University of Veterinary medicine Budapest

Department of surgery and ophthalmology

The critical literature review of mini-invasive spay in dogs

A kutyák mini-invazív ivartalanításának kritikai irodalmi áttekintése

Dr. Tibor Németh

PhD, Dipl. ECVS, CertSACS

professor, head of department, deputy rector for clinical affairs

Alanna Tara Murphy

IH356

2024

Contents:

Table of Contents

Abstract:

My thesis will cover all critical areas of laparoscopic spaying procedures in dogs to provide a concise and full overview of the topic. The areas I wanted to cover are the historical aspect of the development of laparoscopy, the pros and cons of laparoscopic procedures versus traditional spaying methods and the current and future trends of laparoscopic spays. I will accomplish this by using an array of papers with varying viewpoints to build a solid answer to all these questions.

Some of my main questions were how the methods developed, how does pain and complications vary between lapspays and traditional spays, The financial aspects of the surgery and the current and future trends of the procedure

From my research and data compiled on these topics, it is evident that lapspays do have less complications and pain than midline spays with shorter surgery times. That the financial cost of equipment is feasible within a practice and owners are willing to pay more if they are well informed on both procedures. The current equipment is ever changing with newer and more patient safe and user-friendly equipment being developed.

Introduction:

My thesis topic "The critical literature review of mini-invasive spay in dogs" will cover the historical time line of ovariohysterectomy (OHE) and ovariectomy (OE) and the developments associated with this procedure in the past, present and future in dogs. This procedure in more recent years is becoming a much more popular and widespread surgical procedure in the veterinary world and therefore it is indispensable to have a concrete understanding of its uses, benefits and flaws.

Elective surgeries such as OHE and OE are considered to "one of the most commonly performed surgical procedures in small animal practice."[1] They therefore are a core aspect of the daily life of a clinical veterinarian where knowledge on the procedure and its developments is of the utmost importance. There are many reasons for this procedure including population control, reducing certain types of diseases such as pyometra, cancers and behavioural issues like aggression and phantom pregnancy[2]. OHE refers to "complete surgical removal of both ovaries as well as the uterus"[3] while OE is "the removal of both ovaries whilst the uterus is retained."[4] Both of these surgeries generally take a midline approach on the abdomen, however the wound size for OE is usually shorter with some studies seeming to indicate "pain scores to be lower in dogs that underwent an OVE"[5]

The main complications of OHE and OE surgeries post operatively include incontinence due to the lack of sex hormones being produced in the body as well as obesity in the following 2 years after the procedure as well as other forms of cancers such as osteosarcomas and hemangiosarcoma. Bone and joint disease risk may increase as well such as cruciate ligament ruptures.[6]

Laparoscopic surgeries, more commonly known by the public as keyhole surgery, are minimally invasive surgical procedures. In general, it is considered that this type of surgery has "advantages such as less trauma, smaller incision and excellent visualization than traditional open surgery."[7] Other research suggests that this procedure "has several advantages including prompt recovery, shorter anaesthetic period, fewer trauma, less

[1] "World Small Animal Veterinary Association Congress Proceedings, 2016."
[2] "Should I Spay My Dog?"
[3] "Ovariohysterectomy versus Ovariectomy - Which Technique Should I Use?"
[4] "Ovariohysterectomy versus Ovariectomy - Which Technique Should I Use?"
[5] "Ovariohysterectomy versus Ovariectomy - Which Technique Should I Use?"
[6] Hoad, "Spaying Bitches."
[7] Shariati et al., "Comparison between Two Portal Laparoscopy and Open Surgery for Ovariectomy in Dogs."

haemorrhage, and excellent visualization than traditional open surgery"[8] Laparoscopic spays use one or two ports.

This review will cover these aspects in comparison with traditional open spays to create a clearer image of the strengths and weaknesses of both procedures. It will also cover an overview of the timeline of the development of laparoscopic spays in dogs in conjunction with papers regarding development of laparoscopic techniques in human studies as there is generally quite a significant lag time between human medicine. Further developments in the field of laparoscopic surgeries in humans may be significant as future techniques that may be able to be implemented into veterinary medicine over time.

The current trends of laparoscopic spay along with the future and newest research available will be an area that is essential to cover as more and more advancements are made and this technique is improved upon.

[8] Shariati et al.

Methods:

I wanted to take a broad approach with a general overview of all the main aspects of laparoscopic ovariectomy's and hysterectomies in the veterinary field. I used a broad variety of papers for my research from varying countries and sources to gain a universal aspect of the subject and better my knowledge over the subject.

Beginning with the historical overview as a starting point allowed me to gain an appreciation to how this technique evolved, originally from human medicine to becoming a staple in the small animal clinics since the 1980's. The paper "The development of laparoscopy- A historical overview" provided a clear timeline for the evolution of the laparoscopic equipment and technique which was extremely beneficial for this study. This paper was the most conscience on this topic, I choose it for this purpose. It highlighted key pioneers such as Semm whose work greatly revolutionised the procedure as well as highlighting many aspects of conflicting views over the procedure that I found other papers lacked in.

In addition to this, the Canadian article published in the August 2014 issue of Veterinary Practice News "How the laparoscopic spay evolved" gave insight into the veterinary aspect of this and how it began within the field and became a more commonly performed procedure. I choose this article as it gave insight into the history of lap spays within the veterinary community, this married up well with the previous paper to give a full and accurate timeline of events.

In my next section, my focus was more on the benefits and costs of laparoscopic spays, to do this I found three papers online, all of them have a focus on the safety of these procedures. They focused on complications, surgical times and pain scores. Both the studies "Comparison between two portal laparoscopy and open surgery for ovariectomy in dogs" and "Duration, complications, stress, and pain of open ovariohysterectomy versus a simple method of laparoscopic-assisted ovariohysterectomy in dogs" are quite similar, I wanted to include both to compare them due to them including the type of anasthesia used, pain parameters, complication scoring.

This data from these papers provided a two-pronged approach at looking at these factors by looking at the similarities and differences between two papers to provide a more objective view from two different sources.

In contrast to the previous two papers, I found the paper "Outcome of laparoscopic ovariectomy and laparoscopic-assisted ovariohysterectomy in dogs: 278 cases (2003–2013)" focuses more on the outcomes over a long time, this data was beneficial to shed some light over these complications in a bigger population scale and over a longer period of time. I collected the data from these papers and presented them on charts to better interpret it and to be able to compare between the results of all 3 studies.

The final paper in this section focuses more heavily on the financial side of procedure and the feasibility of it in practice. This study "Evaluation of the economic and clinical feasibility of introducing rigid endoscopy and laparoscopy to a small animal general practice" focuses on costs over a 12-month period with data such as customer satisfaction, cost of equipment, cost of training as well as evaluating the income from these procedures in a small practice in the United States.

Next I focused on the sterilization, and future developments of the lap spay in the veterinary community, It was important to take a look at the current opinions of the people regarding the lap spay, the study "Evaluation of pet owner preferences for operative sterilization techniques in female dogs within the veterinary community" provided an insight into the views of the veterinary community itself as pet owners and their choices regarding the mater of sterilization, they would choose for their pet. The data I focused on mainly from this paper was both the willingness of owners to pay more for OVE and which sterilization type was the most popular amongst the veterinary community.

Advancements of equipment was also an aspect I wished to explore for my paper, I felt it was essential to cover both the current equipment and the future of devices that may be implemented within the veterinary field. This paper "Advances in Equipment and Instrumentation in Laparoscopic Surgery" provided these details along with also including and discussing the role of human medicine and the devices and techniques used within in comparison with the current usage of such devices and procedures in veterinary medicine.

Literature review

For my thesis, I wanted to explore a broad range of papers that would give me a rounded and insightful view into the history, pros and cons and future of laparoscopic spaying techniques in dogs.

A critical aspect of this literature review is taking an objective view over both open surgery and laparoscopic surgeries in terms of the pros and cons of both methods. This will give a more insightful look over the reasons clinics may prefer one over the other and which method may have more benefits to recovery time or less complications. For this aspect I picked three papers to contrast and compare.

In a study in 2013 "Comparison between two portal laparoscopy and open surgery for ovariectomy in dogs" the differences between both surgery procedures are "compared in terms of mean operative time, total length of scar, blood loss, clinical and blood parameters and all intra and post-operative complications."[9] This study used 16 dogs weighing an average of 14kg with ages ranging from 6 months to 12 months. The premedication in the study used was acepromazine (0.05 mg/kg IM), ketamine (10ml/kg IM) and general anasthesia used was ketamine (5mg mg/kg IV), diazepam (0.2mg/kg IV) and inhalational isoflurane with 1.5% oxygen.[10]

In a 2005 study, "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs." factors such as duration, stress and pain were investigated between open surgery and laparoscopic spays with 20 intact female dogs were used in this study weighing over 10kg with Laparoscopic and open OHE being the procedures performed. The dogs were premedicated with glycopyrrolate (0.01 mg/kg SC), morphine (0.02 mg/kg SC) and acepromazine (0.03 mg/kg SC) and general anasthesia was achieved via diazepam (0.2 mg/kg IV), propofol (3 mg/kg IV) with isoflurane via intubation tube. Bupivacaine (2mg/kg SC) was also used at the surgical site.[11]

Another study which uses a large case number "Outcome of laparoscopic ovariectomy and laparoscopic-assisted ovariohysterectomy in dogs" provides a broad overview of 278 female

[9] Shariati et al.
[10] Shariati et al.
[11] Cm, Re, and Jj, "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs."

dogs between 2003 and 2013. This study focuses on Intraoperative and post operative complications, duration of anaesthesia, surgery time, complications in short term (≤ 14 days) and long term (>14 days post-surgery) with data of both LapOVE and LapOVH being compared.

The cost of laparoscopic procedures and equipment is another factor that needs to be examined, a study covering the "Evaluation of the economic and clinical feasibility of introducing rigid endoscopy and laparoscopy to a small animal general practice" outlines the costs and the feasibility of Laparoscopic equipment, training costs and time and client satisfaction. The study took place in a small 2 veterinarian clinic in Southern California over a 12-month period where data of clients' pets underwent endoscopic or laparoscopic procedures.

Patient satisfaction was another area I wanted to cover, I used the paper "Evaluation of pet owner preferences for operative sterilization techniques in female dogs within the veterinary community" for this. I chose this survey due to the large population and the fact that it not only broke up the results into traditional spays and lapspays but also investigated the respondents' level of knowledge on the procedures.

There have been many advancements in the technology used within the procedure such as many different approaches to laparoscopic access. I found the study "Advances in Equipment and Instrumentation in Laparoscopic Surgery". This paper covers the ever-changing world of laparoscopic equipment, plus some new developments that are still being worked on. It contains a large amount of relevant information on these devices.

Results:

A historical overview of laparoscopic techniques:

Laparoscopic surgery as we know it today is relatively new in terms of the history of surgical procedures, the first recognised surgical procedure using this technique preformed was an "appendectomy was performed by Semm on 13 September 1980" on a human patient."[12] However, the beginnings of the concept of the laparoscopic era began much earlier in 1901 by gastroenterologist Georg Kelling in Dresden. "He investigated the abdominal cavity of a dog he had insufflated earlier with filtered air, using a Nitze cystoscope."[13] This could be considered as the first occurrence of a laparoscopic procedure; however, his work is not widely known due to the loss of his work during the Dresden bombings.

The next leap in laparoscopic procedures performed on human patients in Sweden by Hans-Christian Jacobaeus in 1910.[14] He coined the term "laparothoracoscopy" with his work "About the options of using cystoscopy for the investigation of serous cavities."[15] Jacobaeus wrote about this procedure being performed on 17 patients, recommending it as a way of being able to visualise body cavities. Unlike previous procedures, Jacobaeus introduced the use of "trocars directly without creating a pneumoperitoneum."[16]

At around the same time in the USA, Bertram M. Bernheim was also contributing developments to the laparoscopic technique, which he referred to as "organoscopy"[17] with the use of a mini-incision with a light and a scope without creating a pneumoperitoneum[18]. However, Bernheim changed his interest from gastroenterology and did not pursue this further. With the end of the first world war the method of insufflation was improved upon with Otto Goetze using the technique for improving X-ray images by using oxygen. This was then changed to CO2 by Swiss gynaecologist Richard Zollikofer in 1924.[19]

Heinz Kalk, a gastroenterologist in Berlin and the founder of the German school of laparoscopy greatly contributed to the development of optics used in the procedure with "135- degree lens system and a double trocar"[20] which he used in the visualisation of the

[12] Alkatout et al., "The Development of Laparoscopy—A Historical Overview," December 15, 2021.
[13] Alkatout et al.
[14] Alkatout et al.
[15] Alkatout et al.
[16] Alkatout et al.
[17] Alkatout et al.
[18] Alkatout et al.
[19] Alkatout et al.
[20] Alkatout et al.

liver and gallbladder for diagnostic purposes, with his new technique he reported not to have a single fatality out of "2,000 liver punctures under local anaesthesia"[21]in 1939.

Moving out of the diagnostic era of laparoscopy, the procedure became more focused upon using the technique for operative uses which broadened the horizon for use within the surgical field. In 1933 Carl Fervers preformed what may be called the first laparoscopic surgery in a rudimentary way with an adhesiolysis[22] with this technique being used and improved upon.

In 1937 J.C Ruddock "reported on more than 500 laparoscopic procedures with biopsies" using "pincers supplied with electrical power for the purpose of coagulation"[23] which has still been in common use for laparoscopy today.

The Hungarian internist and pulmonologist, János Veres, reintroduced the insufflation needle into the procedure which had been lost since Goetze's use of it.[24] Veres however, developed a cannula with a spring mechanism to create a pneumothorax, originally its use was to treat tuberculosis.[25] This type of cannula is still used today in procedures.

Other developments in equipment such as gas insufflation were developed from this stage. Frangeheim with co-operation improved upon the CO2 insufflator in the 1950's[26] while Kurt Semm became the most productive researcher in laparoscopic instrumentation while under the Kiel university, often attributed to being the "birthplace of modern laparoscopy"[27] The 1960's brought along more and more developments, for example the development of optics by the Karl Storz company which used a cold bulb[28] while the 1970's focused on thermocoagulation methods where Semm produced the Roedor loop in 1973 along with a suction, electric insufflator and the first morcellator in 1977.[29] Semms contribution to this field cannot be understated, as many of his devices are still used today within laparoscopic procedures however he was met with controversy during his time as anaesthetic

[21] Alkatout et al.
[22] Alkatout et al.
[23] Alkatout et al.
[24] Alkatout et al.
[25] Alkatout et al.
[26] Alkatout et al.
[27] Alkatout et al.
[28] Alkatout et al.
[29] Alkatout et al.

improvements occurred, the first appendectomy performed by him as mentioned at the beginning of this section, was met with "fierce resistance"[30]

Gotz and Pier, two German scientists, continued with Semms laparoscopic studies in the 1980's to 1990's, using the same technique to preform many appendectomies. [31] Meanwhile Erich Mühe, a German surgeon, preformed the "first laparoscopic cholecystectomy using the instruments developed by Semm"[32] in 1985. He later reported on 97 successful procedures with the same technique, while in 1991 Mouret preformed the first cholecystectomy by a video laparoscopy. [33] These radical developments led to more and more interest from the scientific community, however there were still some firm oppositions against these procedures.

Despite these challenges, a group of German surgeons founded "Surgical Task Group for Endoscopy and Ultrasonography" in 1976. Five years later, the Society of American Gastrointestinal Endoscopic Surgeons (SAGES) was founded in the USA"[34] which was a large step in getting this field more recognition and allowing like-minded surgeons to be able to publish and develop their work. In 1988 the first World Congress of Surgical Endoscopy was held and considered a major success.

The term "minimally invasive surgery" was coined by British urologist John E.A Wickham in 1987 where it gained attention, both positive and negative. The 1990's brought along a large shift in opinion for laparoscopic surgery, the so called "Laparoscopic revolution"[35] which mainly seems to be popularised by the patients themselves, who would rather have a small surgical incision. Semms work on equipment and techniques were indispensable for this radical change.

More and more modern video endoscopic cameras were developed after this stage, the electronic video endoscopy being a key element to this as it allows the assistant to also view the surgical field, allowing the surgeon to use both his hands. This was instrumental in allowing more teamwork between the surgeon and assistants. These mini cameras developed in 1987 quickly resolved the issue of heavy large video cameras used previously.[36]

[30] Alkatout et al.
[31] Alkatout et al.
[32] Alkatout et al.
[33] Alkatout et al.
[34] Alkatout et al.
[35] Alkatout et al.
[36] Alkatout et al.

Veterinary Laparoscopic procedures began around the 1980's. In a 2014 issue of the Veterinary Practice news mentioning Ray Cox, DVM being one of the first to implement this operation technique in small animals, though there were others also implementing this technique in a similar timeframe.[37]

However much like their human counterpart, veterinary laparoscopy went through many developments. With these procedures in the 1980's being rather tedious with surgery times of "2.5 hours"[38] which is far from the length of Lapspays today, which on average take around half an hour to an hour. Using the equipment was also no easy task with "procedure took two to three people operating through three ports"[39] These factors meant this procedure at the time was more complicated than a traditional spay and therefore wasn't a routine surgery method.

About a decade later with improvements in equipment, such as mini video cameras and improvements in videoscopes as discussed previously[40] the procedure begun to be used more routinely within practices, with DVMs such as Cox becoming "one of the pioneers of the single-port laparoscopic-assisted spay."[41] The use of the monopolar cautery systems over time was replaced by bipolar cautery systems which was viewed as much safer by veterinarians such as Cox ""Because this instrument cauterizes only between the paddles, my worries about stray sparks were immediately resolved,"[42]Nowadays with constantly improvements the laparoscopic spays have become more and more mainstream.

The cost and benefits of laparoscopic spays vs traditional spays in dogs:

In the 2005 study "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs." all the procedures were carried out by the same surgeon with the OHE incision size being modified to "middle third of the umbilicopubic distance…to more closely replicate OHEs performed

[37] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."
[38] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."
[39] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."
[40] Alkatout et al., "The Development of Laparoscopy—A Historical Overview," December 15, 2021.
[41] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."
[42] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."

in general practice"[43] while the laparoscopic group in dorsal recumbency attained pneumoperitoneum with CO2 via a Veres needle and mechanical insufflator with "a 12-mm cannula positioned at the level of the umbilicus was used to insert an 11-mm operative laparoscope with a 6 X 114-mm operating channel"[44]

Measurements were taken as "blood samples were obtained at 1,2, 4, 6, 12, and 24 hours after extubation" [45] to examine blood glucose and cortisol levels as stress indicators, with higher levels being linked with this. Palpation of the wound area along with heart rate, respiratory rate and mean arterial pressure were "1, 2, 4, 6, 12, and 24 hours after extubation…by 1 of 2 nonblinded technicians"[46] were the factors used to attribute to pain scores from 0-3. These scores were then combined to give a final total score for each patient within the two groups. The glucose and cortisol levels are a useful parameter to marry up with the pain scores due to it being a less subjective method of measurement.

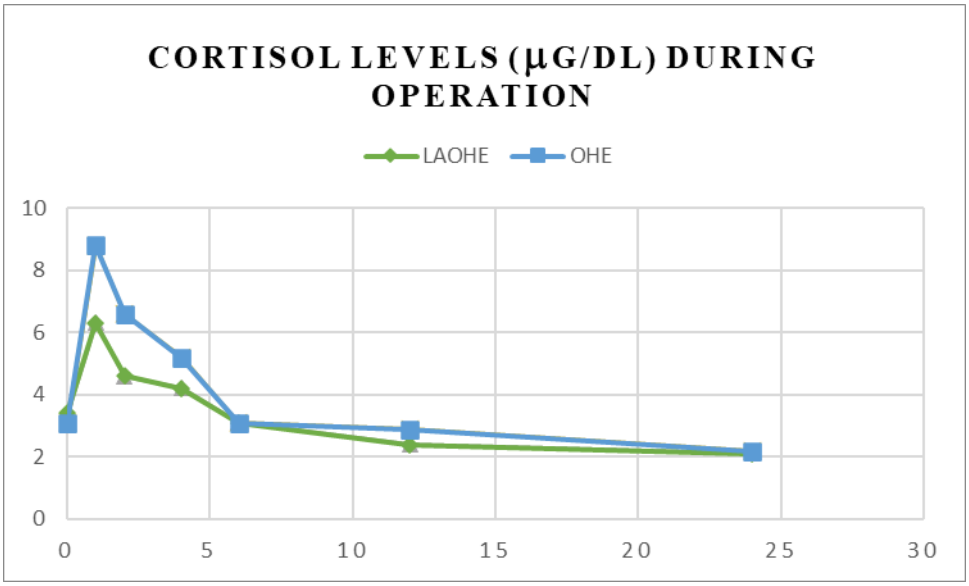

Figure 1 *-Cortisol levels over 24 hours in both laparoscopic and OHE groups*

[43] Cm, Re, and Jj, "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs."
[44] Cm, Re, and Jj.
[45] Cm, Re, and Jj.
[46] Cm, Re, and Jj.

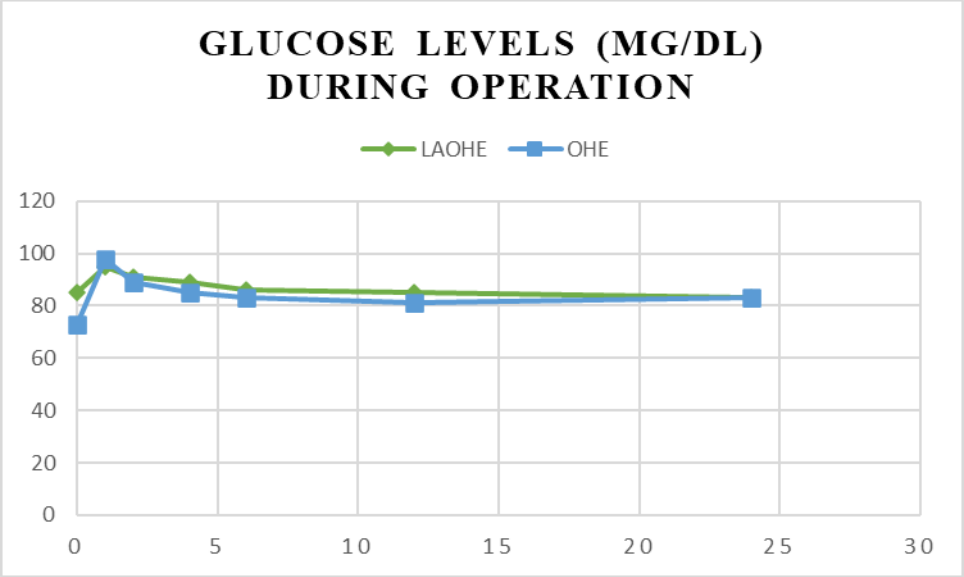

***Figure 2**- Glucose levels over 24 hours in both laparoscopic and OHE groups*

The outcome of this study suggests that the pain scores for the OHE patients were significantly higher than that of the laparoscopic OHE patients during recovery on every point of the scale, which required more pain medications. In particular the cortisol levels preoperatively were much higher in the OHE group after hour 1 and 2 while in Laparoscopic OHE patients there was not a very significant increase, meanwhile glucose stayed elevated longer within the OHE group.[47] **(*see Figure 1 and Figure 2*)**These factors combined suggests that lapspays are less painful for the animal. Surgery time was also recorded, with OHE ranging from an average of 18.6 minutes whilst laparoscopic OHE procedures took slightly longer on average with 20.8 minutes. General anasthesia time follows with a similar trend of 44.0 minutes for OHE and 46.3 minutes for Laparoscopic OHE respectively. [48]

In a similar study in 2013 "Comparison between two portal laparoscopy and open surgery for ovariectomy in dogs"[49] The laparoscopic group had incisions where "two 5- and 10-mm portals were inserted: First in the umbilicus for introducing the camera and the second, caudal to the umbilicus for inserting the forceps"[50] with CO2 insufflation being used to

[47] Cm, Re, and Jj.
[48] Cm, Re, and Jj.
[49] Shariati et al., "Comparison between Two Portal Laparoscopy and Open Surgery for Ovariectomy in Dogs."
[50] Shariati et al.

create a pneumoperitoneum. The traditional OE group had a "4 to 6 cm ventral midline skin incision was performed starting from the umbilicus and extended caudally."[51]

Blood loss within this experiment was measured using the collected blood within the suction machine and the sponges used during the surgery with other factors such as complete blood counts, temperature, respiratory rate and heart rate being "measured on days 0, 1, 3 and 7 after surgery in both groups"[52] with the surgical sites being examined daily. The stitches were removed under general anaesthesia after two weeks using a trocar to achieve pneumoperitoneum with a "camera inserted for evaluation of intra-abdominal adhesions in both groups."[53]Surgery time for the OVE group was an average of 36.6 minutes and the laparoscopic groups average being 17.7 minutes.[54]

The results of this study suggest that the blood loss within the laparoscopic group was less in comparison to the OVE group with the scar generally being longer within the OVE group. Heart rate and respiratory values in both groups were within normal range during the procedure.[55] There were no complications reported in either group i.e. haematomas, infections however there were more adhesions found post operatively within the OVE group "with higher incidence around the ovarian pedicle"[56] (see ***Figure 4)***

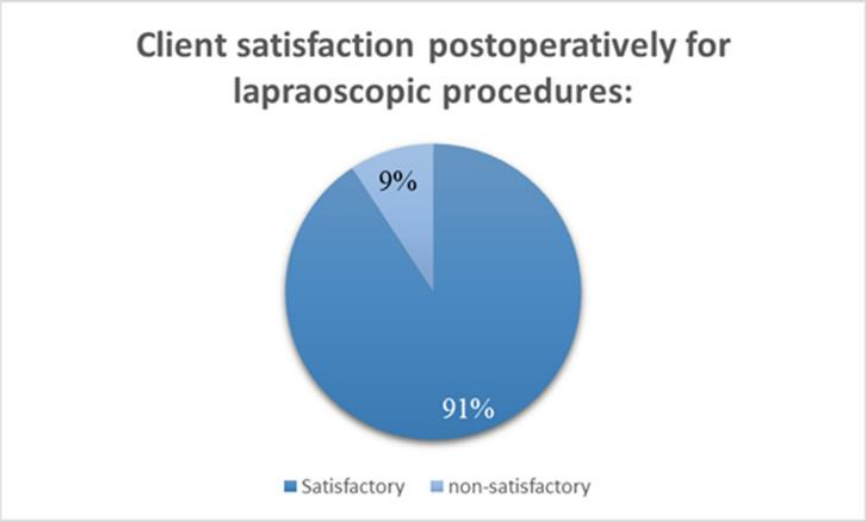

Figure 3- *client satisfaction postoperatively with Satisfactory (n=49) and non-satisfactory (n=5)*

[51] Shariati et al.
[52] Shariati et al.
[53] Shariati et al.
[54] Shariati et al.
[55] Shariati et al.
[56] Shariati et al.

In regards with both studies, there is an average reduction in surgical and anaesthesia time within lapspay group which again would be more in favour of the patient's health.

Another study which used a large case number "Outcome of laparoscopic ovariectomy and laparoscopic-assisted ovariohysterectomy in dogs" Out of 278 dogs, 131 underwent LapOVH and 147 underwent LapOVE **(see *Figure 5*)** with mixed breeds making up a majority of the named breeds with other large pure breeds making up the rest of the majority. **(see *Figure 6***Error! Reference source not found.**)**[57] The dogs were aged 9.8 months on average for LapOVH and 9.2 months in the LapOVE groups. With weight (kg) being 20.1 in the lapOVH and 20.0 in the LapOVE group respectively.[58] Anaesthesia time was 150 minutes on average for LapOVH group with 125 minutes on average for the LapOVE group, respectively. Surgical time was 67 minutes on average for the LapOVH group and 50 minutes on average for the LapOVE group.[59]

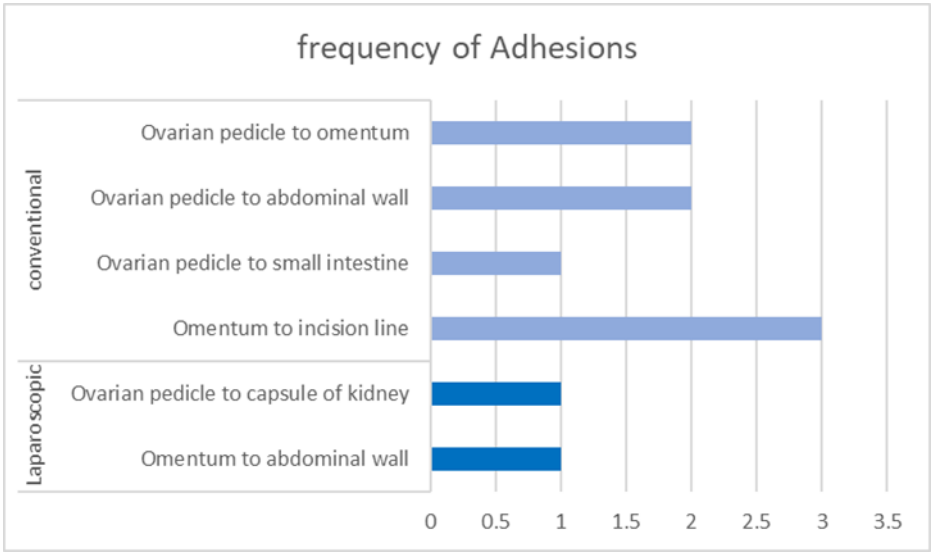

Figure 4 *Number of adhesion complications*

[57] Corriveau et al., "Outcome of Laparoscopic Ovariectomy and Laparoscopic-Assisted Ovariohysterectomy in Dogs."
[58] Corriveau et al.
[59] Corriveau et al.

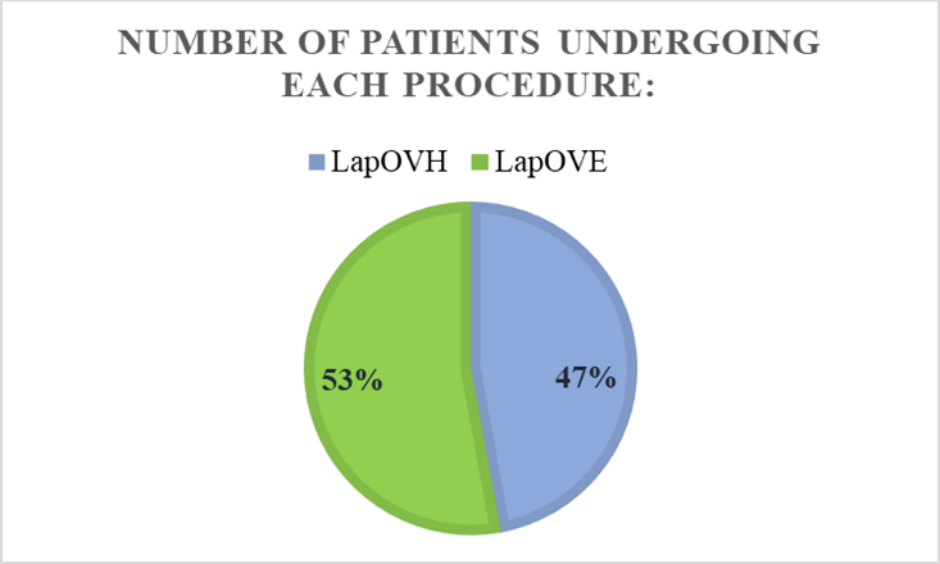

Figure 5 *- percentage of dogs undergoing LapOVH and LapOVE*

-.

Any systemic diseases were noted beforehand, with most of these patients having no systemic illness. **(*see Figure 7*)** Due to the nature of this study where data was collected over a long period of time, the exact anaesthesia drugs were not noted in detail as the previous two studies. Intraoperative complications were noted, such as splenic lacerations or pedicle haemorrhages. [60]**(see *Figure 8 and Figure* 4)** It is evident that the laparoscopic group performed better in this regard.

[60] Corriveau et al.

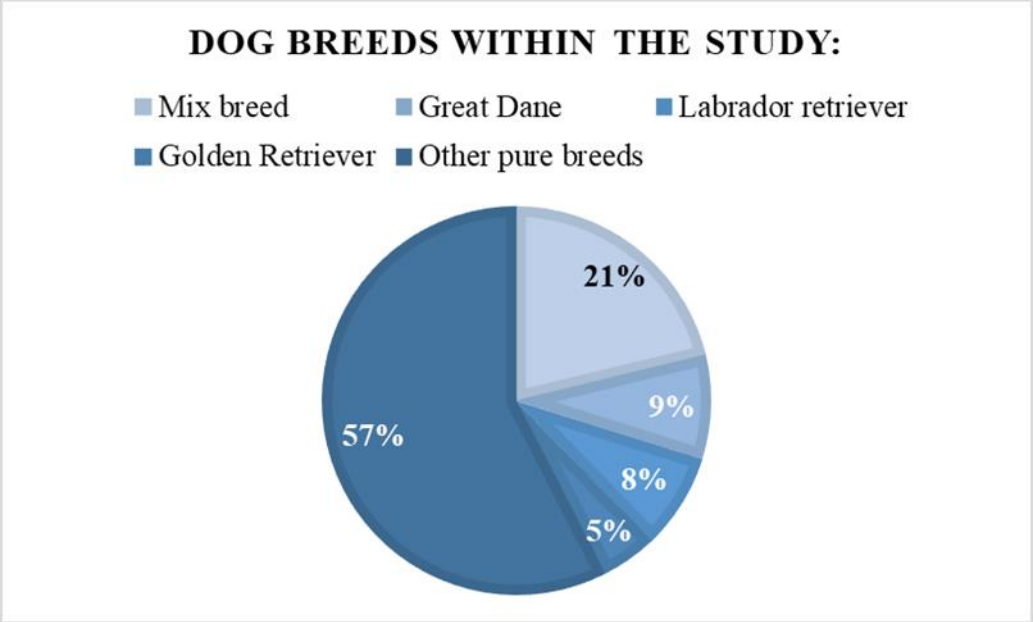

Figure 6 *Breeds represented within the study*

"Evaluation of the economic and clinical feasibility of introducing rigid endoscopy and laparoscopy to a small animal general practice" examined 54 patients which underwent laparoscopic procedures over 12 months with client satisfaction being reported as 90.7% (see ***Figure 3***)[61] however it must be stated that some owners were unreachable for this postpreparative satisfaction survey. This trend found within this paper indicates that the

[61] Jones et al., "Evaluation of the Economic and Clinical Feasibility of Introducing Rigid Endoscopy and Laparoscopy to a Small Animal General Practice."

majority of clients are happy with the outcome of the procedure.

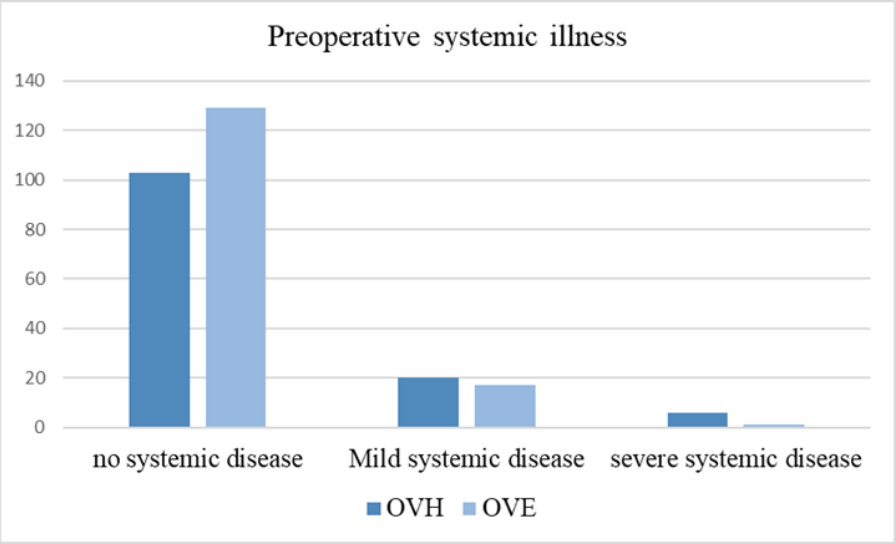

Figure 7 *Preoperative systemic illness within the surgical population*

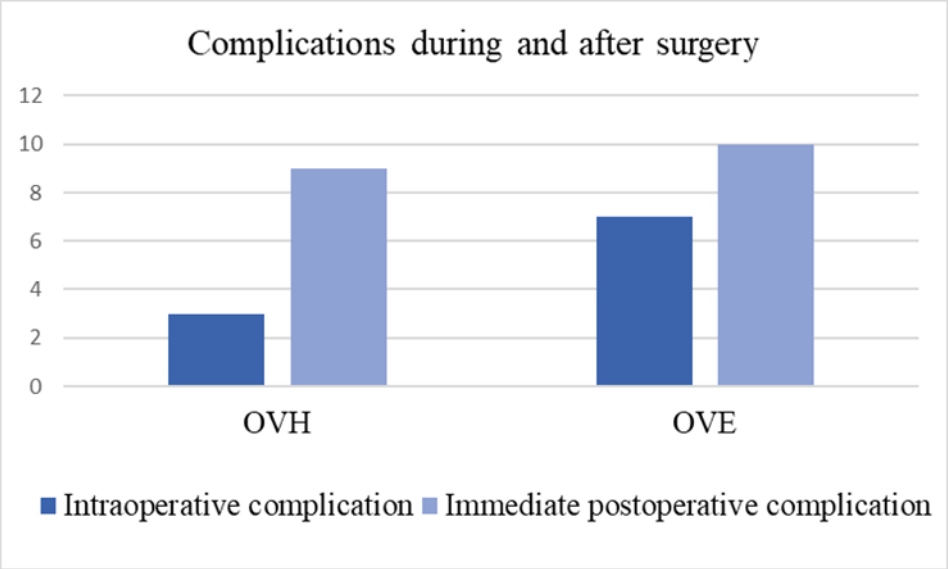

Figure 8 *-Comparison of the intra and post operative complications between both the OVH and OVE groups*

The average surgery time for these patients was 63.7 minutes for 44 OVE patients while an average time of 34 OVE procedures completed by the practice owner was 58.6 minutes, and 73.0 minutes on average for those patients undergoing OVE with prophylactic gastropexy.[62]

[62] Jones et al.

Complications were also noted: 12 minor interoperative complications were reported (e.g. splenic laceration, breach of asepsis) with no postoperative complications being reported.[63]

The cost of the equipment was also evaluated, with the basic equipment (i.e. video camera, telescopes) over a 5-year lease cost "$57,507.70; $889.60/mo or $10,675.20/y."[64] The extra parts including CO2 canisters and refills, 2 handheld pieces for the sealing device and sterile covers came to $994.51 per year with the laparoscopic training costs coming to $3,140.00[65]. The total cost over the yearlong study came to $14,809.71, and the total revenue from the procedures was $50,423.63 with the cost on average being $742.60 per client total with the 44 OVE procedures mean cost came to $708.72.[66] This study suggests that the yearly gross profit for the clinic was $35,613.92 **(see *Figure 9*** Error! Reference source not found.**)** leading there to be a 71% gross profit. This data suggests, regardless of the higher pricing of lapspays, they are quite feasible.

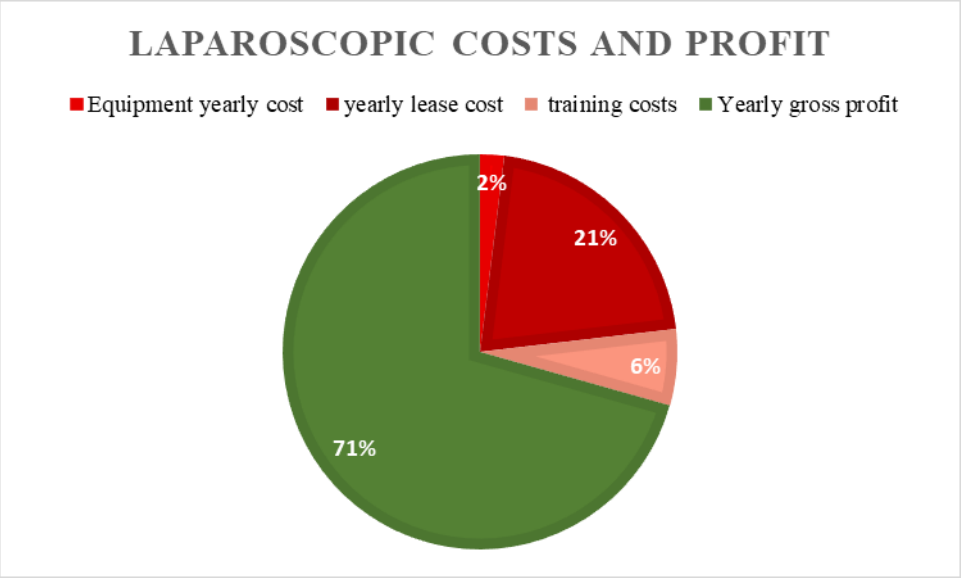

Figure 9 *- Profits and costs of lapspays represented as percentages*

[63] Jones et al.
[64] Jones et al.
[65] Jones et al.
[66] Jones et al.

The current trends and future of laparoscopic spays

The laparoscopic spay has become a frequently used technique in veterinary field, with laparoscopy being used now in a much wider range of keyholes surgeries, even in the urinary system alone: the technique is being used for "LA cystotomy, LA cystolith removal, LA cystopexy, LA tube cystostomy, and LA urinary bladder polyp resections."[67] Many of the commonly agreed upon benefits noted include "reduced patient morbidity, shortened durations of hospitalization, reduced wound contamination and breakdown, and shorter patient recovery periods."[68]

In a 2016 American study with veterinary faculty "Evaluation of pet owner preferences for operative sterilization techniques in female dogs within the veterinary community", the average price for an open spay was $260 with an additional $200 dollars being suggested for the minimally invasive procedures.[69] In a survey population of 3721 individuals with a response rate of 33.2%[70], results showed that the majority chose " single and TP spay as their top 2 choices."[71] It was also noted that out of the study population "respondents whose dogs had a known history of laparoscopic surgery were significantly more likely to choose laparoscopic surgery as a first choice"[72] with 48% of respondents willing to spend "between $100 and $200 more"[73] on laparoscopic OVE than an open spay. This study shows that even with an elevated price, well informed pet owners were happy to pay the extra cost for the surgery to have a Lapspay procedure.

There have been many advancements in the technology used within the procedure such as many different approaches to laparoscopic access which are needed for the insertion of the operative instrumentation and rigid telescope into the abdominal cavity. Threaded metal port cannulas have been used for quite a while, the appeal of these devices is that they are reusable if autoclaved.[74] A new advancement is a stopper which "maintains the telescope in optimal position during cannula advancement."[75] This cannula has spiralling edges which allows insertion via a twisting motion into the body wall however, advancement must be

[67] Steffey, "Laparoscopic-Assisted Surgical Procedures."
[68] Steffey.
[69] Hsueh et al., "Evaluation of Pet Owner Preferences for Operative Sterilization Techniques in Female Dogs within the Veterinary Community."
[70] Hsueh et al.
[71] Hsueh et al.
[72] Hsueh et al.
[73] Hsueh et al.
[74] Huhn, "Advances in Equipment and Instrumentation in Laparoscopic Surgery."
[75] Huhn.

done carefully due to the chance of intragenic damage. The reusable nature of these threaded cannulas makes them both cost effective and environmentally friendly which may appeal to more clinics.

Optical ports used alongside a veres needle are needed to insufflate the abdomen with CO2 prior to the first port placement to allow visualisation. This has reduced the chances of accidental damage and is considered a "safe and reliable method and saves significant operative time."[76] Older devices used integrated cutting blades that dulled quickly however, improvements have been made that don't include this blade but instead features a "ribbed, translucent cannula and a conical dolphin tip"[77] which instead allows visualization of the muscle layers and fascia prior to entering the peritoneum.

Laparoscopic spays were traditionally done through one or two ports near the midline or lateral to the umbilicus however, over time the idea of minimally invasive surgery meant surgeons wanted to avoid many incisions. Some research according to this paper suggests that "incisions through muscle bellies were perhaps more painful than incisions through the linea alba."[78] This has led to changes with the incision methods used, leading more surgeons to perform this through an 11mm to 12mm incision line to return to the original concept of veterinary laparoscopy surgery being minimally invasive. In the human surgical community, the single incision line (SILS) method came from cosmetic reasons.[79] These SILS ports were developed for this purpose, with "4 channels, which allow insertion of 5 to 15 mm diameter cannulas. As such, 5 mm handpieces, 5 to 12 mm telescopes, and 10 to 15 mm stapling devices can all be introduced simultaneously through a 2 cm abdominal access incision."[80] These ports are now also used by veterinarians, with many surgeons preferring to use straight instruments within the channels. These ports are also reusable with sterilization.

More and more important laparoscopic equipment is the sealing device, with both mono- and bipolar systems being available. These systems are more costly, however many times extensions can be added to already existing cautery equipment as a paper suggests that "Most veterinary surgical practices own some form of cautery box, which delivers cutting, coagulating, or blended electrosurgical energy through a monopolar pencil and/or a bipolar

[76] Huhn.
[77] Huhn.
[78] Huhn.
[79] Huhn.
[80] Huhn.

forceps"[81] Monopolar pencils can be fitted to these systems with "J-shaped or L-shaped configuration which allows the surgeon to lightly hook the tissue with the concave aspect or use the back (convex) side for blunt dissection." These are used mainly in conjunction with laparoscopic aspirators as uncontrolled haemorrages can be the most common reason for laparoscopic conversion.[82] Most of these devices have a 5mm suction/lavage with a fenestrated tip connected to a pump with some of them having monopolar elements to allow cauterization to a bleeding vessel. Grounding pads are also essential for the monopolar system to function.[83]

Another development in laparoscopic tools are retractors, which must be made smaller and more mobile to fit and operate within the ports in comparison to other more traditional retractors used in other surgical procedures. To fix this, a 5mm retractor may be used for procedures, " The retractor is placed through a 5 mm port, and is extended into a semicircular hook once in the abdomen."[84]

Specialised cautery and vessel sealing systems have developed from the mono and bipolar forceps made for certain surgical and tissue types. The Ligasure vessel sealing device was approved in "1998, but was not used extensively in veterinary surgery until 2007"[85] which can be used with bipolar systems but not as a monopolar. This was one of the first widely used devices for OVE and OHV in the veterinary field, however more developments of these devices have led to the Ligasure being discontinued. [86] Newer devices such as the Force triad energy platform, which "is an all-in-one generator, and includes monopolar, bipolar, and Ligasure technologies. Vessel sealing devices are approximately twice as fast as those obtained with the first-generation Ligasure device"[87] which entered the veterinary field in 2010. Enseal tissue sealing devices, which are like the Ligasure devices, are currently developing a cordless device which may be available soon.[88]

[81] Huhn.
[82] Huhn.
[83] Huhn.
[84] Huhn.
[85] Huhn.
[86] Huhn.
[87] Huhn.
[88] Huhn.

Discussions/Conclusion

The research and data I found putting together this literature review has been extremely insightful into the field of laparoscopic procedures. It is evident that laparoscopic procedures have had a turbulent history with many obstacles, with Georg Kellings work being lost in 1945 in Dresden in a heavy air attack on the city[89] which evidently caused a large amount of knowledge to be lost to time which hindered the development of procedure during this era until Semms revolutionary work on the subject in the 1970's leading to the first laparoscopic "appendectomy was performed by Semm on 13 September 1980".[90]

Studying a human based paper regarding the total historical view of laparoscopy and minimally invasive procedures combined with a journal concerning the introduction of it into the veterinary field[91,92] provided an insight into how veterinary medicine has a lag time behind human medicine and it's techniques, which seems to be a very strong correlation even throughout other papers within this review, most notably the "Advances in Equipment and Instrumentation in Laparoscopic Surgery" which discusses the current usage of laparoscopic equipment in veterinary medicine which was used widely in the human field prior to its implantation into veterinary laparoscopic procedures. This was an essential part of my research as it not only shows the development but the fact that veterinary medicine follows human medicine with the "2014 issue of the Veterinary Practice news" discussing its implication in the 1980's with some practices in the States. I think this shows that new developments going on currently in the human world of laparoscopy will eventually be implemented within the veterinary community to lead to better surgical standards and quality of care to patients.

Another essential aspect of my study was the cost and benefit ratio of lap spays verses traditional spaying methods, I tried to use as many papers as possible with a broad set of factors such as surgical time, patient pain, financial and patient satisfaction. I felt these papers greatly widened my horizons on all aspects of these procedures and allowed me to obtain many different perspectives.

[89] Alkatout et al., "The Development of Laparoscopy—A Historical Overview," December 15, 2021.
[90] Alkatout et al., "The Development of Laparoscopy—A Historical Overview," December 15, 2021.
[91] Alkatout et al.
[92] "How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada."

I focused on for factors such as pain, operation time and post op complications. For this I used three papers to give a more varied and less biased range of possible results. The first two studies were more controlled over a shorter period with a selected cohort, while the final study looks at a larger selection of cases over a prolonged period. I felt this was important to my study to provide a rounded set of results.

It is evident from these 3 papers that laparoscopic methods all have a general trend in favour of laparoscopic spays. "Pain scores were higher at all points for the OHE group, compared with the LAOHE group"[93] with more dogs needing extra pain medications within that group. The significant difference between the scores striking as it would suggest that laparoscopic methods cause less perceived pain to the patient.

It was also apparent that the laparoscopic group had a much lower level of cortisol which returned to a normal baseline in comparison with the OHE group glucose however was more varied with both groups, with the OHE operations normally scoring higher levels during and right after the operation but lowering slightly below the laparoscopic group which remained marginally higher during the next few hours (see **Error! Reference source not found.Error! Reference source not found.**). This data in tandem with the pain scores strengthens the evidence behind laparoscopic procedures causing less distress and pain for dogs undergoing spaying procedures.

Pain was a major factor focused on within the first two studies, "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs" and "Comparison between two portal laparoscopy and open surgery for ovariectomy in dogs" which was achieved via respiratory and heart rate. The results of both these studies showed a significant difference between pain scores during surgery and post op in the laparoscopic ovariectomy group that opposed to the OHV groups

I found that glucose and cortisol levels are useful parameters to marry up with the pain scores due to it being a much less subjective method of measurement than in the first study, these corelate with stress.

[93] Cm, Re, and Jj, "Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs."

Blood loss was also another issue looked at in "Comparison between two portal laparoscopy and open surgery for ovariectomy in dogs" and, in general is quite a common spaying complication as it leads to hypothermia and anaemia which worsens the patient's recovery time. It is evident with the results that there is less blood loss with the laparoscopic methods used. This may also suggest that other surgeries in the future may be better performed under laparoscopy to reduce patient risk.

Complications after surgery was another factor that I wanted to research, the main areas I focused on were presurgical and post-surgical complications. Most of the patients used in the study had no systemic illness while some had mild systemic illness, I feel having more variety of patients might have been more beneficial for the study than using a mainly healthy cohort to reflect the spectrum of patients seen in the everyday clinic. However, it is evident that within the two groups the laparoscopic group performed better overall with less complications and adhesions.

Age of the animals and breeds were another minor note of interest, over all the studies the median ages are under 2 years of age. Perhaps having an older patient age range might have given a clearer picture between the two operations. In the "Outcome of laparoscopic ovariectomy and laparoscopic-assisted ovariohysterectomy in dogs" which names the major breeds seen with in the study, out of the named purebred and mix breed dogs, most named animals were medium to large type breeds with the average weight being (20.1) in the laparoscopic group and (20.0) in the OHE group[94]. I feel to give a more accurate scope of breeds and weights, more breeds should have been named during the study as it does not help indicate if smaller sized dogs under the average 20kg mark would have reacted. However, this study does include a vast number of breeds over a long period of time.

Economics was another large area of focus within my thesis, the goal was to try and evaluate if the pricing of items such as equipment and training would be covered by the cost of the procedure and how profitable it is to do so. For this I used ""Evaluation of the economic and clinical feasibility of introducing rigid endoscopy and laparoscopy to a small animal general practice" as it provided a yearlong study. The outcome of this study proves that there is quite a high gross profit, regardless of the higher equipment and training costs needed to preform these surgeries.

[94] Corriveau et al., "Outcome of Laparoscopic Ovariectomy and Laparoscopic-Assisted Ovariohysterectomy in Dogs."

In the same vein, client satisfaction was important for this study, “Evaluation of pet owner preferences for operative sterilization techniques in female dogs within the veterinary community” was very insightful. It provided a large survey group in which most clients would opt to pay nearly double the price of a midline spay for laparoscopic surgery. It was interesting to see that more well-informed clients made up the majority of the pro laparoscopy group. This would indicate that more public knowledge needs to be made available about lapspays so owners can make an informed choice.

The current and future trends of lapspay were the last major topic of this thesis. I used the paper “Advances in Equipment and Instrumentation in Laparoscopic Surgery” to round off this aspect. This mainly looks at equipment and techniques that have been implemented into the procedure. It is evident that there have been some major bounds within the last ten years with equipment such as the SILs ports, allowing surgical equipment to fit into a much smaller incision instead of creating a larger wound as done previously. This has really improved the safety and standard for these procedures.

Future developments such as the Enseal device, a handheld cordless sealing tool, will further improve these procedures. These new advancements will make lap spays safer for the patient as well making these procedures more accessible and surgeon friendly. The cordless option will allow the equipment to be more portable, easier to clean and will reduce potential accidental contamination via the electrical cord.

A Summary:

The research for this thesis was very eye opening, I wanted to create a paper that encompassed a full, non-biased view on the use of laparoscopic spaying techniques in veterinary medicine. I achieved this by using a wide variety of sources to understand different perspectives on the issues.

I feel by reviewing historical developments in both human and in veterinary medicine, it shed a light over the many setbacks and backlash against the procedure, and the fact that veterinary medicine has a trend to follow behind human medicine.

The data collected within this research shows that pain, stress and surgical complications are much lower within laparoscopic procedures in comparison to midline spaying as well as a reduction in surgery time overall depending on the experience of the surgeon. These factors would indicate that the lapspay is a better alternative for many dogs.

The financial aspects were another area I wanted to cover. From my research for this thesis, the cost of preforming lap spays is higher in terms of training and equipment, however it is evident that it is a feasible investment for a practice. Further studies then show that owners are willing to pay more for this procedure. Especially those who are well informed on all of their options, this would suggest that owners should have more access to information regarding lapspays to make an informed decision for their pets' surgery.

Finally, it seems obvious that laparoscopic spaying equipment is ever changing and becoming more and more user friendly and accessible to vets. It is also greatly improving patient safety with equipment such as mono and bipolar systems with ligature sealing devices and this trend is only continuing with newer cordless devices being developed soon.

Abbreviations:

OHE – Ovahysterectomy

OE – ovariectomy

LapOVH – Laparoscopic ovahysterectomy

LapOVE – Laparoscopic ovariectomy

SC – subcutaneous

IV – intravenous

IM – intramuscularly

Mg/kg – milligrams per 1 kg of body weight

Laps pay- Laparoscopic spay

SILS – single incision line system

References:

Alkatout, Ibrahim, Ulrich Mechler, Liselotte Mettler, Julian Pape, Nicolai Maass, Matthias Biebl, Georgios Gitas, Antonio Simone Laganà, and Damaris Freytag. “The Development of Laparoscopy—A Historical Overview.” *Frontiers in Surgery* 8 (December 15, 2021): 799442. https://doi.org/10.3389/fsurg.2021.799442.

———. “The Development of Laparoscopy—A Historical Overview.” *Frontiers in Surgery* 8 (December 15, 2021). https://doi.org/10.3389/fsurg.2021.799442.

Cm, Devitt, Cox Re, and Hailey Jj. “Duration, Complications, Stress, and Pain of Open Ovariohysterectomy versus a Simple Method of Laparoscopic-Assisted Ovariohysterectomy in Dogs.” *Journal of the American Veterinary Medical Association* 227, no. 6 (September 15, 2005). https://doi.org/10.2460/javma.2005.227.921.

Corriveau, Kayla M., Michelle A. Giuffrida, Philipp D. Mayhew, and Jeffrey J. Runge. “Outcome of Laparoscopic Ovariectomy and Laparoscopic-Assisted Ovariohysterectomy in Dogs: 278 Cases (2003–2013).” *Journal of the American Veterinary Medical Association* 251, no. 4 (August 15, 2017): 443–50. https://doi.org/10.2460/javma.251.4.443.

Hoad, Julian G. “Spaying Bitches: Why, When, How?” The Veterinary Nurse, October 2, 2018. https://www.theveterinarynurse.com/content/clinical/spaying-bitches-why-when-how/. (13/11/24)

“How the Laparoscopic-Assisted Spay Evolved - Veterinary Practice News CanadaVeterinary Practice News Canada.” Accessed March 19, 2024. https://www.veterinarypracticenews.ca/how-the-laparoscopic-assisted-spay-evolved/print/. (14/11/24)

Hsueh, Christine, Michelle Giuffrida, Philipp D. Mayhew, J. Brad Case, Ameet Singh, Eric Monnet, David E. Holt, Megan Cray, Chiara Curcillo, and Jeffrey J. Runge. “Evaluation of Pet Owner Preferences for Operative Sterilization Techniques in Female Dogs within the Veterinary Community.” *Veterinary Surgery* 47, no. S1 (2018): O15–25. https://doi.org/10.1111/vsu.12766.

Huhn, John C. “Advances in Equipment and Instrumentation in Laparoscopic Surgery.” *Veterinary Clinics of North America: Small Animal Practice* 46, no. 1 (January 2016): 13–29. https://doi.org/10.1016/j.cvsm.2015.08.005.

Jones, Kelly, J. Brad Case, Brian Evans, and Eric Monnet. “Evaluation of the Economic and Clinical Feasibility of Introducing Rigid Endoscopy and Laparoscopy to a Small Animal General Practice.”

Journal of the American Veterinary Medical Association 250, no. 7 (April 1, 2017): 795–800. https://doi.org/10.2460/javma.250.7.795.

“Ovariohysterectomy versus Ovariectomy - Which Technique Should I Use?” https://wvs.academy/research-spotlight/ovariohysterectomy-versus-ovarietomy/. (26/10/24)

Shariati, Elnaz, Jalal Bakhtiari, Alireza Khalaj, and Amir Niasari-Naslaji. “Comparison between Two Portal Laparoscopy and Open Surgery for Ovariectomy in Dogs.” *Veterinary Research Forum : An International Quarterly Journal* 5, no. 3 (2014): 219–23.

Steffey, Michele A. “Laparoscopic-Assisted Surgical Procedures.” *The Veterinary Clinics of North America. Small Animal Practice* 46, no. 1 (January 2016): 45–61. https://doi.org/10.1016/j.cvsm.2015.07.002. (08/10/24)

The Vet Collection. “Should I Spay My Dog?”. https://www.vetcollection.co.uk/health/should-i-spay-my-female-dog/. (17/10/24)

“World Small Animal Veterinary Association Congress Proceedings, 2016.” *VIN.Com*, May 15, 2015. https://www.vin.com/doc/?id=8247824. (12/11/24)

Thesis progress report for veterinary students

Name of student: ALANNA TARA MURPHY

Neptun code of the student: IH356Y

Name and title of the supervisor: Dr. Tibor Németh, Head and professor of small animal surgery

Department: Department and clinic of Surgery and Opthamology

Thesis title: The Critical literature review of mini-invasive spay in dogs

Consultation – 1st semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2024.	03.	01.	literature discussion	
2.	2024	04.	10.	— " —	
3.	2024	05.	20	— " —	
4.					
5.					

Grade achieved at the end of the first semester: grade 5

Consultation – 2nd semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2024.	09.	09.	Advices on thesis writing	
2.	2024	10.	07.	"	
3.	2024.	11.	04.	"	
4.					

5.					

Grade achieved at the end of the second semester: ..... grade 5. .....

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

.....
signature of the supervisor

Signature of the student: .....

Signature of the secretary of the department: .....

Date of handing the thesis in..... 22/11/24 .....