoperative Day 1. This thrombocytosis likely reflects a normal physiological response to tissue injury and vascular disruption.

A significantly higher platelet count was observed in the midline group during the early postoperative period, which may indicate a stronger hemostatic response to greater tissue trauma. While platelet activation is beneficial for initial wound stabilization, excessive platelet activation may also reflect increased tissue injury and inflammation.

The flank group exhibited a more moderate and transient platelet response, consistent with reduced tissue damage and a controlled healing response.

Collectively, the hematological parameters evaluated in this study consistently demonstrate that midline ovariohysterectomy induces a more intense and prolonged inflammatory and stress response compared to the flank approach. Elevated leukocyte and neutrophil counts, prolonged lymphopenia, greater reductions in hemoglobin and PCV, and heightened platelet responses all point toward increased surgical trauma associated with the midline technique.

In contrast, flank ovariohysterectomy was associated with milder hematological disturbances and faster normalization of parameters, indicating reduced tissue injury, improved immune stability, and a more favorable physiological environment for wound healing. These findings are in agreement with previous reports suggesting that minimally invasive or less traumatic surgical approaches result in improved postoperative recovery and wound healing outcomes(Fossum, 2012).

From a clinical perspective, the hematological evidence presented in this study supports the preferential use of flank ovariohysterectomy when the primary objective is to minimize postoperative inflammation and promote rapid wound healing in healthy animals. However, it is important to acknowledge that surgical approach selection should also consider factors such as uterine pathology, surgeon experience, and the need for abdominal exploration.

Hormonal Responses Following Midline and Flank Ovariohysterectomy

Hormonal assays provide critical insight into the physiological stress response and endocrine alterations following surgical intervention. In the present study, serum cortisol and estrogen concentrations were evaluated to assess surgical stress and ovarian endocrine disruption following midline and flank ovariohysterectomy. The observed hormonal patterns clearly demonstrate that while ovariohysterectomy inevitably alters estrogen secretion, the magnitude and duration of cortisol elevation are primarily determined by the extent of surgical trauma rather than ovarian removal. Differences between the midline and flank approaches reflect variations in tissue injury, pain perception, and activation of neuroendocrine stress pathways.

Cortisol is the principal glucocorticoid hormone released from the adrenal cortex and serves as a well-established biomarker of physiological stress. Its secretion is regulated by activation of the hypothalamic–pituitary–adrenal (HPA) axis in response to nociception, inflammation, tissue injury, and psychological stress(Pal, 2021). In the present study, baseline serum cortisol concentrations (Day 0) were comparable between the midline and flank groups, confirming similar preoperative stress status.

Following surgery, serum cortisol levels increased significantly in both groups, reaching peak values on postoperative Day 1. This postoperative elevation reflects acute activation of the HPA axis triggered by surgical trauma, anesthesia, tissue manipulation, and postoperative pain. Such an increase is a normal and expected physiological response to surgery and has been consistently reported following ovariohysterectomy and other abdominal procedures in animals(Fox et al., 1994).

Notably, animals subjected to midline ovariohysterectomy exhibited significantly higher cortisol concentrations than those undergoing flank ovariohysterectomy on postoperative Days 1, 3, and 7. This prolonged elevation suggests that the midline approach induces greater and more sustained stress. The ventral midline incision involves extensive disruption of the abdominal wall, peritoneum, and visceral handling, all of which intensify nociceptive input and inflammatory signaling to the central nervous system. In contrast, the flank approach limits abdominal exposure and visceral manipulation, resulting in reduced activation of the HPA axis.

The gradual decline in cortisol levels observed on postoperative Days 3 and 7 in both groups indicates progressive recovery and adaptation following surgery. However, the persistently higher cortisol levels in the midline group suggest delayed stress resolution. Prolonged hypercortisolemia may negatively influence wound healing by suppressing immune function, inhibiting fibroblast proliferation, and reducing collagen synthesis(Padgett & Glaser, 2003). Therefore, the lower and more rapidly normalizing cortisol levels observed in the flank group indicate a more favorable hormonal environment for postoperative recovery and tissue repair.

Importantly, the observed cortisol changes are independent of ovarian endocrine activity. Cortisol secretion is controlled by the HPA axis and originates from the adrenal cortex, whereas estrogen is regulated by the hypothalamic–pituitary–ovarian axis. Consequently, removal of the ovaries does not suppress cortisol secretion, and postoperative cortisol elevation should be interpreted strictly as a marker of surgical stress rather than ovarian hormone alteration(Pal, 2021).

Estrogen is primarily synthesized by the ovaries and plays a central role in reproductive physiology, tissue metabolism, immune modulation, and wound healing. In the present study, baseline serum estrogen concentrations were comparable between groups, reflecting similar ovarian function prior to surgery. Following ovariohysterectomy, estrogen levels declined significantly in both the midline and flank groups, confirming the effectiveness of ovarian removal.

The most pronounced reduction in estrogen concentration was observed on postoperative Day 1, with further gradual declines on Days 3 and 7. This pattern reflects the abrupt cessation of ovarian steroidogenesis following removal of the ovaries. Residual estrogen detected during the early postoperative period may be attributed to peripheral conversion of adrenal androgens and circulating estrogen metabolites, which gradually diminish over time(Senger, 1997).

Animals undergoing midline ovariohysterectomy exhibited significantly lower estrogen concentrations compared to the flank group during the postoperative period. This difference may be attributed to greater surgical stress and higher cortisol levels in the midline group. Elevated cortisol can suppress hypothalamic and pituitary signaling and alter peripheral hormone metabolism, potentially accelerating the decline in circulating estrogen (Dobson et al., 2012). Additionally, increased inflammatory activity associated with greater tissue trauma may further influence steroid hormone clearance.

Estrogen plays an important role in wound healing by promoting angiogenesis, enhancing fibroblast proliferation, and stimulating collagen deposition. Reduced estrogen levels following ovariohysterectomy may therefore contribute to delayed wound healing, particularly when combined with elevated cortisol levels. The more pronounced estrogen decline observed in the midline group suggests a less favorable endocrine environment for tissue repair compared to the flank group. The more pronounced decline in the midline group may be due to stress-induced metabolic clearance rather than surgical technique per se. It is noted that both groups achieved complete ovarian removal.

In contrast, relatively higher postoperative estrogen concentrations in the flank group may reflect reduced stress-induced suppression and slower metabolic clearance. Although estrogen levels declined in both groups, the more gradual reduction observed in the flank group may support improved wound healing and immune regulation during the postoperative period.

The combined assessment of cortisol and estrogen provides a comprehensive understanding of postoperative endocrine dynamics. Cortisol and estrogen exert opposing effects on immune function and tissue repair. While cortisol is immunosuppressive and catabolic, estrogen has immunomodulatory and anabolic effects that support wound healing. Therefore, the hormonal balance between these two hormones is critical for optimal postoperative recovery.

In the present study, the midline ovariohysterectomy group demonstrated a hormonal profile characterized by persistently elevated cortisol and markedly reduced estrogen levels. This combination may exacerbate stress-induced immunosuppression, delay inflammatory resolution, and impair collagen synthesis. Conversely, the flank group exhibited lower cortisol levels and relatively higher estrogen concentrations during the postoperative period, suggesting a more balanced endocrine environment conducive to efficient wound healing.

These findings support previous reports indicating that surgical techniques associated with reduced tissue trauma and stress result in more favorable hormonal responses and improved postoperative outcomes(Fossum, 2012; Nenadović et al., 2017).

From a clinical standpoint, hormonal assay findings highlight the importance of surgical approach selection in minimizing endocrine stress responses. Lower cortisol elevation and less pronounced estrogen suppression following flank ovariohysterectomy suggest reduced surgical stress and improved postoperative physiological stability. These hormonal advantages may translate into reduced pain, faster wound healing, and lower risk of postoperative complications.

However, it is important to recognize that ovariohysterectomy inevitably results in estrogen depletion regardless of surgical approach. Therefore, while the flank approach offers hormonal advantages related to stress reduction, surgical decision-making should also consider factors such as uterine pathology, need for abdominal exploration, surgeon expertise, and animal condition.

Though the single dose anesthetic drug can suppress circulating cortisol concentrations, it does not completely block the release of cortisol (Cusack & Buggy, 2020). In this study, the concentrations of cortisol were also suppressed on day 0, indicating the effects of anesthetic up to its' duration of anesthesia. From day 1, there was no relation of anesthesia with cortisol secretion.

Physiological Differences in Wound Healing Following Midline and Flank Ovariohysterectomy

Wound healing following ovariohysterectomy is a complex physiological process involving coordinated hemostatic, inflammatory, proliferative, and remodeling phases, all of which are influenced by the extent of surgical trauma and systemic stress response(Fossum, 2012; Gosain & DiPietro, 2004). In the present study, distinct differences in wound healing physiology were observed between midline and flank ovariohysterectomy, indicating that surgical approach significantly modulates local tissue responses and systemic endocrine and hematological dynamics.

The length of the surgical incision was shorter in the right flank approach (RFA) group than in the midventral approach (MVA) group. Surgical duration was also lesser in the RFA than in the MVA. Physiological parameters like rectal temperature and heart rate showed no significant variation in all the animals. Respiratory rate decreased significantly in all the animals, which was transitory in nature. In group-II, one cat showed wound breakdown, one evisceration due to excessive licking, and one mild discharge, whereas in group-I animals, one showed swelling, with otherwise uneventful recovery. Lateral flank approach for ovariohysterectomy reduces the potential for evisceration if wound dehiscence occurs. Hence, the right flank approach is an alternative to the conventional mid-ventral approach for ovariohysterectomy in cats.

The hemostatic phase was more pronounced in animals undergoing midline ovariohysterectomy, reflecting greater vascular disruption and tissue injury. The ventral midline approach requires incision through the skin, subcutaneous tissue, linea alba, and peritoneum, which increases capillary damage and platelet activation(Pavletic, 2018). Platelet aggregation and fibrin clot formation are essential for immediate wound stabilization and serve as a provisional extracellular matrix for inflammatory cell migration(Diegelmann & Evans, 2004). However, excessive tissue disruption during hemostasis may predispose the wound to amplified inflammatory responses. In contrast, the flank approach involves a more localized incision with reduced abdominal wall trauma, resulting in rapid clot stabilization and less initial tissue insult(Fossum, 2012).

The inflammatory phase was significantly more intense and prolonged in the midline ovariohysterectomy group. This was evidenced by sustained leukocytosis, neutrophilia, and delayed resolution of inflammatory indicators. Surgical trauma activates innate immune responses through the release of damage-associated molecular patterns (DAMPs), leading to increased production of pro-inflammatory cytokines such as interleukin-1β, interleukin-6, and tumor necrosis factor-α(Eming et al., 2007). While inflammation is critical for the removal of necrotic tissue and microbial defense, excessive or prolonged inflammation can impair wound healing by increasing oxidative stress and extracellular matrix degradation(Gosain & DiPietro, 2004).

Animals subjected to flank ovariohysterectomy exhibited a comparatively milder inflammatory response with earlier normalization of leukocyte profiles. Reduced inflammatory burden facilitates timely transition from the inflammatory to the proliferative phase, which is essential for efficient wound repair (Gosain & DiPietro, 2004). These findings are consistent with previous reports indicating that minimally traumatic surgical techniques promote controlled inflammation and improved healing outcomes(Pavletic, 2018).

Progression to the proliferative phase occurred more rapidly in the flank ovariohysterectomy group, as indicated by earlier epithelialization, improved wound contraction, and faster tissue regeneration. Fibroblast proliferation, collagen synthesis, and angiogenesis are key events during this phase and are highly sensitive to inflammatory and hormonal environments(Diegelmann & Evans, 2004). Reduced surgical trauma and lower stress hormone levels in the flank group likely enhanced fibroblast activity and neovascularization.

In contrast, delayed proliferative activity observed in the midline group may be attributed to sustained inflammatory signaling and elevated cortisol levels. Cortisol, released via activation of the hypothalamic–pituitary–adrenal axis in response to surgical stress, has well-documented immunosuppressive and anti-proliferative effects(Sapolsky et al., 2000; Vaz & Raj, 2013). Prolonged hypercortisolemia inhibits fibroblast proliferation, suppresses collagen synthesis, and reduces angiogenic factor expression, thereby delaying wound repair (Padgett & Glaser, 2003; Guo & DiPietro, 2010).

Differences were also evident during the remodeling phase of wound healing. Animals undergoing flank ovariohysterectomy demonstrated earlier scar maturation and improved tissue organization, suggesting effective collagen realignment and restoration of tensile strength. Remodeling involves replacement of collagen type III with stronger collagen type I and gradual reduction of capillary density (Gurtner et al., 2008). In contrast, delayed remodeling in the midline group suggests prolonged extracellular matrix turnover and slower recovery of wound integrity, which may increase susceptibility to wound complications such as dehiscence or excessive scarring (Slatter, 2003).

Systemic endocrine responses further explain the observed differences in wound healing physiology. Elevated and persistent cortisol levels in the midline ovariohysterectomy group reflect greater activation of stress pathways due to increased nociception and tissue manipulation (Sapolsky et al., 2000; Vaz & Raj, 2013). Cortisol suppresses inflammatory resolution, impairs macrophage function, and inhibits growth factor activity, all of which are essential for normal wound healing (Guo & DiPietro, 2010). In contrast, lower and more transient cortisol elevations in the flank group indicate reduced stress burden and a more favorable hormonal milieu for tissue repair.

Additionally, estrogen depletion following ovariohysterectomy influenced wound healing dynamics in both groups. Estrogen has been shown to modulate inflammation, enhance angiogenesis, and promote collagen deposition (Ashcroft et al., 1997; Saville & Hardman, 2014). The more pronounced postoperative decline in estrogen observed in the midline group, possibly exacerbated by stress-induced alterations in hormone metabolism, may further contribute to delayed wound healing. The relatively higher postoperative estrogen levels in the flank group may therefore support improved fibroblast activity and scar maturation.

Collectively, these findings indicate that although both midline and flank ovariohysterectomy follow the same fundamental wound healing pathways, the flank approach provides significant physiological advantages by minimizing tissue trauma, reducing inflammatory and endocrine stress responses, and promoting faster progression through the proliferative and remodeling phases. Similar conclusions have been reported in both veterinary and experimental surgical studies comparing invasive and minimally invasive techniques (Fossum, 2012; Pavletic, 2018).

From a clinical standpoint, these physiological differences underscore the potential benefits of flank ovariohysterectomy in enhancing postoperative recovery and wound healing. Nevertheless, surgical approach selection should remain individualized, taking into account pathological conditions, surgeon expertise, and animal welfare considerations. Incorporating histological wound scoring, histological and molecular markers, with objective healing measures for future studies may provide deeper insight into the mechanisms underlying these observations.

Abdominal wall dehiscence (wound breakdown) and subsequent evisceration are rare but life-threatening complications of canine and feline spays (ovariohysterectomy), particularly with the ventral midline approach (Amanawit & Haregawi, 2023). In this study, one case of evisceration and one case of wound breakdown were recorded and corrected later. The most frequent causes are often due to licking or scratching. Besides, running, jumping, or rough play too soon after surgery, subclinical or active infection weakening the tissues, increased abdominal pressure/tension on the sutures, improper knot tying (slipping), insufficient closure of the fascia, or using the wrong suture size can be the causes of these events.

Elevated pain levels correlate significantly with slower wound healing and unfavorable clinical results, creating a "vicious cycle" in which pain heightens stress and decreases patient compliance with treatment. Heightened pain, particularly moderate to severe raises cortisol and catecholamine levels, suppressing the immune system and hindering recovery. Efficient pain control is essential for speeding up recovery (Tegegne et al., 2020). The pain score in this study is correlated with the findings of the cortisol level at different time points.

CONCLUSIONS

The present study demonstrated that the choice of surgical approach significantly influences postoperative physiological, hematological, and hormonal responses following ovariohysterectomy. Although both midline and flank ovariohysterectomy effectively achieved ovarian removal, the magnitude of surgical stress, inflammatory response, and endocrine disturbance differed markedly between the two techniques.

Hematological assessment revealed that midline ovariohysterectomy was associated with more pronounced and prolonged leukocytosis, neutrophilia, lymphopenia, and greater reductions in hemoglobin and packed cell volume, indicating increased tissue trauma, inflammatory burden, and delayed physiological stabilization. In contrast, animals undergoing flank ovariohysterectomy exhibited milder hematological alterations and faster normalization of parameters, suggesting reduced surgical insult and a more favorable environment for wound healing.

Hormonal assay findings further supported these observations. Serum cortisol concentrations increased postoperatively in both groups as a normal stress response; however, significantly higher and more persistent cortisol elevations were observed in the midline group, reflecting greater activation of the hypothalamic–pituitary–adrenal axis. Conversely, the flank group demonstrated lower cortisol levels and earlier recovery toward baseline, indicating reduced surgical stress. Serum estrogen concentrations declined significantly following ovariohysterectomy in both groups due to ovarian removal, with a more pronounced postoperative reduction in the midline group, likely influenced by heightened stress and altered hormone metabolism.

Collectively, the combined hematological and hormonal profiles indicate that flank ovariohysterectomy induces less systemic stress, milder inflammatory responses, and a more balanced endocrine environment compared to the midline approach. These physiological advantages suggest that the flank approach may promote improved postoperative recovery and wound healing under normal clinical conditions.

In conclusion, while both surgical techniques are effective, flank ovariohysterectomy appears to be the preferable approach when the primary objective is to minimize surgical stress and enhance postoperative recovery. Nevertheless, surgical approach selection should be guided by clinical indication, surgeon expertise, and individual patient factors. Further studies incorporating modern anesthetic protocols, long-term healing outcomes, and larger sample sizes are recommended to strengthen and extend these findings.

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Conflicts Of Interest

There is no conflict of interest among the authors.

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