VETERINARY EVIDENCE online

In Cats and Dogs Does Laparoscopic Ovariectomy Offer Advantages Over Open Ovariectomy for Postoperative Recovery?

A Knowledge Summary by

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KNOWLEDGE SUMMARY

Clinical bottom line

Available research suggests ovariectomy by laparoscopy leads to a more positive recovery following surgery, due to reduced pain and smaller reductions in activity levels postoperatively when compared to open ovariectomy. In practices where laparoscopic equipment and expertise are available, offering laparoscopic ovariectomy for routine spays of cats and dogs may be advantageous to patients.

Question

In cats and dogs does laparoscopic ovariectomy offer advantages over open ovariectomy for postoperative recovery?

The Evidence

There are a number of major constraints in evaluating the evidence from these studies to draw a clear conclusion to the original question, including the variety of recovery outcomes measured, the subjective nature of interpreting animals behaviours for pain scoring, lack of blinded pain assessors in four of the five studies, as well as varying different methods and scales used to assess pain. The lack of a blinded trial to evaluate the different techniques is ultimately the major constraint to drawing a definitive clinical bottom line and is required to validate this conclusion from the current evidence available.

Summary of the evidence

Coisman (2013)	
Population:	Domestic, female cats from animal rescue centres
Sample size:	N=24
Intervention details:	**Intervention groups** - 1-portal laparoscopy using extracorporeal suture (L-ECS) method (n=8) - 1-portal laparoscopy using LigaSure (L-Ligasure) method (n=8) - Open ovariectomy (n=8) **Inclusion criteria** - Intact, not pregnant females, assessed as normal on physical examination **Group characteristics** - Mean age 16.5±6.8 months - Mean weight 3.02±0.35kg - No significant difference for either age or weight between groups **Statistical analysis** - One-way ANOVA using Welch's method to assess for unequal variance was used to test for differences in age,

	body weight and surgical time - Tukey-Kramer test used for post-hoc analysis - Complications compared by Pearson's x^2 contingency analysis - Repeated measures ANOVA to test differences in pain scoring - Wilcoxon method for nonparametric comparisons between pairs
Study design:	Blinded, randomised controlled trial
Outcome studied:	- Pre and postoperative pain scores (1,2,3,4 hrs following extubation) using visual analogue scale (VAS), simple descriptive scale (SDS) and von Frey meter (VF) - assessors blinded to surgical group - Surgical complications (scored 0-3 on occurrence) - Surgical duration (start of skin incision through to time of skin closure)
Main findings: (relevant to PICO question):	**Surgical duration** - Significantly longer in L-ECS group (71 minutes; p<0.001) than L-Ligasure (25.5 minutes) and open (17 minutes) groups - No difference between L-Ligasure and and open groups **Surgical complications** - More frequent in L-ECS group than L-Ligasure (p=0.049) and open groups (p=0.008) - No difference was seen between L-Ligasure and open groups **Postoperative pain scores (VAS, SDS and VF)** - Significantly greater VAS score in L-ECS vs. L-LigaSure, p=0.011 at time point 4 hours following extubation - No difference in VAS score seen at any other time point between the three groups - No differences seen in SDS or VF pain score between the three groups
Limitations:	- Pain scores were determined by two observers - blinded to treatment - this could have resulted in variation between pain scoring between individuals when using the VAS and SDS methods - A standardised incision was made for all techniques (location and length) to allow the blinding of pain scorers - this could have strongly impacted on pain scores since invasiveness and tissue damage has been shown to be associated with postoperative pain. This evidence is currently weak in the veterinary field but has been shown more strongly in human medicine - Laparoscopic technique was the less commonly used 1-portal method and the study did not include a 2-portal method comparison, which may not be so relevant for practices. - No reporting of breeds and small sample sizes were used with no statistical analysis performed on whether these numbers were suitable. This makes it possible a type-II

	statistical error may have occurred especially when considering surgical duration results showing no significance between L-LigaSure and open groups - No reporting of confidence intervals, so precision of effect is unknown

Culp (2009)	
Population:	Small breed <10kg female dogs from animal welfare society
Sample size:	N=20
Intervention details:	**Intervention groups** - 2-portal laparoscopic ovariectomy (n=10) - Open ovariectomy (n=10) **Inclusion criteria** - Intact, females weighing <10 kg **Group characteristics** - Age (years): open median, 2, range 0.5 - 3; laparoscopic median, 1, range 0.5 - 3, - Weight (kg): open median, 4.6, range 2 - 4.8; laparoscopic median, 5, range 2 - 10 - Presurgical activity: open median, 235,170; range 57,322-677,623, laparoscopic median, 256,166; range 71,928-542,956 **Statistical analysis** - Mann Whitney test to compare surgical times - Wilcoxon signed test to compare activity counts - Linear regression analyses to evaluate association of surgical procedure and activity counts change
Study design:	Randomised, controlled trial
Outcome studied:	- Surgical duration (start of skin incision through to time of last suture) - Degree of haemorrhage (minor, moderate, severe) - Incision length - Activity levels pre- and postoperative (previously reported as an objective measure of pain in humans)
Main findings: (relevant to PICO question):	**Degree of haemorrhage** - 6/10 dogs in the open group experienced minor bleeding compared to 3/10 dogs in the laparoscopic group **Surgical duration** - Significantly shorter (p=0.005) in the open group (21 minutes) compared to the laparoscopic group (30 minutes) **Postoperative activity levels** - 25% decrease (non-significant) in dogs undergoing laparoscopic surgery in days 1 and 2 post-surgery compared to preoperative baseline activity levels (95% confidence

	intervals 11-38%) - 62% (p=0.002) decrease for days 1 and 2 compared to preoperative baseline activity (confidence intervals 95%, range 48-76%)
Limitations:	- Activity levels were measured in animal welfare centre runs not viewed by study investigators so the type of activities were unable to be reported, however baseline activity levels were shown to be comparable with pet dogs within the home over 24 hours - The LigaSure device used for haemostasis in the laparoscopic group was not used in the open surgical group adding a further variable between the two groups - Only individuals working within the welfare centre were blinded to surgical treatment and not the study investigators, which provides a source of bias into the study - The use of accelerometry was at the time a relatively new technique (this has since been validated in veterinary medicine to monitor activity levels within osteoarthritis, Belshaw et al., 2016, Brown et al., 2010)

Gauthier (2015)	
Population:	Domestic, female pet cats
Sample size:	N=60
Intervention details:	**Intervention groups** - Open flank ovariectomy (n=20) - Open ventral midline ovariectomy (n=20) - 2-portal laparoscopic ovariectomy (n=20) **Inclusion criteria** - Healthy - classified as American Society Anesthesiologists category (ASA) category ASA 1 - females - Suitable temperament based on a behavioural assessment (aggressive cats excluded) - Not administered analgesics within 48 hours of surgery **Group characteristics** - Mean age (months): open flank, 10.2±1.3; open midline, 8.3±0.8; laparoscopic, 11.0±1.7 - Body weight (kg): open flank, 3.14±0.61; open midline 2.70±0.39, laparoscopic, 2.62±0.47 - No significant difference between groups for age, laparoscopic group weight $p<0.05$ **Statistical analysis** - 1-way ANOVA - Tukey test for post hoc analysis - Fisher exact test
Study design:	Randomised, controlled trial
Outcome studied:	- Postoperative pain (1, 2, 4, 6, 12 hours following extubation) using 4A Vet composite pain scale. This is a compound pain scale, which has been validated to assess postoperative pain

	in dogs and cats. Five parameters are evaluated through behaviour and response to give an overall rating of pain between 0-18 (D Holopherne-Doran et al 2010, Mahler and Reece 2007). The assessors were not blinded to surgical group - Number of additional morphine boluses given postoperatively - Quality and duration of recovery - Surgical duration (first skin incision through to last suture) - Anaesthesia duration (induction through to endotracheal extubation) - Pre- and postoperative body temperature
Main findings: (relevant to PICO question):	**Surgical duration** - Significantly longer in the laparoscopic group (41±16 minutes, p=0.019; 36.8°C, p=0.033) compared to open flank (24±9 minutes) and open midline (35±9 minutes) **Postoperative body temperature** - Significantly lower in the laparoscopic group (36.8°C, p=0.033) compared to open flank (37.7°C) and open midline (37.4°C) **Subjective quality and duration of recovery** - No differences were seen between the three groups **Pain scores** - Significantly lower in animals following laparoscopic ovariectomy vs. open midline (p<0.001) and open flank techniques (p=0.016) - In the laparoscopic group, no animals experienced severe pain following surgery at any time point, however following open midline surgery this was recorded in 5% of animals 2, 4 and 6 hours postoperatively and in 5-20% of animals following open flank surgery at varying time points - Weak pain was experienced by 50% of animals 1 hour following laparoscopic surgery and increased to 95% at 12 hours; the remainder having experienced moderate pain. - Following open midline surgery, weak pain was experienced in 50% of animals 1 and 12 hours postoperatively with the remainder having experienced moderate or severe pain **Postoperative morphine boluses** - Significantly lower in animals undergoing laparoscopic ovariectomy (0.55±0.61) compared to open midline (2.30±2.39) and flank (3.25±3.18) techniques (p<0.001)
Limitations:	- The study investigators - including pain scorer - were not blinded to surgical method providing a large source of potential bias - The number of observers evaluating pain score postoperatively was not reported, so it is unclear whether additional variation in pain scores may have been present - All surgeries were performed with inexperienced vet

	students assisting the surgeon which could have impacted on surgical duration, especially in the laparoscopic surgeries due to unfamiliarity with the endoscope tool - No reporting of confidence intervals, so precision of effect is unknown - Breeds were not reported, so it is unclear how this relates to in practice

Vasiljević (2015)	
Population:	Female dogs, medium to large breeds
Sample size:	N=20
Intervention details:	**Intervention groups** - Laparoscopic ovariectomy (n=10) - Open ovariectomy (n=10) **Inclusion criteria** - Healthy - ASA classified category ASA 1- females **Group characteristics** - Not reported **Statistical analysis** - 1-way ANOVA - Dependent t-test
Study design:	Randomised, controlled trial
Outcome studied:	- Intraoperative pain score using changes in heart rate, arterial blood pressure, respiratory rate and body temperature at certain time points during surgery - Postoperative pain score using multifactor pain scale (0-9) at 15, 30 minutes, and 1, 3, 6 hours following surgery - evaluated by same observer, not blinded to surgical group
Main findings: (relevant to PICO question):	**Intraoperative parameters of pain** - Significant changes in parameters during all surgical time points when compared to baseline values in animals undergoing open ovariectomy ($p<0.05$) - In animals undergoing laparoscopic ovariectomy no significant changes were recorded from baseline except within phase III for respiratory rate and arterial blood pressure ($p<0.05$) **Pain scores** - Animals within the laparoscopic ovariectomy group experienced either mild or moderate pain at 15 and 30 minutes post-surgery, and either no or mild pain at 1, 3 and 6 hours post-surgery - A maximum of two animals experienced moderate pain, and no animals experienced severe pain - Animals undergoing open ovariectomy experienced either mild, moderate or severe pain at all time points following surgery, with two animals experiencing severe pain, up to

	seven animals experiencing moderate pain and a maximum of five animals experiencing mild pain.
Limitations:	- The study investigators - including pain assessor - were not blinded to surgical method providing a large source of potential bias in terms of pain scoring - The study did not report the laparoscopic technique used or how many surgeons were involved in performing the surgeries, so we cannot know whether variation was controlled in these areas - No reporting of confidence intervals, so precision of effect is unknown - Breed, mean ages of the groups were not reported, nor was the source of the animals so it is unclear whether groups were considered similar at the start of the trial

Freeman (2010)	
Population:	Female dogs both research and shelter animals
Sample size:	N=30 - research animals (n=10) - shelter animals (n=20)
Intervention details:	**Intervention groups** - Ovariectomy performed by natural orifice transluminal endoscopic surgery (NOTES) using a transgastric approach (n=9 or 10). This technique involved passing an endoscope through the mouth into the stomach and through an incision in the gastric wall into the abdominal cavity - 2-portal laparoscopic ovariectomy (n=10) - Open ovariectomy (n=10) **Inclusion criteria** - Healthy, females **Group characteristics** - Mean body weight (kg): NOTES, 21.7±10.5; laparoscopic, 18.8±4.4; open, 20.4±3.8 - No significant differences between groups **Statistical analysis** - Repeated-measures analysis of variance for effects of surgical procedure, time and interaction between the two - Bonferroni-adjusted post-tests for each group to baseline if indicated by significant F test (ratio of two variances) - Spearman's correlation coefficient for relationship between serum IL-6 and cortisol
Study design:	Non-randomised controlled trial
Outcome studied:	- Blood markers of systemic stress and surgical stress - Postoperative pain at 2, 4, 6, 12, 18, 24, 36, 48, 72 hours following surgery using a pain scale - Nociceptive threshold using cuff placed around abdominal cavity (used to interpret abdominal pain) using a previously

	documented method - Surgical duration - Rectal temperature
Main findings: (relevant to PICO question):	**Surgical duration** - Significantly longer ($p<0.001$) in the NOTES group compared to the laparoscopic and open groups - Little difference between mean surgical duration between laparoscopic (44 minutes, range 35-65) and open (35 minutes, range 25-65) groups, but no statistical analysis was performed on these data **Rectal temperature** - Significantly lower ($p<0.05$) at time points 36 and 48 hours post-surgery in the NOTES group compared to the laparoscopic and open groups **Postoperative pain scores** - Significantly lower in animals undergoing NOTES surgery compared to animals undergoing open ovariectomy at all time points ($p<0.05$) and animals undergoing 2-portal laparoscopic surgery at time points 0, 12, 24 and 36 hours ($p<0.05$) - Lower in animals undergoing laparoscopic ovariectomy when compared to the open ovariectomy group across most time points following surgery, however statistical comparisons were not reported **Postoperative nociceptive threshold** - Significant lower in animals undergoing open surgery when compared to animals in the laparoscopic surgical group (at time points 6 and 12 hours, $p<0.05$) and the NOTES group (at time point 18 hours, $p<0.05$)
Limitations:	- No direct statistical comparison of pain scores, rectal temperature or surgical duration was reported for the laparoscopic ovariectomy and open surgery groups so differences can only be tentatively suggested - No reporting of confidence intervals, so precision of effect is unknown - Two major sources of bias within the study result from no random assignment of animals to surgical groups and the subjective nature of pain scoring performed by two assessors - Unclear if pain assessors were blinded - therefore means a large source of bias is possible - No reporting of number of surgeons involved with surgeries across both groups so it cannot be determined if variation was controlled in this aspect - Type of pain scale used was not reported making it difficult to compare results to those of other studies - As two populations of animals were used and mean ages of groups not reported, the groups may not have been similar at the start of the trial

Appraisal, application and reflection

There are a number of major constraints in evaluating the evidence from these studies to accurately draw a conclusion to the original question, including the variety of recovery outcomes measured, the subjective nature of interpreting animals behaviours for pain scoring, lack of blinded pain assessors in four of the five studies, as well as varying different methods and scales used to assess pain.

There is much variation in surgical duration of the laparoscopic procedures across the studies - this is difficult to accurately evaluate due to the different laparoscopic techniques used. The experience of the surgeon must also be taken into consideration, as their experiences and confidence is expected to heavily impact on the success of the surgery. When compared to open techniques, surgical duration was longer for laparoscopic procedures across the majority of studies, however this was not always significant, and associations to recovery cannot be drawn. While results of studies measuring surgical complications (Coisman et al.) and degree of haemorrhage (Culp et al.) cannot be linked directly to recovery success, these results may offer advantages postoperatively. Complications were significantly more frequent in only one of the laparoscopic groups in the study by Coisman et al., and this is most likely to be attributable to the vessel sealing method used rather than surgical technique. Culp et al. reported fewer dogs experienced haemorrhage during laparoscopic surgery, which is a positive aspect of this technique that is valuable to mention, but further studies are needed to validate this result and to assess impact on recovery.

Pain scales are not inclusive of all variables, so different factors relating to pain may be overlooked, depending on the pain scoring method used. The large variability in the recording of pain is a major limitation to how accurately results of these studies can be compared. This highlights the need for greater use of objective pain scoring methods and consistency of pain scoring tools in order to assess pain levels and drawing conclusions between different studies.

Four out of the five studies suggest laparoscopic techniques are associated with reduced postoperative pain and less reduced activity levels. However in these four studies, the investigators assessing pain were not blinded to treatment, which is a large source for bias that ultimately limits the conclusions that can be drawn. Blinding to surgical treatment could have been possible using a large abdominal plaster or bandage to conceal the surgical incision length, and this highlights the need for a fully blinded study to be conducted to provide a stronger level of evidence.

From the studies available, the two which offer the strongest level of evidence are Culp et al., 2009 and Gautier et al., 2015. Both randomly assigned animals to surgical groups using computer generated or statistical methods, and sample sizes were appropriate for analysis. Both studies reported characteristics of surgical groups and the number of surgeons carrying out surgeries, and used a consistent, standard anaesthetic protocol for all groups within each study as well as the commonly described 2-portal laparoscopic method. Both studies reported significant and substantial beneficial treatment effects of laparoscopic surgery compared to open surgery.

The only study which did not report postoperative recovery advantages following laparoscopic ovariectomy vs. open ovariectomy was Coisman et al., 2013. This was also the only study using a standardised incision site and length for all techniques studied. While this meant observers could be blinded to the surgical intervention, this may have impacted on postoperative pain scores. Some studies have shown associations between pain, surgical invasiveness and tissue damage, however the evidence is weak, so this can only be speculated but is a factor readers must take into consideration when interpreting results of this study.

Freeman et al., 2010 primarily investigated the NOTES technique (using a transgastric approach) vs. a 2-portal laparoscopic and open ovariectomy methods. While limited direct statistical comparisons were reported

between laparoscopic and open surgeries, it is valuable to include these results, as pain scores were lower in animals undergoing laparoscopic techniques. These results are in line with other studies included in this summary, but they must be considered with more caution.

While the evidence suggests laparoscopic techniques can lead to a better recovery, the lack of a blinded trial to evaluate the different techniques is ultimately a major constraint to drawing a definitive clinical bottom line and is required to validate this conclusion from the current evidence available. Reduced pain and smaller reductions in activity levels have been attributed to the less invasive nature of laparoscopic techniques, due to the shorter surgical incisions, reduced tissue damage and less organ handling. Reduced haemorrhage risk is a further advantage that may be beneficial to postoperative recovery, whereas surgical duration does not seem to be associated with recovery parameters. Duration is highly variable between studies - this is likely due to the laparoscopic method used and experience of the surgeon. Further benefits of laparoscopic surgery also suggested include reduction in materials required, such as suturing material, anaesthetic volume and postoperative analgesia.

Finally, it is important to consider a number of factors when adopting laparoscopic ovariectomy including carbon dioxide insufflation risks associated with laparoscopic techniques, the cost of equipment and surgical training and whether these factors result in additional costs for clients.

Methodology Section

Search Strategy	
Databases searched and dates covered:	• CAB Abstracts 1973 to 2016 Week 22 • Medline 1950 to June 2016 • Web of Science (citation search)
Search terms:	1. cats/ 2. Cat OR cats OR “Felis sylvestris catus” OR “Felis domesticus” OR “Domestic cats” OR “Domestic cat” OR “Felis catus” OR “Felis domestica” OR “Felis silvestris” OR “Felis silvestris catus” OR “Felis sylvestris” OR “Felis sylvestris catus”OR “Felis catus domestica” OR feli* 3. queens/ 4. Queen OR queens 5. 1 OR 2 OR 3 OR 4 6. dogs/ 7. bitches/ 8. Dog OR dogs OR Bitch OR Bitches OR “Canis familiaris” OR cani* 9. 6 OR 7 OR 8 10. 5 OR 9 11. Ovariectomy/ 12. Oophorectomy OR ovariectomy OR “open ovariectomy” OR “conventional ovariectomy” OR “traditional ovariectomy” OR “open oophorectomy” OR “conventional oophorectomy” OR “ traditional oophorectomy” OR Ovariectomies OR Oophorectomy OR Oophorectomies OR “Female castration” OR “Female Castrations” OR “Bilateral Ovariectomy” OR “Bilateral Ovariectomies” OR “flank ovariectomy” OR neuter OR neutering OR spay OR spaying OR spey OR speying OR desex OR sterilise OR sterilisation

	13. 11 or 12 14. Laparoscopy/ 15. Laparoscopy OR “Laparoscopic ovariectomy” OR “ovariectomy by laparoscopy” OR “laparoscopic oophorectomy” OR “oophorectomy by laparoscopy” OR Laparoscopies OR Peritoneoscopy OR Peritoneoscopies OR Celioscopy OR Celioscopies OR “Laparoscopic Surgical Procedure” OR Laparoscopic Surgery” OR Laparoscopic Surgeries OR “Laparoscopic Surgical Procedures” 16. 14 or15 17. 10 AND 13 AND 16
Dates searches performed:	July 2016

Exclusion / Inclusion Criteria	
Exclusion:	Studies were excluded if they did not investigate the two ovariectomy methods relevant to the clinical question. These included studies comparing open ovariohysterectomy vs laparoscopic ovariectomy or comparison of different laparoscopic ovariectomy techniques only. Papers were also excluded if the study populations were those other than domestic dogs or cats, or, if parameters and outcomes were not linked to patient pain or recovery.
Inclusion:	Papers were included if the studies compared open ovariectomy and laparoscopic ovariectomy techniques. All laparoscopic methods (1-, 2- and 3- portal access and natural orifice transluminal endoscopic surgery (NOTES) techniques) were included, as were different laparoscopic instruments and vessel-sealing technologies and methods. Only those studies measuring intra- and postoperative parameters linked to recovery and pain outcomes in domestic dogs and cats were considered. The NOTES technique involves passing an endoscope through a natural orifice and then through an internal incision within an organ to reach the desired location in a body cavity.

Search Outcome

Database	Number of results	Excluded – Duplicates	Excluded – Not English	Excluded – Study design	Excluded – did not answer PICO	Total relevant papers
CAB Abstracts	127	0	5	1	117	4
Medline	70	3	0	0	66	1
Total relevant papers when duplicates removed						5

CONFLICT OF INTEREST

The author declares no conflict of interest.

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