Ovariectomy is an effective sterilization method for female dogs; complication rates are similar to those of an ovariohysterectomy.1,2 Because there are no advantages to performing an ovariohysterectomy compared to an ovariectomy in otherwise healthy dogs, the ovariectomy is an appropriate option for sterilization.3,4 The methods used for laparoscopic ovariectomy in canines include suture ligation, surgical laser, monopolar and bipolar electrocoagulation, vessel sealing devices (VSDs), and ultrasonic devices.5–9

VSDs are frequently used to provide safe and efficient hemostasis during laparoscopic ovariectomy.10 VSDs work by applying high-current and low-voltage across the tissue to denature elastin and collagen in the blood vessel wall to create a permanent seal.8,11,12 VSDs are available in a range of sizes; the largest device can seal vessels up to 7 mm in diameter, even when the vessel is surrounded by tissue.13

Ultrasound devices use reverse piezoelectric techniques to convert electrical energy to mechanical energy. The ultrasonic vibrational energy causes thermal tissue heating that allows blood coagulation and tissue transection.14,15 Ultrasonic devices are only available as a 5-mm diameter that can seal up 3- to 5-mm diameter vessels. The surrounding tissue can affect the ability of the device to seal blood vessels.12

Ohlund et al8 compared a 5-mm ultrasonic device (SonoSurg; Olympus Optical) to a 10-mm...
VSD (LigaSure; Medtronic) to perform laparoscopic ovariec-
tomy in dogs. They found no differences between the 2 tech-
niques. However, the 10-mm VSD could grasp more tissue than the 5-mm ultra-
sonic dissector. Spillebeen et al12 compared the 5-mm Sonicision (Covidien) cordless ultrasonic dis-
sector (SCUD) to a 5-mm VSD (Valleylab/Covidien) for laparoscopic ovariec-
tomy in dogs. The SCUD was slower to perform the ovariectomy, and more bleed-
ing was observed. However, in that study, the ovar-
ian bursa was removed instead of performing a more standard technique. The ovarian bursa was grasped with forceps, and the ovarian bursa was excised. A more common technique for laparoscopic ovariec-
tomy involves grasping the proper ligament to ele-
vate the ovary within the abdomen. This allows for ligation or sealing of the ovarian pedicle, the suspensor-
y ligament, and the uterine horn, close to the level of the proper ligament.10,16–19 Spillebeen et al12 also
assessed the cost difference between the 2 devices, which revealed a significant cost difference with the VSD being approximately 10 times more expensive to initially purchase.12

As the demand for economic laparoscopic options increases, additional studies of the more affordable SCUD are reasonable to clarify the potential risks and benefits of this device compared to the VSD using a more standard ovariectomy approach. The purpose of this randomized, prospective clinical trial was to compare a 5-mm SCUD and a 5-mm VSD to perform laparoscopic ovariectomy in healthy dogs, during which sealing of the ovarian pedicle and uterine horn was performed. We hypothesized that surgery time for removal of the ovaries, the number of applications of the device, and intraop-
erative complication rates would be similar between the 2 devices.

Methods

The study protocol was approved by the Institutional Animal Care and Use Committee of Colorado State University before enrollment (IACUC No. 2101). Ten consecutive healthy, intact, client-
owned female dogs admitted for laparoscopic ovariec-
tomy were included in the study. No dogs had a previous history of pregnancy or coagulation disor-
ders. All owners were informed about the study pro-
tocols, and written consent was obtained for each dog before enrollment. Each dog was used as its own control. For each dog, each ovarian pedicle was randomly assigned to the SCUD group (n = 10) or the VSD group (10). When the first patient enrolled in the study underwent surgery, the surgeon ran-
domly chose the ovary (left or right) that would be removed using the SCUD. The pedicle used was then alternated for the subsequent surgeries to ensure an equal distribution of right and left ovariec-
tomies in each group. In the SCUD group, the ovariectomy was completed using the SCUD device; in the VSD group, it was completed using the VSD device.

Breed, age, body weight, body condition score, and physical examination results were recorded for each dog. The anesthesiologist chose the anesthesia protocol used. All surgical pro-
cedures were performed by the same board-certified surgeon experienced in laparoscopic ovariec-
tomies. The laparoscopic ovariectomies were performed using a single incision laparoscopic port (SILS port; Medtronic), as described by Manassero et al10 In each case, the left ovary was resected first. A 5-mm, rigid, 0-degree telescope (Hopkins telescope; Karl Storz) was used. A 5-mm grasping forcep (Fine Teeth Babcock; Karl Storz) was introduced into a 5-mm cannula to elevate the ovary in the abdominal cav-
ity by grasping the proper ligament of the ovary. For each pedicle, the amount of fat around the pedicle was graded from 1 to 5 (Figure 1): 1 = minimal to no fat, 2 = small amount of fat, 3 = moderate amount of fat, 4 = large amount of fat (significant fat but ovar-
ian artery still visible), and 5 = abundant amount of fat (ovarian pedicle completely surrounded by fat and ovarian artery not visible). Either a 5-mm SCUD or VSD handpiece was introduced through 1 of the 5-mm cannulas of the single port access. A 5-mm palpation probe was placed next to the ovarian pedi-
cle and the uterine horn to assess the diameter of the pedicle and the horn. The ovarian pedicle was sealed and transected before suspensory ligament and uterine horn transection. The SCUD was first applied using a “slow” mode to provide better hemostasis. It was then used in the “fast” mode to achieve tis-

tue transection, at the surgeon’s discretion. The fast

Figure 1—Pictures of ovarian pedicle fat scores 1 to 3: grade 1 (A), grade 2 (B), and grade 3 (C). No cases in this study had an ovarian pedicle fat score of 4 or 5.
mode was used to transect tissue that was not transected using the slow mode. The number of applications required for each device to achieve complete ovary resection was recorded. The time from the first application of the device to the last application to complete the ovariec-
tomy was recorded and described as surgery time for the purpose of this study. The ovarian pedicle was observed for signs of hemorrhage. If hemorrhage was visible, the VSD would be used as a rescue device to achieve hemo-
stasis. After ovariec-
tomy, the ovarian pedicle and stump of the uterine horn were macro-
scopically evaluated for signs of bleeding or lack of sealing of the uterine horn. Each dog was kept in the hospital for observation, until discharge to the owner 6 to 8 hours after the surgery was completed. Each owner was contacted by the primary resident on the day of surgery to ensure the owner was able to observe the patient appetite, energy level, adherence to recom-
pended activity restrictions, the appearance of the surgical site, and any perceived postoperative pain or discomfort.

A Shapiro-Wilk test was used to assess the data for a normal distribution. Because the data did not meet the assumptions of a normal distribution, Wilcoxon signed-rank tests were used to compare the surgery times and numbers of applications of each device between the SCUD and VSD groups. The effects of the ovarian pedicle fat score on the number of applications of each device and surgery times using the SCUD versus the VSD were also evaluated using Wilcoxon signed-rank tests. A linear regression analysis was used to examine the correlation between body condition score and ovarian fat score. The results are presented as median and range values. Values of $P < .05$ were considered significant.

**Results**

The breeds of the 10, client-owned female dogs included in the study were as follows: Belgian Malinois ($n = 1$), mixed ($2$), German Shepherd ($2$), Labrador Retriever ($1$), Briard ($1$), American Pitbull Terrier ($1$), Shih Tzu ($1$), and Great Dane ($1$). The median age was 12 months (range, 6 to 30 months). The median body weight was 25.3 kg (range, 4.5 to 36 kg), and the median body condition score was 4 (range, 4 to 7).

All ovaries were identified and evaluated in the abdominal cavity during surgery. Examination using a telescope revealed no ovarian or uterine abnormalities. All uterine horns appeared smaller than twice the diameter of the palpation probe; all ovarian pedicles were less than 5 mm in diameter. The median fat score was 2 (range, 1 to 3) for both the left and right ovarian pedicles. The R-square value for the linear correlation between body condition score and ovarian pedicle fat score was 0 ($P = 1$) for the right ovarian pedicle and 0.07 ($P = .810$) for the left ovarian pedicle.

The median value for the number of times the SCUD was applied was 9 (range, 7 to 13); the VSD was applied a median of 10 (range, 5 to 18) times ($P = .98$). The median surgery time to remove 1 ovary with the SCUD was 96 seconds (range, 45 to 417 seconds); it was 110 seconds (range, 42 to 164 seconds) when the VSD was used ($P = 1$; Figure 2).

![Figure 2](https://example.com/figure2.png)

**Figure 2**—Surgery time required to seal the ovarian pedicle, suspensory ligament, and uterine horn. The solid line within the 2 box-and-whisker plots represents the median surgery times to perform the ovariec-
tomy. There was no significant difference between the median surgery time for the Sonicision cordless ultrasonic dissec-
tor (SCUD) versus the vessel sealing device (VSD) ($P = 1$). The upper and lower limits of the box represent the interquartile (25th and 75th percentiles) range of surgery times to complete an ovariec-
tomy. There were no major outliers that would represent shorter or longer times to complete the ovariec-
tomy with the 2 devices.

A complete ovariec-
tomy was performed bilat-
ernally in each dog, which was confirmed based on the macroscopic evaluation. After each ovariec-
tomy was completed, there was no ovarian pedicle bleeding, and the stump of the uterine horn appeared sealed. The lumen of the uterine horn was not macroscopic-
ally visible in any case. Each case returned for a 2-week postoperative suture removal, which revealed that no dogs developed postoperative complications.

**Discussion**

The surgery time for ovary removal, the number of times the devices were applied, and intraop-
erative complications were not significantly different between the 2 devices. Ovary removal using the SCUD device did not fail in our population of dogs. The 5-mm SCUD was safe for laparoscopic ovariec-
tomy, and we found it was a good alternative to the 5-mm VSD. The population of dogs in this study was...
operative bleeding was observed when the SCUD laparotomy.21 Hemorrhage can occur during surgery from the ovarian pedicle is a potential complication. Spillebeen et al12 found that an effect of the ovarian pedicle fat score on the surgery time was more likely because abundant fat was present in many of their cases. They also reported that prolonged dissection of the ovarian pedicle was necessary to achieve better hemostasis. The ovarian pedicles in their study population had more fat than our population. In this study, because no more than a moderate amount of fat was present in any ovarian pedicle, the fat score did not affect the surgery time of any device.

The median number of times the SCUD and VSD were applied to complete the ovariec- tomywas similar between the 2 devices. To our knowledge, the number of applications of each device has not been reported in any other studies related to laparoscopic ovariectomy in dogs. Spillebeen et al12 did not report the number of times they applied each device; however, they mentioned more dissection of the ovarian pedicle was necessary with the SCUD than with the VSD. The number of times each device was used was recorded in this study because it is a function of the size of the jaw of the device and the amount of tissue that can be sealed at each bite. It is not affected by the power setting of either device. Like any other laparoscopic ovariectomy study, the VSD was set at the 2-bar level. The SCUD can be used at 1 of 2 different power settings, at the surgeon’s discretion. The slow power mode provides more coagulation; the fast power mode is used for cutting. The surgeon chooses the power mode by changing the depression of the trigger, which makes sealing faster or slower, depending on the surgeon’s satisfaction with the obtained seal. The SCUD application time is subjective and left to the surgeon’s discretion, while the VSD determines when the seal is complete, and it is safe to transect the tissue. Because the number of times each device was applied was similar, the amount of tissue sealed with each bite by each device was similar.14,20

During surgery, the ovarian pedicle was sealed before the suspensory or uterine horn was transected. This approach allowed for good visualization of any hemorrhage from the ovarian pedicle. Hemorrhage from the ovarian pedicle is a potential complication of ovariectomy performed using laparoscopy or laparotomy.21 Hemorrhage can occur during surgery or the postoperative period if the ovarian pedicle is not completely sealed.21,22 In our study, no intraoperative bleeding was observed when the SCUD was used. No cases required a salvage procedure to control hemorrhage using the VSD. The SCUD was applied using slow mode across the ovarian pedicle to allow for better hemostasis. The fast mode was then used for tissue transection.12,14,21 The maximum ovarian pedicle fat grade was 3 in our study; therefore, hemostasis of an ovarian pedicle with a greater fat grade was not assessed in our study. Spillebeen et al12 found some hemorrhage after the application of the SCUD during ovarian bursa dissection, which was likely related to the more abundant fat present around the ovarian pedicles in their dogs. No postoperative complications were observed in our study while the dogs were in the hospital nor were they reported by the owners.

In all cases, the proximal part of the uterine horn was sealed and transected. Macroscopically, all uterine horn stumps appeared to be sealed. Most of the dogs in this study were young, and none were ever pregnant. Therefore, the uterine horns were smaller than 10 mm in diameter. The VSD can seal uterine horns less than 10 mm in diameter.24 There are no similar data available for the SCUD. No other studies related to laparoscopic ovariectomy with an ultrasonic dissector mentioned the presence of a seal of the uterine horn.11,12 More studies are needed to assess the limitations of the SCUD when used to seal uterine horns.

Three generations of ultrasonic devices have been introduced. The first-generation device was the Harmonic ACE. The second generation devices were the Ultracision and SonoSurg, and the third generation was the Sonicision device. Compared with the SonoSurg, the Sonicision tends to reach higher temperatures due to more displacement of the active blade.14 Kim et al.20 found that the Sonicision has a maximum cutting temperature of 227.1 °C, which is higher than the SonoSurg maximum of 184.4 °C.20 Thermal spread was not directly visualized during our study. However, histology was not performed to evaluate thermal damage to the retrieved ovarian tissue. The histological evaluation of the ovarian bursa by Spillebeen et al.12 found limited thermal spread using the SCUD. Thermal damage spread is similar between the SCUD and the VSD.12 In our study, there was increased cloudiness in the abdominal cavity because of the heat produced by the SCUD. The SCUD device also tended to produce more smoke than the VSD.12,25 The increased smoke can interfere with the visualization of the surgical field. The amount of smoke was not a problem during this study and did not result in a longer surgery time. Applying the hot tip during the transection of the ovarian pedicle has the potential to partially transect the ovarian pedicle before the device is activated. This problem did not occur in this study. However, we observed some fat melting from the ovarian pedicle during subsequent applications of the instrument to the pedicle. Controlling the instrument during the procedure is important to avoid touching organs with the hot blade.21,22 Compared with the fast mode, the SCUD’s slow mode purportedly provides better hemostasis.
while cutting the tissue at a slower rate. Switching between the 2 modes is simple and easy to control. However, the surgeon has to be fully aware of the mode selected, because activation of the fast mode from the beginning of the procedure can result in the transection of the tissue without an appropriate seal. To eliminate intraoperative complications due to device mishandling, the surgeon was familiar with both SCUD and VSD use.

In this study, a single incision laparoscopic port was used. Clashing of instruments can occur when a single incision port is used. The SCUD is the only cordless and battery-operated hemostatic energy device available. These characteristics provide an increase in device mobility and also reduce the chances of field contamination associated with a cord. The size of the handle holding the SCUD battery was not associated with instrument clashing during laparoscopy using a single port access. The cordless feature provided an increase in portability and the ability to move without tangling cables with the other cables or tubing in the surgical field.

This study had some limitations. The sample size was limited to 10 ovaries in each group. A power calculation could not be performed because a nonparametric statistical analysis was used. A sample size calculation was performed instead, before starting the study, which revealed a sample size of 10 ovaries with a 20% difference in surgery times between groups should result in a study power of 80% if the data had a normal distribution. The population included in the study was limited to dogs with no previous history of pregnancies, and none of the dogs had a large uterus. The largest dog in our population was 36 kilograms. It is not known if larger dogs with larger ovarian pedicles can be safely operated on with the SCUD. Uterine pathology or a dilated uterus can interfere with the ability of the SCUD and VSD to completely seal a uterine horn. In this study, all procedures were performed using laparoscopy, but the SCUD can also be used during laparotomy.

The ovariectomy surgery time was not significantly different between the 2 devices, and both devices were applied the same number of times to complete the ovariectomy. Hemorrhage from the ovarian pedicle or the uterine horn was not observed. Ovariectomy with the SCUD was successful in our population of dogs, making the 5-mm SCUD safe for laparoscopic ovariectomy in healthy dogs.

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Supplementary Materials

Supplementary materials are posted online at the journal website: avmajournals.avma.org