Comparison of surgical variables and short-term postoperative complications in healthy dogs undergoing ovariohysterectomy or ovariectomy

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Objective—To determine whether ovariohysterectomy (OVH) required more time to complete and was associated with more short-term postoperative complications than ovariectomy (OVE) in dogs.

Design—Randomized prospective clinical trial.

Animals—40 healthy, sexually intact female dogs.

Procedures—OVH (in 20 dogs) or OVE (20 dogs) was performed by use of standardized anesthetic and surgical protocols. Physical characteristics of the dogs, surgical variables, pain scores derived from behavior-based composite pain scales, and surgical wound characteristics were analyzed.

Results—Body weight, age, body condition score, and distance between the sternal manubrium and the pubic rim were comparable among dogs that underwent either surgical procedure. Body weight was positively correlated with the total duration of the procedure and with time required for closure of the surgical wound. No effect of body condition score was determined for any variable. Skin and fascia incision lengths relative to the distance from the sternal manubrium to pubic rim were significantly greater in dogs that underwent OVH, compared with those of dogs that underwent OVE, but total surgical time was not different for the 2 procedures. No other significant differences were detected between the 2 groups.

Conclusions and Clinical Relevance—Significant differences in total surgical time, pain scores, and wound scores were not observed between dogs that underwent OVH and dogs that underwent OVE via standardized protocols. (J Am Vet Med Assoc 2011;238:189–194)

Ovariohysterectomy is the traditional surgical technique for neutering healthy female dogs in the United States.1,2 Laparoscopic OVH and OVE have been described3–5 as minimally invasive procedures for neutering female dogs. Comparative studies6–8 of surgical time, complications, and pain and incision scores for endoscopic OVH versus OVH via a conventional midline celiotomy approach (ie, open OVH) revealed that laparoscopic or laparoscopy-assisted OVH was associated with less pain and surgical stress than was open OVH. However, many veterinarians in general clinical practice still prefer to perform an open OVH because of the equipment cost, training requirements, and increased time associated with endoscopic procedures.9

Intraoperative and long-term complications have been reported10–12 after OVH in young healthy dogs. In a retrospective study13 on the long-term effects of OVH and OVE in dogs, no differences were detected in complication rates between the 2 procedures. Ovariectomy consequently has replaced OVH as the preferred procedure for neutering healthy female dogs in many European countries and is taught to students at our veterinary teaching hospital. A literature review14 performed by researchers from our department to determine whether OVE is a safe alternative to OVH revealed no significant differences between the 2 techniques for the incidence of long-term postoperative urogenital problems, including endometritis, pyometra, and urinary incontinence. On the basis of the assumption that OVH would generally require more surgical time and could potentially result in more complications than would OVE (because more tissue is transected and ligated and a larger incision is required), OVE was recommended as the preferred method for neutering female dogs.

The objective of the study reported here was to determine whether differences in surgical variables and short-term postoperative complications (including blood loss; erythema, swelling, discharge, dehiscence, and pain of surgical wounds; and degree of pain as-
small-animal surgeries would be detectable between dogs that underwent open OVH and those that underwent OVE in a prospective clinical trial. Our hypothesis was that surgical time would be significantly decreased for OVE, compared with that required for OVH, when performed by an experienced surgeon. We further hypothesized that there would be no significant differences in variables used to assess pain and surgical incisions (ie, surgical wounds) or in the described short-term postoperative complications between the 2 techniques.

Materials and Methods

Dogs—Forty client-owned sexually intact healthy female dogs (age range, 7 months to 10 years) that were admitted for neutering at the Faculty of Veterinary Medicine in Utrecht, The Netherlands, were included in the study. The dogs were of several breeds. These included mixed breed (n = 12), Labrador Retriever (8), German Shepherd Dog (4), Belgian Shepherd (2), Golden Retriever (2), American Bulldog (2), and 1 of each of the following breeds: Beagle, Heidewachtel, Stabyhoun, American Staffordshire Terrier, Boxer, Rottweiler, Münsterlander, English Cocker Spaniel, Viszla, and Hungarian Mudi. Dogs were determined to be healthy on the basis of medical history and physical examination, and enrollment criteria included a requirement that the most recent estrus had ended ≥6 weeks prior to the date of surgery. Age was recorded and a BCS was determined for each dog (range, 1 [emaciated] to 5 [obese]). Written consent was obtained from all owners before each dog was randomly assigned to either the OVE or OVH surgical treatment groups. The study protocol was reviewed and approved by the Ethics and Research Committee of the Department of Clinical Sciences of Companion Animals.

The randomization procedure for group assignment was as follows: before the start of the study, 40 sheets of paper marked OVH (20 sheets) or OVE (20) were placed in 40 identical envelopes, and the envelopes were sealed. The envelopes were mixed and 40 were assigned to each animal consecutively at the time of enrollment in the study. After induction of anesthesia, the corresponding numbered envelope was opened. Each skin incision was begun and immediately prior to its closure, blood (10-mL) and urine (10-mL) samples were obtained via these catheters for another research study. To confirm the assessment that dogs were healthy, the following biochemical and CBC variables were analyzed in heparinized plasma and blood samples obtained for the other study: BUN concentration (reference range, 3.0 to 12.5 mmol/L); alkaline phosphatase activity (reference range, <73 U/L) and creatinine (reference range, 50 to 129 µmol/L), bile acids (reference range, <10 µmol/L), phosphorus (reference range, 0.65 to 2.12 mmol/L), sodium (reference range, 141 to 150 mmol/L), and potassium (reference range, 3.6 to 5.6 mmol/L) concentrations; plasma total calcium concentration (reference range, 1.98 to 2.97 mmol/L); Hct (reference range, 32% to 61%); total leukocyte count (reference range, 5.5 × 10^9 cells/L to 14.6 × 10^9 cells/L); and platelet count (reference range, 144 × 10^9 platelets/L to 603 × 10^9 platelets/L).

Surgical procedures—All surgeries were performed by 1 board-certified surgeon with >25 years of experience performing canine OVH and OVE procedures (MEP), with the help of 1 assistant (various veterinary students). Standardized surgical protocols were used for all procedures.

Hair was clipped at the surgical site, and the skin was aseptically prepared. A ventral median celiotomy was performed with the incision starting at the cranial border of the umbilicus. The initial length of the incision was estimated by the surgeon and extended during surgery if it was deemed necessary according to the following criteria: after cutting the suspensory ligaments, both ovarian pedicles had to be ligated with as little traction as possible; for OVH procedures, the uterine body had to be ligated without traction; and visual inspection of the ovarian and uterine pedicles in their normal anatomic positions had to be possible before the abdominal incision was closed. Each skin incision was made with a standard No. 10 scalpel blade, and subcutaneous tissues were dissected at the midline and separated from the abdominal fascia with Mayo scissors. Hemostasis was achieved by use of monopolar electrosurgical equipment.

A small incision was made in the linea alba and extended in either direction with scissors to access the abdominal cavity. The left uterine horn was located and retracted caudoventrally to expose the ovarian bursa and suspensory ligament. The suspensory ligament was coagulated and then cut with scissors approximately 5 mm cranial to the ovarian bursa. The broad ligament was perforated at the level of the ovarian bursa, and a
Blood loss was estimated by determining the weight of used surgical sponges after surgery.21 Dry cotton gauze sponges6 that were weighed before use were removed from the operating table immediately after use and kept in a sealed airtight bag to be weighed after surgery was completed. The BL was defined as (blood loss [mL]/(BW [kg] × 0.1)), where 1 g was accepted as the equivalent of 1 mL; the result was expressed as a percentage.21

The time between predetermined stages of the surgical procedure was measured by use of a stopwatch. The TST was measured as the time from the start of the skin incision until closure of the incision was complete. The TSS was measured from the start of the skin incision until counting of the used surgical sponges was started. The TWC was measured from the start of placement of the first suture in the abdominal fascia until the incision was completely closed (including the fascia, subcutaneous tissues, and skin).

The SP (measured in centimeters from the cranial tip of the manubrium to the cranial rim of the pubis at the midline) and the length of incisions in the skin and in the abdominal fascia were measured for each dog in dorsal recumbency by use of a sterilized metal ruler with millimeter markings. The $S_p$ was defined as the measured length of the skin incision (in mm)/SP. Similarly, the $F$ was defined as the measured length of the linea alba incision (in mm)/SP, and both measurements were expressed as percentages.

**Pain score and wound score assessment**—Postoperative pain scores were determined by use of the GCMPs long and short forms at 2, 5, 6, 12, and 24 hours after the start of placement of the first suture in the abdominal fascia (ie, time 0). Long-form descriptor weights were added together to determine a total pain score. Results from all sections of the short form were added together, and the total score of the short form was used to determine whether rescue analgesia was needed; the criterion for this was a score > 15. Postoperative characteristics of the surgical wound were scored at 2, 6, 12, and 24 hours from time 0 by subjective assessment of swelling, redness, dehiscence, discharge, and pain at palpation. Scores were assigned for each of these features from 0 to 4 as follows: 0, not detected; 1, barely detectable; 2, mild; 3, moderate; 4, severe. The scores were evaluated separately and were added together to obtain an overall wound score for each time point. Four senior veterinary students who were unaware of the surgical technique that was used and were trained by the surgical staff to correctly assess pain and wound scores performed these assessments. Each student evaluated 10 of the 40 patients.

**Statistical analysis**—Surgical variables were evaluated by use of commercially available statistical analysis software.3 The effect of surgery type on dependent variables was compared by use of ANOVA. The BW, BCS, and SP were used as covariates, and the TST, TSS, TWC, BL, $F$, and $S_p$ were used as dependent variables. A Pearson correlation analysis was used to examine the influence of BW, BCS, and SP on the dependent variables. A quantile-quantile plot was used to assess normality of the data. To evaluate pain scores and wound scores, a statistical program was used. Individual dog effect (random
effect) and procedure (OVE or OVH), time, and their interactions (fixed effects) were used together in a mixed-effect model to evaluate log-transformed pain scores. For wound scores, logistic regression analysis was used with individual dogs considered as a random effect and the type of surgical procedure (OVE vs OVH), time, and their interaction as fixed effects. For all analysis, values of $P < 0.05$ were accepted as significant.

### Results

The results of biochemical and hematologic analysis were within normal limits for all dogs. The age, BW, BCS, and SP of dogs that underwent OVE were compared with those of dogs that underwent OVH (Table 1). No significant differences were detected for these variables between the 2 groups.

#### Surgical variables

- Analysis of the quintile-quintile plot indicated that all data were normally distributed. The results of correlation analysis revealed no significant relationship between BW and BL_{\text{rel}}, S_{\text{rel}}, and F_{\text{rel}} but a significant positive correlation between BW and TST ($r = 0.517$; $P < 0.001$), TSS ($r = 0.473$; $P = 0.002$), TWC ($r = 0.436$; $P = 0.005$), and SP ($r = 0.84$; $P < 0.001$) was detected. No significant effect of BCS was determined for any variable. A significant positive correlation was observed between SP and TST ($r = 0.418$; $P = 0.007$), TSS ($r = 0.338$; $P = 0.033$) and TWC ($r = 0.397$; $P = 0.011$). No significant correlation was found among SP, S_{\text{rel}}, F_{\text{rel}}, and BL_{\text{rel}}. Mean values for F_{\text{rel}} and S_{\text{rel}} were significantly ($P = 0.000$ for both) increased for dogs that underwent OVH, compared with those that underwent OVE; however, no difference was detected for TST, TSS, TWC or BL_{\text{rel}} between these 2 groups (Table 2).

#### Pain scores and wound characteristics

- Rescue analgesia was not needed for any dog because none had postoperative pain scores $> 15$ as determined by use of the GCMPs short form. No significant differences were detected between dogs that underwent OVH and those that underwent OVE for any variables evaluated by use of the short and long forms of the GCMPs. Similarly, no significant differences were found for total wound scores at any time point between dogs that underwent OVH and those that underwent OVE.

### Discussion

Differences in surgical variables, wound characteristics, and short-term complications (including blood loss, erythema, swelling, discharge, dehiscence, and degree of postoperative pain) were evaluated in a prospective clinical trial of healthy dogs that underwent either OVE or OVH. The dogs in each group were considered comparable because no significant differences were detected for age, BW, BCS, or SP.

The TST, TSS, and TWC durations were positively correlated with BW, which is in agreement with the results of another report that indicated OVH procedures in large dogs were more time-consuming than those in small dogs. The preoperative BCS had no significant influence on the TST, TSS, TWC, BL_{\text{rel}}, F_{\text{rel}}, or S_{\text{rel}}. The BCS reflects an estimation of the amount and distribution of body fat; visible and palpable features and the silhouette of the dog are used in a semiquantitative but subjective 1 to 5 scoring system, with 1 indicative of emaciation and 5 indicative of obesity. Ovariohysterectomy was shown to be more difficult in obese dogs. The amount of intra-abdominal fat and its relationship with the BCS were not investigated in our study. Therefore, it remains unclear whether the amount of intra-abdominal fat had an effect on the variables evaluated in the present study that was not reflected in the results of external BCS evaluation.

Although the F_{\text{rel}} and S_{\text{rel}} were shorter in dogs that underwent OVE, compared with those that underwent OVH, no difference was observed between dogs that underwent the 2 surgical procedures for TST, TSS, TWC, or BL_{\text{rel}} On the basis of those results, the hypothesis that surgical time would be decreased for OVE, compared with that required for OVH when both procedures were performed by an experienced surgeon, was rejected.

In several studies, intra-abdominal hemorrhage has been described as the most common cause of death after OVH in dogs. The incidence of intra-abdominal hemorrhage after OVH has also been associated with BW of the patients (2% vs 79% in dogs that weighed $< 22.7$ kg [50 lb], respectively). In a study in which investigators analyzed the complications observed during and after OVH of 142 dogs at a veterinary teaching hospital, 9 had intra-abdominal hemorrhage from the ovarian arteries during surgery, and 4 had intra-abdominal hemorrhage after surgery. These results suggested that complications such as hemorrhage may occur more frequently in surgeries performed by relatively unskilled students; the exteriorization of the ovaries and ligation of the ovarian pedicles were reported to be the most difficult parts of the

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**Table 1**—Mean $\pm$ SEM physical characteristics assessed for 40 healthy dogs of various breeds (age range, 7 months to 10 years) that underwent either OVE or OVH.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgical treatment group</th>
<th>OVE ($n = 20$)</th>
<th>OVE ($n = 20$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW (kg)</td>
<td></td>
<td>26.0 $\pm$ 6.0</td>
<td>24.4 $\pm$ 7.3</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td>2.8 $\pm$ 3.0</td>
<td>1.9 $\pm$ 1.2</td>
</tr>
<tr>
<td>BCS</td>
<td></td>
<td>3.1 $\pm$ 0.6</td>
<td>2.7 $\pm$ 0.6</td>
</tr>
<tr>
<td>SP (cm)</td>
<td></td>
<td>61.0 $\pm$ 6.6</td>
<td>61.0 $\pm$ 8.1</td>
</tr>
</tbody>
</table>

*The BCS was scored from 0 to 5 according to a previously described method. No significant ($P \leq 0.05$) differences were detected for any variable between dogs that underwent OVE, compared with those that underwent OVH.

**Table 2**—Mean $\pm$ SEM values of surgical variables determined for the 40 dogs in Table 1 that underwent either OVE or OVH.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Surgical treatment group</th>
<th>OVE ($n = 20$)</th>
<th>OVE ($n = 20$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST (s)</td>
<td></td>
<td>2.105 $\pm$ 0.059</td>
<td>2.105 $\pm$ 0.052</td>
</tr>
<tr>
<td>TSS (s)</td>
<td></td>
<td>1.133 $\pm$ 0.265</td>
<td>1.177 $\pm$ 0.213</td>
</tr>
<tr>
<td>TWC (s)</td>
<td></td>
<td>930 $\pm$ 92</td>
<td>892 $\pm$ 69</td>
</tr>
<tr>
<td>BL_{rel}(%)</td>
<td></td>
<td>0.7 $\pm$ 0.45</td>
<td>0.6 $\pm$ 0.39</td>
</tr>
<tr>
<td>F_{rel}(%)</td>
<td></td>
<td>21.3 $\pm$ 3.1</td>
<td>17.7 $\pm$ 1.8*</td>
</tr>
<tr>
<td>S_{rel}(%)</td>
<td></td>
<td>23.8 $\pm$ 3.6</td>
<td>19.8 $\pm$ 2.0*</td>
</tr>
</tbody>
</table>

*Value was significantly ($P = 0.000$) different between the OVE group and the OVH group. See Table 1 for remainder of key.
procedure. Seven of the 9 dogs with intra-abdominal hemorrhage during those surgeries had bleeding from the right ovarian pedicle. The right ovary is positioned more cranially in the abdomen than the left ovary and would be more difficult to exteriorize adequately. In a review of complications following elective surgeries at 5 private general veterinary practices, 11 of 62 dogs that underwent OVH had surgical complications, an unspecified number of which included hemorrhage. Although the surgical techniques and materials used for OVH were similar among the 5 practices, the procedures were performed by different surgeons, and the data collection procedures and definitions of surgical complications varied substantially; therefore, it is difficult to compare the results of both studies with the results of the strictly standardized study reported here. We used a study design in which 1 experienced veterinary surgeon performed all surgeries using a standardized protocol to eliminate the problem of interindividual variability among surgeons.

Life threatening, intra-abdominal hemorrhage associated with OVH and OVE may occur from the ovarian or uterine pedicles or from the suspensory and broad ligaments. Blood loss can be quantified via gravimetric (ie, weight analysis) or colorometric methods. Gravimetric methods are easy to conduct and were determined to be reliable. In the study reported here, analysis by use of a gravimetric method detected no difference in BL between dogs that underwent OVH and those that underwent OVE. To prevent intra-abdominal hemorrhage, the ovarian and uterine pedicles were double ligated with 1 strand of suture material, and electrosurgical equipment was used routinely in all procedures. The double-ligation technique performed by an experienced surgeon was reliable; no hemorrhage from the ovarian or uterine pedicles was observed. The use of electrosurgical equipment was not mentioned in the other studies discussed here. In the present study, the suspensory ligament was coagulated before it was cut with scissors. It is possible that this prevented hemorrhage from the suspensory ligament vessels. Hemorrhage was considered minor and not life threatening in any of the dogs of the present study, and no adverse consequences developed.

The recognition and evaluation of pain in animals are challenging. The assessment of human pain is conducted by means of self-reporting of pain by the individual, and the visual analogue scale is considered to be the preferred standard. The recognition of pain in animals relies mainly on the interpretation of their behavior by an observer. Behavior-based methods used to assess pain in animals were historically based on the scales used for humans; however, these were found to be unreliable in the assessment of pain in dogs in a hospital setting. Investigators have used pain scales in dogs to evaluate pain scores (evaluated by use of the long and short forms of the GCMPS) between dogs that underwent OVH and those that underwent OVE. It is likely that more tissue was traumatized during OVH procedures than during OVE because the former required larger incisions and resulted in a larger wound surface. The sensation of pain in both procedures apparently was mostly blocked by the pain medication that was provided before, during, and after surgery. The effectiveness of the analgesics had the disadvantage of limiting the range of pain behavior that could be observed, thus obscuring a possible difference in the detection of pain between the 2 procedures. The degree of postoperative pain in 426 dogs that underwent elective castration or OVH was evaluated in another study, in which 1 of 3 different perioperative analgesic treatments (morphine, nalbuphine, and ketoprofen) was administered or no analgesic was given. Significant differences were revealed in postoperative pain scores among the 4 treatment groups, which suggested that treatment with morphine or ketoprofen was superior to treatment with nalbuphine and to no perioperative analgesic administration. Results of that study indicated that the degree of postoperative pain assessed in the dogs was not dependent on the length of the incision, duration of surgery, or experience of the surgeon. Because a standardized analgesic protocol was used in the study reported here, we could not exclude that differences in pain scores would be detected between dogs that underwent OVH and those that underwent OVE if other analgesic protocols had been used.

In another study performed in our department, Van Goethem et al recommended OVE as the preferred surgical procedure for neutering female dogs because OVH was thought to be more time-consuming and to have more intraoperative and postoperative complications. However, significant differences were not detected between dogs that underwent OVH and those that underwent OVE in the present study with respect to surgical time, postoperative short-term complications. However, significant differences were not detected between dogs that underwent OVH and those that underwent OVE in the present study with respect to surgical time, postoperative short-term complications (including blood loss and dehiscence), pain scores, or surgical wound scores. The results of the present study suggest that the uses of OVH and OVE procedures for neutering healthy female dogs have equivalent outcomes in regard to these measures.

b. Vasofix Certo. B. Braun, Melsungen, Germany.
References