

Comparison of Ovariectomy and Ovariohysterectomy in Terms of Postoperative Pain Behavior and Surgical Stress in Dogs

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Abstract : This study was conducted to evaluate the clinical relevance and effectiveness of ovariectomy (OVE) and ovariohysterectomy (OVH) in terms of postoperative pain behavior and surgical stress. Thirteen healthy intact mongrel purpose-bred female dogs were used in this study. OVE was performed in six dogs whereas OVH was performed in seven dogs. Prior to, 1, 2, 4, 6, 12, and 24 h after surgery, pain assessment was performed by using the Short form of Composite Measure Pain Scale (CMPS-SF) and blood analysis for the determination of glucose, creatine kinase (CK), and cortisol were done. Also, surgical time, duration of anesthesia, and incision length were compared between two groups. As a result, OVH group as opposed to OVE group showed significantly longer in surgical time, duration of anesthesia, and incision length. Also, based on the two-way ANOVA test, the CMPS-SF had significant differences ($p < 0.05$) between two groups, with the OVE dogs having lower values at 1, 2, 4, and 6 h postoperatively. In addition, in terms of CK, the value at 1, 2, 4, 6, and 12 h were significantly ($p < 0.05$) increased from the baseline value for the OVH group. However, as for CK in OVE group, the values at 4, 6, and 12 h were significantly increased from the baseline value. As for blood glucose, a significant ($p < 0.05$) increase from the baseline was shown at 1 h postoperatively in OVH group and no significant increase was shown in OVE group. In terms of serum cortisol level, the values at the 1 and 2 h were significantly ($p < 0.05$) increased from the baseline value for both groups. In conclusion, our study has shown that OVE can be considered as a superior choice in terms of sterilization technique in female dogs, considering shorter incision length, surgical time, duration of anesthesia along with lower pain and surgical stress response than OVH.

Key words : ovariohysterectomy, ovariectomy, behavior, dog, pain.

Introduction

Gonadectomy is one of the commonly performed surgical techniques in veterinary practice since it is considered as the most reliable mean of pet population control (22). It is also indicated for treatment of ovarian tumors, to promote involution of placental sites (non-responsive to medical treatment), to prevent recurrence of vaginal hyperplasia and hormonal changes that can interfere with medical treatment in patient with endocrine disease such as diabetes, and to minimize the transfer of inherited disease such as generalized demodicosis (2,5,29). On the other hand, OVH is the preferred choice for most of the uterine disease, including congenital anomalies, pyometra, localized or diffuse cystic endometrial hyperplasia, uterine torsion, uterine prolapsed, uterine rupture and uterine neoplasia (2,5,23). In performing gonadectomy, a

choice between ovariohysterectomy (OVH) and ovariectomy (OVE) can be made. The OVH is most commonly preferred approach in spaying dogs in United States (2,5,23) whereas OVE is commonly performed and thus replaced OVH as a standard procedure for gonadectomy in European countries including Netherlands (25).

Following the surgeries, postoperative pain is an inevitable part of the surgery that all veterinarians have to face in their practice. In addition, postoperative pain in animals is crucial to the overall recovery process because the pain can easily result in a decrease in food intake, exacerbated protein catabolism, depression of respiratory function, cardiac dysrhythmias, central hypersensitivity to noxious stimuli and chronic pain (9,10). In terms of anticipated levels of pain associated with surgical procedures, illness or injuries, OVH is considered moderate (10). One study showed that OVH, in fact, caused in an increased pain score, sedation score, and time spent for sleeping, and decreased greeting behaviors during interaction with caregivers after surgery (4). As such, researchers also have made efforts to figure out effective

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ways to control pain after OVH. In a clinical setting, perioperative analgesia for OVH is commonly achieved by administering opioids in combination with NSAID. Slingsby *et al.* (21) showed that administration of short-acting opioid meperidine in combination with carprofen in bitches yielded a beneficial effect in OVH.

On the other hand, OVE has a major advantage in that it can be performed through a smaller celiotomy and with less traction on the female genital tract (25). In addition, Okkens *et al.* (15) reported that OVE does not increase the risk of cystic endometrial hyperplasia-endometritis or other complications in comparison with OVH. They also reported no significant differences in occurrence of urinary incontinence between OVE and OVH. Technically, OVH is more complicated since more tissues are ligated and transected and time consuming due to a need of larger celiotomy to expose entire uterus (6).

The present study was aimed to investigate the extent of postoperative pain and stress of OVE and OVH in terms of behavioral assessment and biochemical measures after each procedure.

Materials and Methods

Animals

This study was approved by the Animal Care and Use Committee at Gyeongsang National University (approval number: GNU-LA-27).

Thirteen healthy intact mongrel purpose-bred female dogs (mean \pm SD of OVH group, 4.8 ± 0.4 kg; OVE group, 4.4 ± 0.3 kg) were considered for inclusion in this study. All dogs had physical examinations prior to the surgery, in which there were no abnormal findings. Also, complete blood count and serum biochemical profile were performed before their admission as candidates. Twenty-four hours prior to the surgery, to minimize the stress, the dog was placed in a kennel of a room which was isolated from contact of any kind.

Anesthesia

Identical anesthetic protocol was applied to all of the participating dogs. Dogs were preanesthetized with the combination of intramuscular injection of atropine (0.04 mg/kg) and acepromazine (0.04 mg/kg) and intravenous injection of butorphanol (0.4 mg/kg). Then, general anesthesia was induced 20 min after the pre-medication with propofol (3 mg/kg IV titrated to effect) and maintained with isoflurane in 100% oxygen via endotracheal intubation in a circle rebreathing system. Electrocardiogram, capnography, pulse oximetry, respiratory rate, non-invasive blood pressure, and esophageal temperature were monitored continuously throughout the anesthesia. Ventilator settings were varied by adjusting to maintain the end tidal CO₂ partial pressure around 35-45 mmHg throughout the procedure. In terms of depth of anesthesia during the surgery, we kept it to an extent in which surgical manipulation was possible. Esophageal temperature

was maintained at 38-39°C with a circulating water blanket (Medi-Therm, Gaymer, New York, USA) and lactated Ringer's solution was administered intravenously during the procedure at a rate of 10 ml/kg/h.

Surgical procedures

All of the surgical procedures were performed entirely by a single surgeon who had much experience in OVH. Also, all surgeries were performed in the morning in order to standardize the time of surgery (4). For both OVH and OVE, the dogs were surgically clipped and prepared from xiphoid to the pubis.

As for OVH, the incision was made from the cranial third to pubis because the ovaries were more difficult to exteriorize than the uterine body. Once the abdominal cavity was opened, by using OVH hook or index finger, the left uterine horn was located. The ovary was retracted while the suspensory ligament was broken with the index finger. Then, the ligation of the ovarian vessels was started by making a window in the mesovarium caudal to the ovarian vessels. The ovarian pedicle was double clamped since the dogs were considered small, and the pedicle was severed between the clamp closest to the ovary and the middle clamp. The clamp most distant to the ovary was removed so that the pedicle ligature could be placed in its groove. Absorbable suture material was used for ligature. The pedicle was grasped with small hemostat, the remaining clamp was removed, and the pedicle was inspected for bleeding. The pedicle was gently placed into the abdomen, and the hemostat was released. The identical procedure was done on the opposite side. The broad ligament was severed or torn. Three clamps were placed on the uterine body just cranial to the cervix. The uterine body was severed between the proximal and middle clamps. The uterine arteries were individually ligated caudal to most caudal clamp. Then the caudal clamp was removed, and the uterus was ligated in the groove that remained. The uterine pedicle was grasped with a small hemostat above the clamp, the clamp was removed, and the pedicle was inspected for bleeding. The pedicle was gently replaced into the abdomen, and the hemostat was removed. Then, the abdomen was closed in a routine manner. Incision length of the abdominal wall was measured by a digital vernier caliper.

As for OVE, A midline incision was made caudal to the umbilicus and extended caudally. The ovary was located and retracted while the suspensory ligament was broken with the index finger. Then, ovarian artery and vein were ligated in the same manner as OVH. The ovarian pedicle was severed. The uterine artery and vein were ligated and severed at the proper ligament at the cranial tip of the uterine horn. The abdomen was closed in a routine manner.

Recovery period

Then, prior to the extubation, 0.4 mg/kg of butorphanol was administered intravenously as analgesia in both OVE and OVH group. Following the extubation, proper dressing and

elastic bandage was applied to the sutured area and the bandage covered most of the abdomen so that the observer would be completely blinded to the procedure. Then, the dog was transported to the same kennel where it stayed before the surgery.

Pain assessment

Throughout the study, pre and postoperative pain was evaluated by a blinded observer who was not aware of which surgical procedure has been performed on the testing dogs. The observer used a short form of Glasgow Composite Measurement of Pain Scale (CMPS-SF) to increase the reliability and minimize the subjectivity of the pain scoring systems (26). Prior to the surgery, the pain assessment was done to use it as a baseline. Then, these scorings were done at 1, 2, 4, 6, 12, and 24 h following tracheal extubation. The total pain score ranging from 0 to 24 was calculated for each time slot.

The behavioral observation procedures were standardized and blinded investigator initially evaluated posture, movement, and vocalization of the testing dog quietly from outside the room through an enclosed window so that the testing dog would not be disturbed. Any changes in the posture of the dog upon entering the room were to be noticed and recorded. After entering the room, the investigator started to communicate with the dog by calling out its name friendly in front of the kennel. Then, the door of the kennel was opened and the dog's movements and postures were evaluated by following the details of CMPS-SF. When possible, the dog was taken out of the cage to evaluate its mobility; when this was not possible, its ability to stand was assessed. Then, the investigator softly palpated the wound area and observed their reaction. Upon completion of observing the dog and recording the score, the score sheet was submitted to the test leader.

Blood sampling

Blood sample was collected by jugular venipuncture at each designated time. Then, the blood sample for serum cortisol concentration measurement was dispensed into a serum separator tube, clot formation was allowed to occur for 30 minutes, and the sample was immediately centrifuged at 3000 rpm for 10 minutes. Then, serum was harvested immediately, stored at -70°C in labeled Eppendorf tubes, and evaluated for cortisol concentration at the end of the study by a commercial laboratory via radioimmunoassay procedure (Coat-A-Count cortisol, Diagnostic Products Corporation, USA). The remaining blood sample for serum glucose and CK was dispensed into a lithium-heparin tube and centrifuged immediately for 10 minutes. Following centrifugation, serum glucose and CK concentration was measured with a dry chemistry analyzer (Fuji DriChem 3500s, Fujifilm, Japan) immediately after sample acquisition.

Statistical analysis

The incision length, and surgical time of two groups of dogs

were compared by an unpaired *t* test. A two-way ANOVA for repeated measures was used to compare the effects of each treatment group and postoperative time on CMPS-SF. The group means of CMPS-SF and their corresponding 95% confidence intervals at each time point were recorded. A one-way ANOVA for repeated measures was used to compare differences within treatment groups for serum cortisol, CK, and glucose concentrations obtained at various times. If a significant effect was detected, the Dunnett multiple comparison test was used to compare baseline values with values obtained at each subsequent measurement point. Statistical significance was based on a *p* value of 0.05 or less. All statistical tests were performed with SPSS 18.0 software (SPSS Inc., USA).

Results

No intra- or postoperative complications were observed in either of the two groups of dogs. Body weight (mean \pm SD of OVH group, 4.8 ± 0.4 kg; OVE group, 4.4 ± 0.3 kg) was not significantly different between the groups. However, incision length (OVH group, 10.1 ± 2.2 cm; OVE group, 4.4 ± 0.3 cm), surgical time (OVH group, 52.3 ± 2.1 min; OVE group, 35.8 ± 2.8 min), duration of anesthesia (OVH group, 66.1 ± 4.4 min; OVE group, 47.1 ± 4.0 min) showed a significant difference between two groups.

Based on the two-way ANOVA test, the CMPS-SF had significant differences ($p < 0.05$) between two groups. The OVE group had significantly lower pain scores than the OVH group at 1, 2, 4, and 6 h postoperatively (Fig 1). For the OVH group, the highest and the lowest CMPS-SF scores were measured 1 h (mean \pm SD, 8.6 ± 1.2) and 24 h postoperation (2.6 ± 2.6) respectively. Similarly, the highest and the lowest CMPS-SF scores for the OVE group were measured 1 h (4.8 ± 1.7) and 24 h postoperation (0.1 ± 0.4).

The mean \pm SD serum chemistry analysis taken from two groups of dogs are shown Table 1. As for glucose, the value

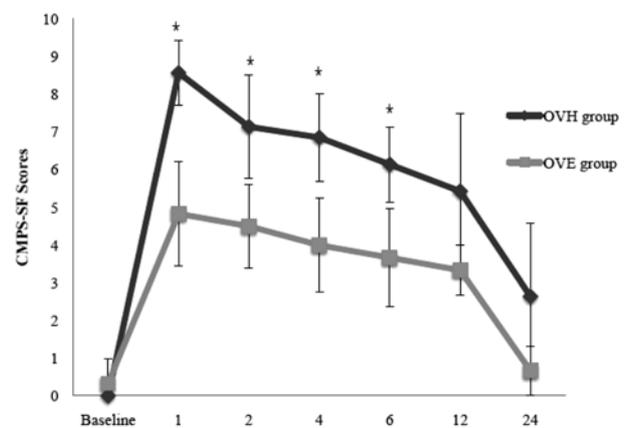


Fig 1. Mean CMPS-SF scores and their corresponding 95% confidence intervals taken from OVE and OVH groups of dogs at each time point.

Table 1. Mean \pm SD chemistry analysis taken from two groups of dogs

Variable	Group	Baseline	Time (h) after extubation					
			1	2	4	6	12	24
GLU	OVH	100.0 \pm 14.9	168.7 \pm 101.9*	140.7 \pm 54.4	108.4 \pm 14.1	93.7 \pm 17.0	94.3 \pm 9.4	81.6 \pm 31.9
	OVE	83.3 \pm 36.9	114.2 \pm 19.0	108.3 \pm 12.8	96.5 \pm 44.3	115.2 \pm 12.4	102.2 \pm 10.8	90.8 \pm 16.0
CPK	OVH	125.1 \pm 30.0	906 \pm 765.8*	874.6 \pm 549.1*	1181.7 \pm 564.1**	1170.3 \pm 609.8*	1318.1 \pm 668.0**	765.1 \pm 605.0
	OVE	121.8 \pm 108.2	299.5 \pm 127.0	488.8 \pm 250.3	665.2 \pm 479.2*	910.2 \pm 575.3**	871.5 \pm 577.0**	376.5 \pm 168.7
Cortisol	OVH	5.1 \pm 2.5*	15.5 \pm 5.1*	10.1 \pm 2.9	4.2 \pm 1.9	2.9 \pm 1.0	2.7 \pm 0.8	1.4 \pm 0.9
	OVE	3.0 \pm 1.8*	9.9 \pm 3.1**	9.2 \pm 5.1	4.0 \pm 1.6	3.5 \pm 2.3	2.1 \pm 1.6	1.5 \pm 0.8

An *indicates significant ($p < 0.05$) differences from preoperative concentration within each group.

**indicates highly significant ($p < 0.01$) differences from preoperative concentration within each group.

at 1 h time point was significantly increased from the baseline for the OVH group. However, no significant increases, compared to the baseline, were found in OVE group. In addition, in terms of CK, the value at 1, 2, 4, 6, 12 h time point were significantly ($p < 0.05$) increased from the baseline value for the OVH group. However, as for CK in OVE group, the values at 4, 6 and 12 h were significantly increased from the baseline value.

Cortisol concentrations peaked at 2 h in both experimental groups. The values at the 1 and 2 h were significantly ($p < 0.05$) increased from the baseline value for both groups.

Discussion

OVH is one of the most commonly practiced neutering techniques in female dogs in United States as opposed to OVE in Europe (3,25). Previous studies have indicated that the OVE was less invasive and less time-consuming than OVH (25). Although it is possible to perform OVH through a small median celiotomy, atraumatic technique and correct placement of the uterine ligature near the cervix typically requires a larger celiotomy compared to OVE (25). Thus, the duration of surgery and anesthesia may be shorter for OVE, and because the celiotomy is shorter, the broad ligaments are not disrupted, and the uterine stump left intact, there should also be less surgical trauma (3,25). In correlation with previous studies, a significant difference has been shown between OVH and OVE groups in incision length, surgical time as well as the duration of anesthesia (25). This leads the author to believe that factors addressed in previous studies were also proven to be valid in our study. Okken *et al.* (15) reported that there were no indications that endometritis had developed in bitches underwent OVE. On the other hand, in a retrospective study of 62 dogs that had OVH, 17.7% developed complications such as hemorrhage, ovarian remnant syndrome, and urinary incontinence (19). In addition, there have been a few reports that most ovarian remnants occur after OVH (11,16,18,27). Our study also showed that no noticeable pre- and postoperative complications have been addressed in OVE group. Thus, it seems that OVE can be technically con-

sidered as valid as OVH.

Alleviating pain in animals is an essential aspect of ascent welfare and also an obligation of veterinary clinicians (13). Prior to formulating proper form of treatment for postoperative pain, many strategies have been implemented to better control postoperative pain because it could yield many unwanted effects (6,26). As such, proper measurement of pain became more important than ever before. As for the pain scoring system, many researchers have come up with different types such as CMPS-SF, the University of Melbourne pain scale (UMPS), visual analogue scale (VAS), most of which have been criticized for being too subjective or unreliable, even if they included measurement of physiological variables (6,26). Reid (20) concluded that, using VAS, there were no statistical differences between the observer's scores in dogs that had underwent surgeries. The CMPS-SF is the only pain scale that has been validated for the assessment of acute pain in dogs (6,13,24,30). The use of the CMPS-SF has been validated at the University Utrecht and it was shown to be a reliable clinical tool to define different pain intensities and change in pain score over time in a population of dogs undergoing a variety of surgical procedures (14). As such, in this study, to increase the level of objectivity and reliability, all of the measurements were performed by the same observer who remained unaware of the procedures performed (26). In this study, CMPS-SF scores were relatively high in OVH group as opposed to OVE group. In addition, the CMPS-SF scores were shown to be significantly different between groups, which may indicate the presence of more severe pain from the procedure that may involve longer surgery time and incision length.

Since wide range of variability occurs among observers when it comes to scoring postoperative pain, the importance in correlation of these observations with other supplemental measurement have been emphasized. As such, cortisol as objective measurement has been validated in previous studies in dogs (28,30). However, this is not always the case, as several studies (7,17) comparing the stress response in open and laparoscopic surgeries in human subjects have led to conflicting outcomes. In this study, although the cortisol val-

ues at the 1 and 2 h were significantly increased from the baseline value for both groups, there were no significant differences between two groups. The results in this study lead the author to believe that changes in the cortisol concentration is not considered as mere reflection of changes in pain scores.

In humans, cats as well as dogs, glucose has been considered as an indicator of stress and pain (28). The release of catecholamine during stressful event lead to increased glucose levels to satisfy higher metabolic demand (28). On the other hand, there have been some reports that glucose could be an unreliable means of indicating stress and perhaps it does not always explain the extent of the stress present in animals (1,8,12). We found increased glucose concentration at hour 1 in OVH group. In spite of these changes, we did not find any significant differences between groups at any time. However, considering a dramatic increase of glucose at hour 1 of OVH group, the author believes that glucose measurement can supplement the objective measurement of stress.

Muscle damage is somewhat inevitable part of elective surgery, especially surgical procedures that involves opening the abdominal wall. Creatine kinase (CK) is the marker most widely used to evaluate muscle damage (1). CK has also been considered as an indicator to measure physiological stress in other species such as broiler chicken, especially during road transportation. In addition, under the heat stress, domestic fowl (*Gallus domesticus*) showed significant increase of CK (12). Since muscle trauma can be related to inflammation and pain, it may also be useful factor in evaluating patients in veterinary medicine (3). In this study, we found significantly increased CK at hour 1, 2, 4, 6, and 12 in OVH group compared to their baseline. On the other hand, we found steadily increased CK at 1 and 2 h which were followed by significantly increased CK at 4, 6, and 12 h in OVE group compared to their baseline. A dramatic increase in CK immediately after the surgery leads the authors to believe that CK is indeed a contributing factor in measuring stress and pain in animals.

Although the results of the present study showed statistically significant differences in CMPS-SF scores, the use of other pain assessment method may be necessary because a valid and reliable method for evaluating pain in animals is crucial despite the fact that there is no method for assessing pain that can be defined as "golden standard". In addition, constant application of such methods should be done to test their validities and see if the scores may change in a predictable way after elective surgery. By doing so, we can formulate proper forms of treatment at each time.

Conclusion

Although OVH is widely used in many different countries as a standard sterilization procedure, OVE has not shown significant factors that make it less preferable choice as an elective surgery. Our study has shown, as a matter of fact, that considering shorter incision length, surgical time, duration of

anesthesia, OVE can be considered as a superior choice in terms of sterilization technique. In addition, significantly lower pain scores in CMP-SF along with significantly lower value of glucose and CK leads the author to conclude in such way.

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개에서 난소자궁절제술과 난소절제술 후 나타나는 통증 행동과 스트레스 반응의 비교

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요 약 : 본 연구는 개에서 난소자궁절제술과 난소절제술의 실시가 동물의 통증행동과 스트레스에 미치는 영향을 비교하고, 임상적용 가능성을 평가하기 위하여 실시되었다. 13 마리의 건강한 암컷 중 (4.2-5.5 kg) 6 마리의 개에서 난소절제술이 행하여졌고, 7 마리에서 난소자궁절제술이 이루어졌다. 술 후 두 그룹 간에 수술 시간, 마취 시간, 복벽의 절개 길이를 비교하였다. 또한 술 전과 술 후 1, 2, 4, 6, 12, 24 시간째에 Short form of composite measure pain scale (CMPS-SF) 를 사용하여 통증 점수를 측정하였고 혈중 glucose 와 creatine kinase 그리고 cortisol 수치를 측정하였다. 난소자궁절제술을 시행한 그룹에서는 난소절제술을 시행한 그룹에 비해 유의적으로 ($p < 0.05$) 긴 수술 시간, 마취 시간, 복벽 절개 길이를 나타내었다. Two-way ANOVA test 결과 CMPS-SF에 의한 통증점수가 두 그룹 간에 유의적 ($p < 0.05$) 차이를 보였으며 술 후 1, 2, 4, 6 시간째 난소절제술을 행한 그룹에서 유의적으로 낮은 수치를 나타내었다. Glucose 의 경우 난소자궁절제술을 행한 그룹에서는 술 전과 비교해 유의적 ($p < 0.05$) 농도 증가가 술 후 1 시간째에 나타났으나 난소절제술을 행한 그룹에서는 술 후 전체 관찰기간 동안 유의적 농도 증가가 관찰 되지 않았다. Creatine Kinase 의 경우 난소자궁절제술을 행한 그룹에서는 술 전과 비교하여 술 후 1, 2, 4, 6, 12 시간째에 유의적 ($p < 0.05$) 농도 증가를 나타내었으나 난소절제술 그룹의 경우 술 후 4, 6, 12 시간째에만 술 전과 비교하여 유의적 ($p < 0.05$) 농도 증가를 나타내었다. Cortisol 의 경우 두 그룹 모두 술 후 1, 2 시간째에 유의적인 ($p < 0.05$) 농도 상승을 나타내었다. 본 연구 결과 난소절제술을 이용한 암컷의 증성화 수술 방법은 난소자궁절제술에 비해 짧은 복벽 절개, 수술 시간, 마취 시간을 요하며, 적은 술 후 통증과 스트레스를 유발하므로 난소절제술을 시행하는 것이 환자에게 바람직할 것으로 판단된다.

주요어 : 난소자궁절제술, 난소절제술, 행동, 개, 통증