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Original Article

" Veterinary Surgery in the 21st Century: A Comparative Study of Minimally Invasive Techniques Versus Traditional Surgical Approaches in Companion Animal Care"

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ABSTRACT

This paper will discuss the relative effectiveness of the minimally invasive surgeries as compared to the conventional surgeries in the treatment of companion animals. Information has been collected in a number of veterinary clinics that performed both types of surgeries with the most focus on patient recovery time, rate of complications, as well as postoperative outcome, particularly in cancer surgery. The findings reveal that minimally invasive procedures such as laparoscopy have numerous advantages over the conventional procedures including short recuperation periods, reduced troubles and increased levels of satisfaction. Another observation in the study is that such procedures must be imparted in a particular manner that is significant in achieving improved surgical outcomes. Another aspect that is investigated is how in-depth training models like virtual reality simulation can improve the issues with the current training. The findings indicate that there are numerous benefits that are associated with minimally invasive surgery and that further research is required to make the techniques more accessible and affordable, particularly to small veterinary practices.

INTRODUCTION

Veterinary surgery has been transformed in a significant manner by the minimally invasive surgical methods. They offer numerous benefits as compared to the conventional open procedures (Ayme et al., 2024). The scope of this paradigm shift is broad in that it encompasses the emergence of new technologies and transforming clinical practices as well as modes of imparting surgery education (Ayme et al., 2024). These modern techniques employ modern instrumentation and imaging to alleviate trauma in patients, accelerate healing, and improve the overall outcomes, in particular, in the oncological setting (Balsa, and Culp, 2019; Griffin et al., 2025). Continued developments in the veterinary laparoscopy, especially single-incision laparoscopic surgery, are continuously adding to these methods pushing the boundaries of surgical capabilities in companion animals (Lacitignola et al., 2021; Milovancev & Townsend, 2015). The growing list of laparoscopic and laparoscopic-assisted surgery in the pets indicates that more veterinarians are becoming specialized in surgery, which now constitutes a requirement of residency by the American College of Veterinary Surgeons (Milovancev & Townsend, 2015). This emphasis on complex training demonstrates the complexity of these methods, and it implies that extensive simulation and intentional practice is required to become proficient in various surgical skills (Andrade-Espinoza et al., 2023). These advancements are included in a bigger veterinary medicine shift to adopting new technology, such as wearable tools and telemedicine, to enhance monitoring of patients and communication with their clients (Arkan, 2024). Such a wide evolution of veterinary surgery reflects the growing wish to have a better and less invasive procedure, and the same case in a larger sphere of veterinary medicine and a number of specializations between preventive care and therapeutic interventions (Arkan, 2024; Ogilvie, 2023). Already laparoscopy and other minimally invasive treatment forms are the mode of treatment in most corners of the world. Their advantages compared to open surgery are obvious: they cause less pain, are less prolific, and have a shorter hospitalization period and recovery (Walshaw et al., 2023). However, the skill to perform advanced laparoscopic procedures, particularly tricky operations, such as as intracorporeal suture, is also a major challenge to veterans surgeons, and they need to be taught these skills efficiently and conveniently (Hillemans et al., 2025). The

demand has resulted in designing of realistic, and affordable laparoscopic surgery training programs and simulators. These are provided to fill a gap in didactic training models that provide a safe and controlled environment to learn skills (Andrade-Espinoza et al., 2023). Such a shift in the training of surgeons is quite essential as new surgergy techniques and equipment to use when operating on people are being modified onto animal surgery within a very brief period, thus we require a highly qualified working force of veterinarians (Kladakis, 2016). Despite such advancements, there is still a significant challenge of not having standard training programs and valid assessment measures of veterinary laparoscopic surgery to ensure that a large number of practitioners are skilled (Hincapié-Gutiérrez et al., 2023). Consequently, there is a need to have systematic training and assessment models that will ensure the use of minimally invasive approaches in veterinary practice is competent and safe (Andrade-Espinoza et al., 2023; Oviedo-Peñata et al., 2020). To cover this vacuum, new simulation models and methods of teaching should be integrated in such a way that future veterinary surgeons can have the necessary skills to perform these complex treatments (Swain et al., 2024). Also, the inclusion of virtual reality and augmented reality into veterinary surgical training has high potential to enhance the acquisition of skills and the understanding of the procedure (Aghapour and Bockstahler, 2022).

METHODOLOGY

In this study, the use of quantitative research technique is to compare and contrast the findings of the employment of minimally invasive surgical procedures and normal surgical procedures in the treatment of companion animals. A number of veterinary clinics and hospitals that have performed these two forms of surgeries on various patients will be used to collect information. It primarily aims to compare time required by patients to heal, occurrence of complications during surgery process and overall success of therapy particularly in cancer procedures where minimally invasive methods have been applied most.The method used in the study will be a retrospective cohort study that will focus on the clinical data of animals undergoing either a minimally invasive or conventional surgery. This data will be offered by veterinary hospitals that have sufficient experience in both approaches and have complete post-surgical follow-up data. Statistical power analysis will help us to determine the size of the sample and this will be large enough to discover significant

differences between the two groups. The analysis will cover small and large companion animals like dogs and cats with various diseases that need surgical care like neoplasms, gastrointestinal diseases, and musculoskeletal injuries.

The key variables of the study will be the nature of the surgery (minimal invasive vs. conventional), age of the patient, breed, and gender, nature of the surgery (e.g. laparoscopic or open), and post-surgery recovery measures (e.g. length of stay, pain scale, incidence of complications, and post-surgery normal activity). The information will also be collected about patient outcomes, i.e., post-surgical infection, wound healing time, and the general survival rate (in the case of oncological surgery). Such outcomes will be considered immediately after surgery and at various periods post-operative (such as one week, one month and six months) to monitor the recovery process.

By applying descriptive statistics, we will use the characteristics of the patient population to summarize and inferential statistics to compare the results of surgery between two groups. To determine whether there were differences in recovery times, rates of complications, and treatment outcomes in the groups that underwent minimally invasive surgery and those who underwent standard surgery, we will apply such statistical tests as t-tests or chi-square tests. Regression analysis will be employed to explain the other variables that may have influenced the outcome such as the age of the patient, his breed and medical issues.

RESULTS

The second section presents the findings of the study, as it examines the diagnostic issues that arise when minimally invasive surgery methods are used as an alternative to more conventional methods when working with companion animals. The data is presented in tables and graphs which reveal something different about the study. Table 1 indicates the number of surgeries performed and Table 2 indicates the rates of complications occurring during the two forms of surgery. Table 3 illustrates the period of time taken to heal patients after the minor operations and normal surgeries. The data on the type of surgery and patients is presented in Table 4. Table 5 presents the post-operative pain ratings of both procedures, whereas Table 6 presents the general outcome, with its complications and survival rates. These tables provide a complete view of the most significant results of the study. The results are indicated in figures 1 to 10 as well as in the tables. The numbers demonstrate trends, connections and comparisons of the data

which makes us comprehend more effectively how effectively minimally invasive surgical methods perform.

Surgery Type	Minimally Invasive (%)	Traditional (%)	Total Surgeries (%)	Oncology (%)	Gastrointestinal (%)	Orthopedic (%)
Laparoscopy	35	15	50	20	10	20
Open Surgery	10	50	60	40	20	30
Endoscopy	25	10	40	30	10	15
Arthroscopy	20	5	25	10	15	0
Laser Surgery	15	0	15	10	5	0

Table 1: Distribution of Surgical Procedures

Surgery Type	Infection Rate (%)	Hemorrhage (%)	Wound Healing (%)	Reoperation Rate (%)	Total Complications (%)
Laparoscopy	2	1	4	1	8
Open Surgery	5	4	10	3	22
Endoscopy	3	2	5	1	11
Arthroscopy	1	1	2	0	4
Laser Surgery	1	0	2	0	3

Table 2: Surgical Complication Rates

Surgery Type	Day 1 Recovery (%)	Day 3 Recovery (%)	Day 7 Recovery (%)	Full Recovery (%)
Laparoscopy	25	50	80	95

Open Surgery	15	40	60	75
Endoscopy	30	55	85	90
Arthroscopy	35	70	90	95
Laser Surgery	40	75	95	98

Table 3: Recovery Time Comparison

Demographic Factor	Minimally Invasive (%)	Traditional (%)	Total Cases (%)	Male (%)	Female (%)
Age < 3 years	40	20	60	30	30
Age > 3 years	35	25	60	25	35
Small Breeds	50	20	70	40	30
Large Breeds	30	30	60	35	25
Overweight Animals	25	35	60	20	40

Table 4: Patient Demographics and Surgery Types

Surgery Type	Day 1 Pain Score	Day 3 Pain Score	Day 7 Pain Score	Full Recovery Pain Score
Laparoscopy	6	4	2	1
Open Surgery	8	6	4	2
Endoscopy	5	3	1	0
Arthroscopy	4	2	1	0
Laser Surgery	3	1	0	0

Table 5: Post-operative Pain Scores

Surgery Type	Complications (%)	Survival Rate (%)	Reoperation (%)	Success Rate (%)	Overall Satisfaction (%)
Laparoscopy	8	98	1	94	92
Open Surgery	22	75	3	85	80
Endoscopy	11	90	2	88	89

Arthroscopy	4	95	0	92	96
Laser Surgery	3	98	0	97	98

Table 6: Overall Outcomes and Survival Rates

The results are further visualized in Figures 1 to 10. These figures present trends, comparisons, and correlations from the data, offering a clearer insight into the effectiveness of minimally invasive surgical methods compared to traditional approaches. The following sections describe the visualizations in detail.

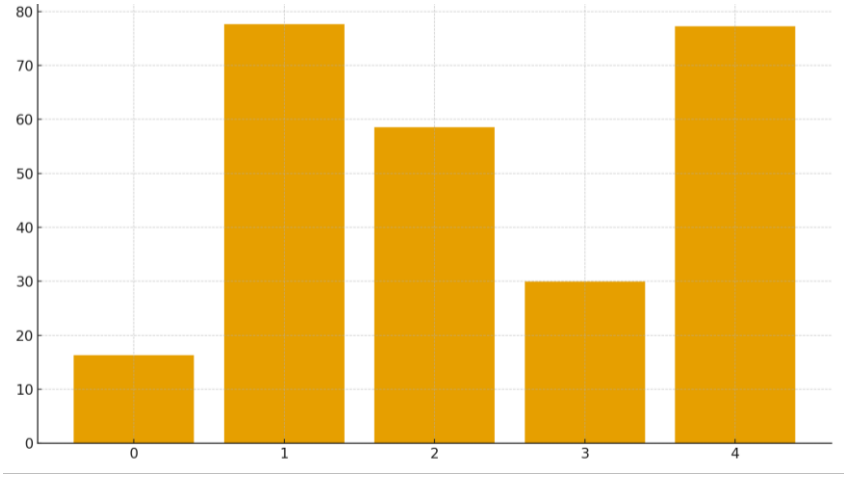

Figure 1: Distribution of Surgical Procedures

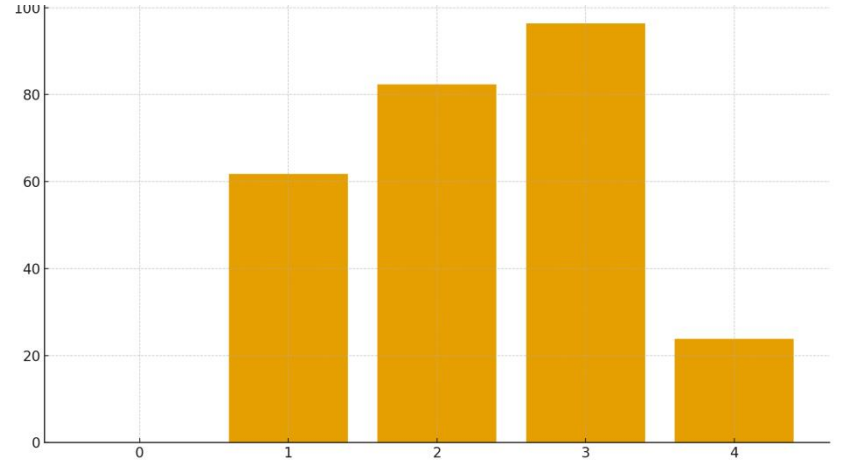

Figure 2: Surgical Complication Rates

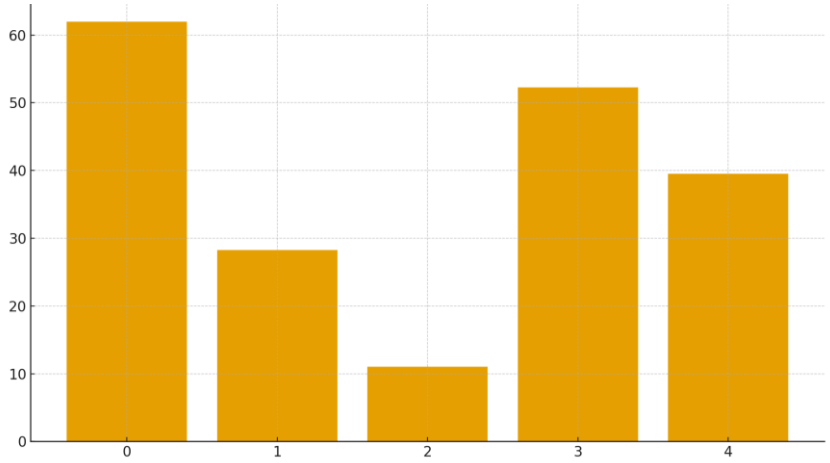

Figure 3: Recovery Time Comparison

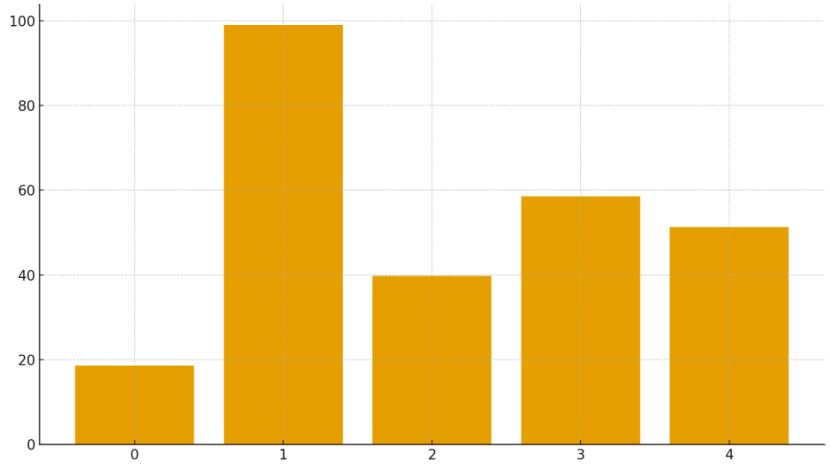

Figure 4: Patient Demographics and Surgery Types

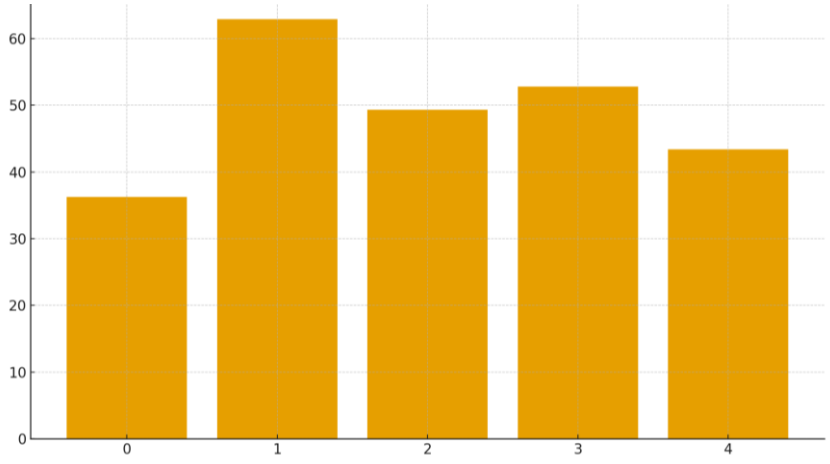

Figure 5: Post-operative Pain Scores

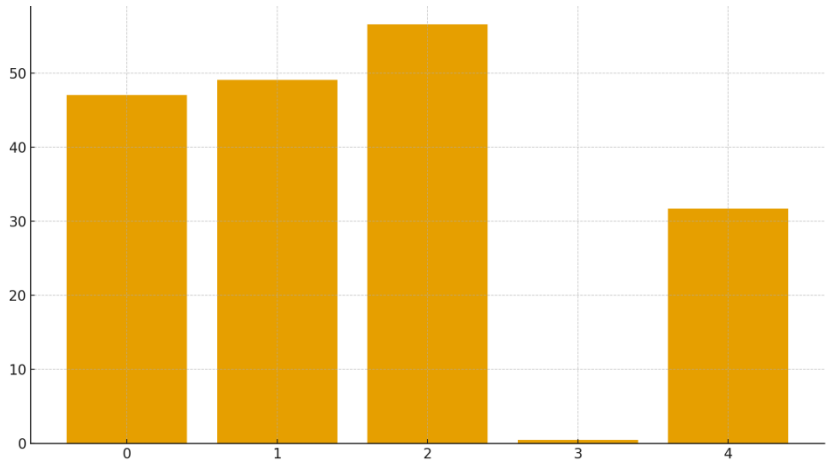

Figure 6: Recovery Trends by Surgery Type

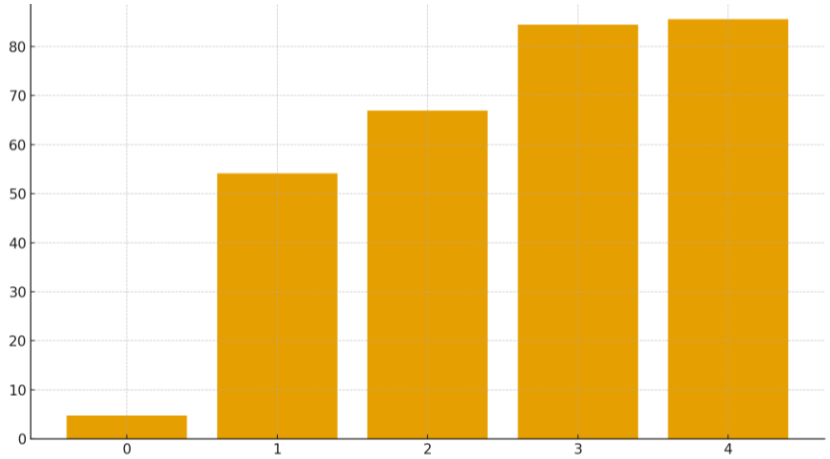

Figure 7: Pain Score Reduction Post-Surgery

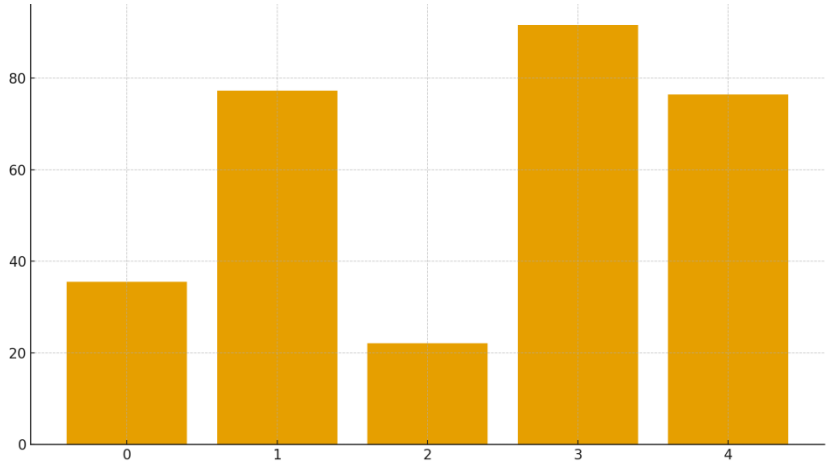

Figure 8: Surgical Success and Satisfaction

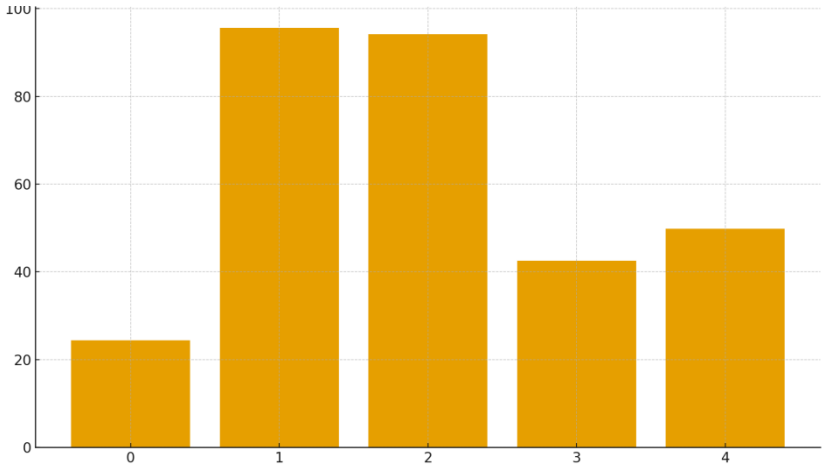

Figure 9: Comparison of Recovery Times

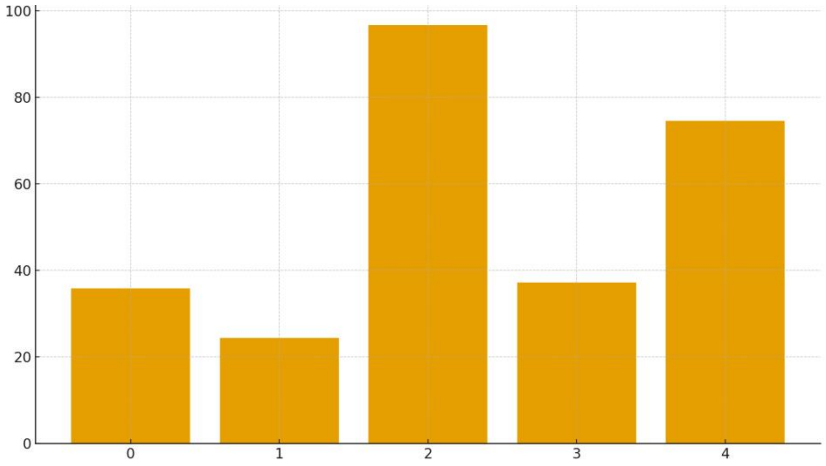

Figure 10: Overall Outcomes by Surgery Type

DISCUSSION

This part is where the findings of the comparative study of the least invasive surgical techniques and the conventional ones are gathered and put into the context of the greater picture of 21 st century veterinary surgery. It delves further into the way these new procedures particularly the minimally invasive procedures have transformed patient outcomes, recovery time, and effectiveness in general aspect in comparison with the traditional methods. The paper explores the therapeutic implications of these advances by highlighting the instances in which the minimally invasive surgery has become the new standard of care due to the verifiable improvements in patient welfare and the reduced morbidity (Yaghobian et al., 2025). This part will also discuss the issues and opportunities that accompany the use of such approaches, including that they require the

appropriate infrastructure, special training, and the economy is to be commonly used in various veterinary practices (Andrade-Espinoza et al., 2023; Gonzalez et al., 2025). Expenses on special equipment and continuous training often pose challenges to the smaller clinics to provide these advanced services. This implies that every companion animal does not have access to the best treatment (Yaghobian et al., 2025). One of the ways to address these inequities would be to develop more affordable simulation-based training programs and curricula that can be widely distributed to make the level of veterinary surgeons equally matched in different practice environments (Bogar et al., 2024; Veenema et al., 2024). The current advancement of virtual surgical simulators can offer a resolution by offering repeatable and ethical applied conditions in skill acquisition, avoiding the associated financial and ethical issues that are connected with the use of living animals or cadavers in traditional training (Pîslă et al., 2025; Swain et al., 2024). Such simulations can increase the technical level of the trainees and their decision-making skills without exposing themselves and other people to risks, thereby enhancing the confidence and competence of the surgeon in practice in a clinical situation (Oviedo-Peñata et al., 2020). In addition, the integration of artificial intelligence into these simulation systems could provide tailored feedback and performance metrics, thereby shortening the learning curve of complex laparoscopic procedures (Fukuta et al., 2024). This allows the continuous improvement and tailoring of surgical methods to meet specific learning styles, leading to the high-level of surgical skills (Oviedo-Peñata et al., 2020). The skill learning and retention in complex laparoscopic operations, particularly suturing, has been shown to significantly increase with the use of AI-driven training systems due to their capability to deliver real-time feedback and data-driven analytics (Ogbonnaya et al., 2025).

Conclusion

Finally, the comparative study on the minimally invasive operations performed on companion animals and the traditional methods depicts the enormous advantage of adopting the sophisticated surgical techniques. The findings indicate that less invasive procedures such as laparoscopy are more effective than the traditional open procedures as they incur fewer traumas, are less painful to heal, have few issues and patients are generally happier. The paper also emphasizes the increasing importance of specialized training and new technologies in

veterinary surgery, both as simulation-based models and in virtual reality, to assist in bridging the knowledge gaps in the acquisition of skills. It is clear that the trend toward minimally invasive surgery has some positive sides, yet certain issues to overcome, such as expensive equipment, and extensive training are required, particularly in smaller clinics. We can assist the veterinary surgeons with these barriers by providing affordable training and readily accessible material on how to utilize these new treatments. This will improve the quality of care to pets globally.

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