

Pedicle ties provide a rapid and safe method for feline ovariohysterectomy

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Abstract:

Objectives:

The specific objectives of the present study were to 1) evaluate the rate of hemorrhage-related complications across a large number of feline pedicle tie procedures and 2) evaluate for a difference in surgical time between traditional pedicle double-ligation and pedicle tie procedures.

Methods:

In the initial phase of the study 2136 intact female cats underwent an ovariohysterectomy using the pedicle tie technique. Hemorrhagic complications not detected intra-operatively were to be confirmed via exploratory surgery or necropsy. The second phase of the study recorded the duration of surgery for 4 groups: kittens undergoing pedicle ties (n=50), kittens undergoing pedicle double ligation (n=49), adult cats undergoing pedicle ties (n=50), and adult cats undergoing pedicle double ligation (n=54). Kittens were defined as a cat 4 months old or younger. Statistical comparisons of age, body weight, and surgical times between the pedicle tie and pedicle double ligation groups were performed within, but not between, kitten and adult cat categories.

Results:

Six of 2136 cats (0.281%) experienced a hemorrhage-related complication associated with the ovarian pedicle. Five of the 6 ovarian pedicle hemorrhage-related complications were recognized and corrected intra-operatively, with the remaining hemorrhagic event being detected post-operatively.

Surgical times were significantly shorter in pedicle tie kittens compared to pedicle double ligature kittens (4.7 ± 0.1 minutes and 6.7 ± 0.1 minutes, respectively) and pedicle tie adult cats compared to pedicle double ligature adult cats (5.0 ± 0.2 minutes and 7.0 ± 0.2 minutes, respectively).

Conclusions and Relevance:

The present study demonstrates that the pedicle tie technique is associated with a very low risk for hemorrhage-related complications and is significantly faster than double ligating the ovarian pedicle in both kittens and adult cats. Use of the pedicle tie technique has the potential to be of significant economic benefit in institutions that are performing large numbers of feline ovariohysterectomies.

Introduction

Traditionally, when performing an ovariohysterectomy (OHE) on the feline patient, two ligatures are placed around each ovarian pedicle to achieve hemostasis and prevent hemorrhagic complications¹. A relatively new technique has emerged where the ovarian pedicle is ligated on itself in a manner similar to the way that feline spermatic cords are auto-ligated when performing

castrations. This is often referred to as an ovarian pedicle tie (PT) and is rapidly gaining popularity among practitioners who perform high quality/high volume spay and neuter surgeries.

To the author's knowledge, there are no publications in the peer reviewed veterinary literature regarding this technique. Veterinarians who routinely perform PT anecdotally state that the main advantage is that it allows the ovarian pedicle to be ligated in less time than it would take to pass two ligatures around the structure and tie the ligatures. The claimed result is that there is less anesthetic time, less surgical time, and a reduction in the amount of suture used resulting in less foreign material left within the patient. Furthermore, the safety of the new procedure remains unproven, with particular concern existing for potential post-operative life-threatening hemorrhage due to a non-traditional method for ovarian vascular pedicle ligation.

To address this information gap, the specific objectives of the present prospective clinical study were to 1) evaluate the rate of hemorrhage-related complications across a large number of PT procedures and 2) evaluate for a difference in surgical time between traditional pedicle double-ligation (PDL) and the new PT procedure. The corresponding hypotheses were 1) the rate of ovarian pedicle hemorrhage-related complications would be as low as, or lower than, previously reported hemorrhage associated with traditional PDL and 2) PT procedure would be significantly faster than traditional PDL.

Materials and Methods

Animals

Three experienced spay/neuter veterinary surgeons (Ellingsen, Ellis, Rekers) performed all of the surgeries in this study. In the initial phase of the study 2136 consecutive intact female cats underwent an OHE using the PT technique. The PT technique was used in all cats during

this phase of the study, regardless of concurrent estrus or pregnancy status. At the beginning of the study this technique was already in use at the Oregon Humane Society (OHS) so no new training or equipment was needed and there was there no impact on the surgeons or surgical work-flow. Approximately half of these cats came from a local low cost spay/neuter program and the remainder of the cats were owned by the OHS at the time of surgery. Owners and cattery staff were advised to monitor for potential problems in the perioperative period and report any concerns to the medical team. Intra-operative hemorrhage was identified by direct observation of active bleeding from the vascular pedicles after transection, or accumulation of blood in the peritoneal cavity during surgery. Hemorrhagic complications not detected intra-operatively were to be confirmed via exploratory surgery or necropsy.

In the second phase of the study the surgeries were timed using a stopwatch in order to allow comparison of surgical time between PT and PDL. The cats were divided into four different groups: kittens undergoing PT, kittens undergoing PDL, adult cats undergoing PT, and adult cats undergoing PDL. The reason to divide adult cats from kittens is that a kitten OHE is presumed to be faster than an adult cat OHE and we wanted to ensure our comparison would be between similar groups. For the purposes of this study a kitten was defined as a feline that was 4 months of age or younger. Based on an *a priori* power analysis (see Statistics subsection below), each group was designed to have at least 40 cats.

Surgery

All patients were given buprenorphine (0.015 mg/kg IM) prior to anesthesia. Propofol (given IV to effect, typically at 6-7 mg/kg) was used for induction and the patients were intubated and maintained on isoflurane in 100% oxygen for the duration of the procedure. The

abdominal area was clipped and scrubbed with 4% chlorhexidene and alcohol before cats were moved into the operating room.² A ventral midline celiotomy was performed for all surgeries and the uterus was located using a spay (or Snook) hook. After a hemostat was placed on the proper ligament, the suspensory ligament was torn using a hemostat or cut with a scalpel blade to allow the ovary to be well exteriorized. A window was then created within the broad ligament to facilitate isolation of the ovarian pedicle. For the PT procedure a hemostat was then directed parallel to the ovarian vascular pedicle, pointed in a proximal direction. The hemostat was then twisted to form a simple overhand knot in the vascular pedicle; the pedicle was cut distal to the hemostat and the cut end slipped over the end of the hemostat to complete the knot.³ The PDL method was performed in a similar manner except that after the window was made in the broad ligament, a hemostat was placed across the vascular pedicle just proximal to the ovary. Two separate absorbable suture ligatures were then placed around the ovarian vascular pedicle prior to transection. For all surgeries, the uterine body was then exteriorized and ligated. The body wall was closed in a simple continuous pattern and the skin was closed using an intradermal suture pattern.

For the second phase of the study (timed surgeries), timing started when the scalpel touched the skin and the timing stopped when the skin closure was complete. After recovering from anesthesia, all patients that were part of the low cost spay/neuter program were discharged to their owner in the evening with instructions to monitor for complications and contact OHS if any problems arose. Patients that belonged to OHS were returned to the cattery part of the shelter and monitored for problems before being available for adoption 24 hours later.

Statistics

An *a priori* power analysis was performed using a commercially available computer statistical analysis software package (GraphPad StatMate v2.00 for Windows, GraphPad Software, San Diego, CA, USA) using historic institutional data on surgical times for PT and PDL techniques with the following parameters: expected difference in surgical times between PT and PDL groups of 1.0 minute; expected standard deviation for surgical times of 1.5 minutes; two-tailed p value with significance level of 0.05; and power of 80%. Results indicated a sample size of 40 cats/group was necessary. Statistical comparisons described below were planned prior to study execution to compare kittens to kittens and adult cats to adult cats.

Comparisons of age, body weight, and surgical time between the PT and PDL groups were performed within kitten and adult cat categories. Normality was assessed by the D'Agostino & Pearson omnibus normality test. Normally distributed data were compared using an unpaired t-test with Welch's correction and non-normally distributed data were compared using the Mann-Whitney test. Statistically analyzed data are reported as mean \pm standard error of the mean (SEM) and descriptive data are reported as median and range. Statistical significance was set at $p < 0.05$ and all hypothesis testing was two-sided. All statistical analyses were performed using commercially available statistical analysis software (GraphPad Prism v6.02 for Windows, GraphPad Software, San Diego, CA, USA).

Results

A total of 2136 intact female cats underwent PT with all cats having two ovarian pedicles (4272 ovarian PTs performed). The median age of these cats was 6.0 months (range 1.5 – 148.0 months) and median body weight was 2.8 kg (range 0.8 – 6.2 kg).

Six of 2136 cats (0.281%) experienced a hemorrhage-related complication associated with the ovarian pedicle. In 5 of these cases, the ovarian pedicle hemorrhage was identified and corrected via suture ligation intra-operatively. In the remaining cat, no hemorrhage was appreciated intra-operatively, but the cat remained weak, became tachycardic, and was slow to recover from anesthesia well into the post-operative period. Upon re-exploration of the abdominal cavity, the left ovarian pedicle was found to be actively hemorrhaging. This pedicle was suture ligated and the cat recovered without further complication.

Hemorrhage-related complications not specific to PT, detected intra-operatively, included 3 cats (0.140%) with uterine-pedicle hemorrhage requiring additional suture ligatures and 1 cat (0.047%) with bleeding from the suspensory ligament that was judged to require a suture ligature.

The following number of cats were enrolled in the second (timed) phase of the study: kittens undergoing PT (n=50), kittens undergoing PDL (n=49), adult cats undergoing PT (n=50), and adult cats undergoing PDL (n=54). Mean age was not significantly different between PT kittens (2.5 ± 0.1 months) and PDL kittens (2.3 ± 0.1 months). Mean body weight was not significantly different between PT kittens (1.3 ± 0.1 kg) and PDL kittens (1.3 ± 0.1 kg). Surgical times were significantly shorter in PT kittens (4.7 ± 0.1 minutes) compared to PDL kittens (6.7 ± 0.1 minutes).

Mean age was not significantly different between PT adult cats (14.5 ± 2.0 months) and PDL adult cats (19.5 ± 2.7 months). Mean body weight was not significantly different between PT adult cats (3.1 ± 0.1 kg) and PDL adult cats (3.2 ± 0.1 kg). Surgical times were significantly shorter in PT adult cats (5.0 ± 0.2 minutes) compared to PDL adult cats (7.0 ± 0.2 minutes).

Discussion

The two primary objectives of the present study were to evaluate the rate of hemorrhage-related complications associated with PT and compare the surgical times between PT and PDL techniques. We accept both of our hypotheses as the rate of hemorrhage-related complications was very low (0.281% of cats) and PT surgical times were significantly shorter than PDL surgical times in both kittens (4.7 ± 0.1 vs. 6.7 ± 0.1 minutes) and adult cats (5.0 ± 0.2 vs. 7.0 ± 0.2 minutes). Collectively, these data support the use of PT for hemostasis of feline ovarian pedicles during ovariohysterectomy as a safe and rapid surgical technique.

In this series of 2136 consecutive feline PT surgeries, only one post-operative ovarian pedicle related hemorrhagic complication occurred (0.023% of all 4272 ovarian pedicles). This suggests that the incidence of potentially life-threatening post-operative hemorrhage specifically due to the PT technique is very low. An additional 5 cats undergoing PT had intra-operative hemorrhage noted from their ovarian pedicles. The potential for this hemorrhage to become life-threatening in the post-operative period is unknown, but in each of the 5 cases we chose to address this hemorrhage intra-operatively by placing suture ligatures on the ovarian pedicle to stop bleeding. At the authors' institution, it has been routine to perform PT for cats in estrus or during pregnancy and such cats were not excluded from the current study. Importantly, none of the cats that experienced hemorrhagic complications in the present study were noted to be in estrus or pregnant at the time of surgery.

Because ovarian pedicle related hemorrhagic complications were so rare in this study, we further described all other hemorrhagic complications not directly related to the PT technique. This included 3 other cats with concern for hemorrhage from the tearing of the uterine body which was addressed by placing additional suture ligatures. Uterine body related hemorrhage is

not specific to the PT technique, and therefore these 3 cats were considered separately from complications which were specifically related to the ovarian PT technique. A single additional cat had hemorrhage from the suspensory ligament which was judged to require a suture ligature. Many veterinarians who perform high quality/high volume spay/neuter surgeries will cut the suspensory ligament with a scalpel blade or tear the ligament with a hemostat prior to ligating the ovarian pedicle. The reason for this is that the incision is generally too small to allow the ligament to be manually broken down. The vascular supply to the suspensory ligament is small and this vessel will generally stop bleeding without intervention. Although it is unknown whether the suspensory ligament related hemorrhage in this cat would have progressed to cause post-operative complications, a suture ligature was placed as a safeguard. This cat was also considered separately from the PT technique specific complications since suspensory ligament breakdown, and potential bleeding, can occur with either technique.

Comparisons of hemorrhage-related complication rates between the present report and previous studies are challenging for several reasons. Reports of complication rates in ovariohysterectomies in the literature are largely from teaching institutions and involve student performed surgeries. One previous study reported that 21 out of 476 cats (4%) undergoing traditional ovariohysterectomy with PDL experienced intraoperative hemorrhage.⁴ Specific characterization of the hemorrhagic events were not detailed in this study. Another study evaluating post-operative complication rates in a variety of elective surgeries in dogs and cats stated that 7 of 43 cats (16.3%) undergoing traditional ovariohysterectomy with PDL experienced post-operative complications.⁵ Those complications included hematomas, swelling or infection of the incision site as well as intraoperative hemorrhage, with details regarding the hemorrhagic events not being reported. A recent review article addressing the complications of

OHE in dogs and cats reflects a similar interpretation of the available veterinary literature, stating that the prevalence of intraoperative bleeding is low and post-operative mortality due to hemorrhage is extremely rare.⁶ Differences between these previous reports and our study, such as the involvement of students and the setting under which surgeries were performed, preclude direct comparison of reported complications rates. However, it is reasonable to conclude that when performed correctly, PTs appear to be at least as safe as traditional PDL.

The second focus of our study was to compare surgical times between PT and PDL techniques. Most settings in which PT are used are high volume/high quality spay and neuter clinics in which a large number of female cats are spayed. Coupled with the fact that many of these programs have limited resources, this large volume of surgery amplifies the importance of surgical efficiency. The data demonstrate that PT are faster than the traditional method of double-ligating the ovarian pedicle. In both the kitten and adult cat groups, PT were approximately 2 minutes faster than the PDL method (or 28.6% faster and 29.9% faster, respectively). Two minutes saved per spay may be relatively inconsequential for an individual animal, but when considering a population of animals (2 minutes multiplied across a large volume of cats over a period of months or even years) the time savings can amount to significant resources available to be used for the betterment of other animals within the population. Indeed, according to our data, performing PDL for the same 2136 cats would have taken an additional 71.2 hours of time over the course of a year. This time amounts to nearly two weeks of extra work, and pay, for at least two employees (a surgeon and anesthetist, both of whom would have had to be present for the 71.2 hours of extra surgical time).

Several limitations to the present study must be considered when interpreting the results. Approximately half of the cats in the first phase of the study were privately owned. Therefore,

we relied on owners to report any complications that may have occurred after discharge. From another perspective, specifically because these were privately owned animals, it is reasonable to expect that serious complications (such as hemorrhagic shock and/or death) would have resulted in owner complaints. Furthermore, cats were monitored within our facility for an average six hours post-operatively before being discharged to their owners. Granted, this would only detect hemorrhage that was significant enough to cause shock-like conditions or seepage from the incision (smaller amounts of hemorrhage could go undetected) but the authors are confident that serious hemorrhagic complications were captured within the present data set.

Another limitation of this study is the possibility for experimenter bias. The surgeons who participated in this study having been using the PT method, almost exclusively, for several years. Therefore, it could be argued that they have become more adept at performing this procedure. However, it should be noted that they all performed PDLs for many years before switching to PTs. Also, the surgeons could not be blinded to the procedure that they were performing, so there is the possibility that they could, consciously or subconsciously, perform PT faster than PDL. Using three different surgeons in this study helped to decrease the likelihood that one surgeon could significantly sway the data. Also, given the volume of surgeries to be performed each day with at least two people observing surgery (the person monitoring anesthesia and the person timing the procedure) plus two people inducing the surgeries, it is doubtful that a surgeon would be able to intentionally slow down without drawing attention to that fact. Finally, the act of being timed combined with the competitive nature of many people in the veterinary field likely decreases the chances that any of the veterinarians performing these procedures would slow down.

Conclusions

The present study demonstrates that PTs are safe and significantly faster than the traditional PDL method for feline ovarian vascular pedicle ligation. This is of significant economic benefit in institutions that are performing large numbers of feline ovariohysterectomies. Although the average small animal practitioner would see less of an economic benefit employing this technique, if she or he spayed only 2 cats per week this would save the practitioner about 200 minutes per year. There is also the potential that patient morbidity and mortality will be positively impacted as this technique becomes more widely used, especially in high volume feline spay operations. Decreased surgery time will lead to a decreased risk of complications including hypothermia or infection. To the author's knowledge, this represents the first study describing and evaluating the PT procedure in the peer reviewed veterinary literature.

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Conflict of Interest Statement

The Author(s) declare(s) that there is no conflict of interest.

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