Intraoperative pain responses following intraovarian versus mesovarian injection of lidocaine in mares undergoing laparoscopic ovariectomy

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EQUINE

Objective—To compare intraoperative pain responses following intraovarian versus mesovarian injection of lidocaine in mares undergoing laparoscopic ovariectomy.

Design—Randomized controlled trial.

Animals—15 mares between 4 and 20 years old.

Procedure—Standard bilateral laparoscopic ovariectomy was performed. Prior to manipulation of the ovary, 2% lidocaine (10 mL) was injected into the ovary and saline (0.9% NaCl) solution (10 mL) was injected into the mesovarium on 1 side, with saline solution (10 mL) injected into the ovary and 2% lidocaine (10 mL) injected into the mesovarium on the other side. Presence (yes vs no) and severity (visual analogue scale) of pain were scored at 5 times (grasping of the ovary, dissection of the mesosalpinx, tightening of the first loop ligature, tightening of the second loop ligature, and transection of the ovarian pedicle) by 2 individuals blinded to treatment and each other's observations.

Results—During 4 of the 5 observation periods, significantly fewer mares had signs of pain following mesovarian injection of lidocaine, and during 2 of the 5 observation periods, visual analogue scale score was significantly lower.

Conclusions and Clinical Relevance—Results suggest that mesovarian injection of lidocaine is associated with significantly lower pain responses, compared with intraovarian injection, in horses undergoing laparoscopic ovariectomy. (*J Am Vet Med Assoc* 2005;227:593–596)

Laparoscopic ovariectomy can be somewhat painful when performed in standing horses, particularly when the ovary is grasped with forceps for manipulation and when the ovarian pedicle is ligated. Even with epidural administration of detomidine, signs of pain are typically observed if local anesthesia of the ovary or mesovarium is not performed and can range from mild behavioral reactions, such as stomping the hind feet, to explosive behavior that prevents completion of the procedure without additional analgesia or sedation. For this reason, injection of 15 to 20 mL of 2% mepivacaine[1-3] or 2% lidocaine[4,5] into the broad ligament, mesovarium, and mesosalpinx has been recommended for horses undergoing laparoscopic ovariectomy. On the other hand, although infiltration of the broad ligament with mepivacaine negates the need for additional analgesics during the procedure,[6] irrigation of the broad ligament with benzocaine-tetracaine has been reported to be inadequate.[6]

Direct injection of lidocaine into the ovary is technically easy and could decrease operative time for horses undergoing laparoscopic ovariectomy, compared with infiltration of the mesovarium with lidocaine, because it is a single injection and little manipulation is needed. Regional anesthesia can be accomplished in stallions by injecting an anesthetic drug directly into the testes prior to castration.[7] With this technique, the anesthetic drug should reach the inguinal canal within 90 seconds via lymph vessels,[7] and castration can be accomplished painlessly after approximately 10 minutes.[7] Sensory nerve fibers from the human testis travel within the genital branch of the genitofemoral nerve, which courses along the spermatic cord.[8] Similarly, nerve fibers from the human ovary and outer third of the fallopian tube travel within the ovarian nerve plexus along the ovarian artery.[9] Therefore, injection of an anesthetic drug into the ovary could potentially provide anesthesia of the ovarian nerve plexus. To our knowledge, however, there are no reports that have compared the use of intraovarian versus mesovarium infiltration of lidocaine in horses undergoing laparoscopic ovariectomy.

The purpose of the study reported here, therefore, was to compare intraoperative pain responses following intraovarian versus mesovarian injection of lidocaine in standing mares undergoing bilateral laparoscopic ovariectomy. Our hypothesis was that there would be no difference in pain responses following intraovarian versus mesovarian injection.

Materials and Methods

Fifteen adult client-owned mares ranging from 4 to 20 years old (mean, 10.5 years) were used in the study. Mares were in various stages of estrus at the time of the study. Reasons for ovariectomy included behavior problems (n = 9), signs of pain during estrus (5), and episodes of laminitis during estrus (1). Horses consisted of 5 Arabians, 6 American Paint Horses, 1 American Quarter Horse, 1 Peruvian Paso, 1 Hanovarian, and 1 Trakehner. Owners of all horses provided informed consent. The study protocol was approved by the Animal Care and Use Committee at Colorado State University.

Feed was withheld for 24 hours prior to surgery. Thirty minutes prior to surgery, horses were treated with procaine penicillin G (22,000 U/kg [10,000 U/lb], IM) and phenylbutazone (4.4 mg/kg [2 mg/lb], PO). Horses were premedicated with xylazine hydrochloride (100 mg, IV) and butorphanol tartrate (5 mg, IV) prior to arrival in the surgical suite. They

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were restrained in stocks, and detomidine hydrochloride (40 µg/kg [18.2 µg/lb]) mixed with sterile saline (0.9% NaCl) solution (qs to 10 mL) was administered in the epidural space to provide sedation.

Three portals were created in each flank as described[10] following infiltration of each site with 2% lidocaine (10 to 15 mL/site). A straightened mare urinary catheter[a] (length, 32 cm; external diameter, 8 mm) was bluntly inserted into the middle portal for insufflation. Carbon dioxide gas was used for abdominal insufflation, and intra-abdominal pressure was maintained between 10 and 15 mm Hg. A blunt trocar laparoscopic cannula[b,c] (internal diameter, 10 to 11 mm; length, 15 to 20 cm) was placed in the cranial portal, and a laparoscope[d] (length, 56 cm; diameter, 10 mm; 30° angle) inserted through this cannula was used to examine the reproductive tract and abdominal cavity. Cannulas were then placed in the remaining 2 portals.

In each horse, 2% lidocaine (10 mL) was injected into the ovary and saline solution (10 mL) was injected into the mesovarium on 1 side, with saline solution (10 mL) injected into the ovary and 2% lidocaine (10 mL) injected into the mesovarium on the other side. Which side received the injection of lidocaine in the ovary was randomly chosen. All injections were prepared by an individual who was not otherwise involved in the study so that the 2 individuals scoring pain responses were blinded to the treatment.

Injections were performed with an 18-gauge laparoscopic injection needle (overall length, 42 cm; needle length, 2 cm; external diameter, 5 mm). Atraumatic grasping forceps[b] were used to stabilize the ovary and mesovarium during injections. For intraovarian injection, the entire dose was administered at a single site. For mesovarian injection, the dose was administered at 3 sites beginning cranially and working caudally at 1.5-cm intervals. Fifteen minutes was allowed to elapse after injections were complete before ovariectomy was begun to allow for absorption of lidocaine from the ovary.

Ovariectomy was performed by means of sharp dissection of the mesosalpinx and proper ligament of the ovary, followed by double-loop ligation (modified Roeder slipknot with size 1 polyglyconate[11]) of the ovarian pedicle and sharp transection distal to the ligatures. In all mares, the left ovary was removed first. One individual (DAH) performed left ovariectomy in all mares, and a second individual (EGF) performed right ovariectomy. Following transection of the right ovarian pedicle, the right ovary was passed to the left side of the abdomen and both ovaries were removed by enlarging the caudoventral portal in the left paralumbar fossa to approximately 5 cm in length. This portal was closed by placing size 0 polyglyconate in a simple continuous pattern in the fascia of the external abdominal oblique muscle, followed by 2-0 polyglyconate in a simple continuous pattern in the subcutaneous tissue and 2-0 nylon in a simple interrupted or Ford interlocking pattern in the skin. Abdominal pressure was relieved by opening the cannula ports to allow passive evacuation of carbon dioxide from the abdomen. All of the remaining portals were closed by placing 2-0 nylon in a cruciate or simple interrupted pattern in the skin.

Intraoperative pain responses were recorded by both surgeons at 5 time points: after grasping of the ovary with a 2 × 3 claw forceps,[b] during sharp dissection of the mesosalpinx, during tightening of the first loop ligature, during tightening of the second loop ligature, and during transection of the ovarian pedicle. Observers recorded pain responses independently from each other and were blinded to each other's observations for the duration of the study.

At each observation time, signs of pain (eg, body movement, stomping the rear feet, and kicking) were recorded as present or absent and severity of pain was recorded by use of a **visual analogue scale (VAS)**, as described,[12] by placing a mark on a 10-cm-long line, where 0 represented no signs of pain and 10 represented signs of pain so severe that the procedure could not be continued without additional sedation or analgesia. For analysis of VAS scores, scores from the 2 observers were averaged to obtain a final VAS score for each observation time in each mare.

Postoperatively, feed was withheld until the horses were awake and was gradually reintroduced over the subsequent 24 hours. A single dose of procaine penicillin G (22,000 U/kg, IM) was administered 12 hours after surgery, and administration of phenylbutazone (4.4 mg/kg, PO, q 24 h) was continued for 4 days after surgery. Horses were discharged between 24 and 36 hours after surgery. Owners were instructed to confine the horses to a stall for 2 weeks with twice-daily hand walking and to have the sutures removed after 14 days.

Statistical analyses—For each observation time, the χ^2 test was used to determine whether presence of pain (yes vs no) was associated with treatment (intraovarian vs mesovarian injection of lidocaine); responses from both observers were included in these analyses. In addition, the χ^2 test was used to determine whether presence of pain was associated with observer (EGF vs DAH). The Mann-Whitney *U* test was used to compare final VAS scores between treatments at each observation time and compare raw VAS scores between observers. For all analyses, values of $P \le 0.05$ were considered significant.

Results

One horse developed a seroma in the area of the caudoventral portal in the left flank that responded to conservative treatment by the referring veterinarian. No other postoperative complications were recorded.

There was no significant association between presence of pain and observer at any observation time. Similarly, there was no significant difference in raw VAS scores between observers at any observation time.

At all observation times except the first (ie, grasping of the ovary), there was a significant association between presence of pain (yes vs no) and treatment (intraovarian vs mesovarian injection of lidocaine), with fewer horses reported as having signs of pain following mesovarian injection of lidocaine **(Figure 1)**. During placement of the

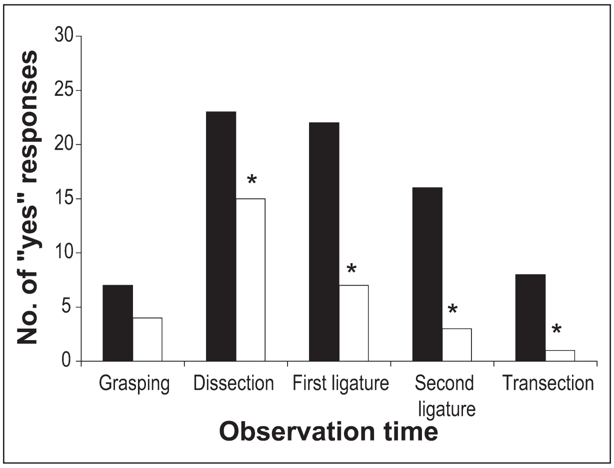

Figure 1—Total number of times pain responses were reportedly seen by 2 observers at 5 observation times (grasping of the ovary, dissection of the mesosalpinx, tightening of the first loop ligature, tightening of the second loop ligature, and transection of the ovarian pedicle) in 15 horses undergoing standing laparoscopic ovariectomy. In each horse, 10 mL of 2% lidocaine was injected in 1 ovary (black bars) and 10 mL of 2% lidocaine was injected in the mesovarium of the opposite ovary (white bars) prior to ovariectomy. *Significantly ($P \le 0.05$) different from value for other treatment.

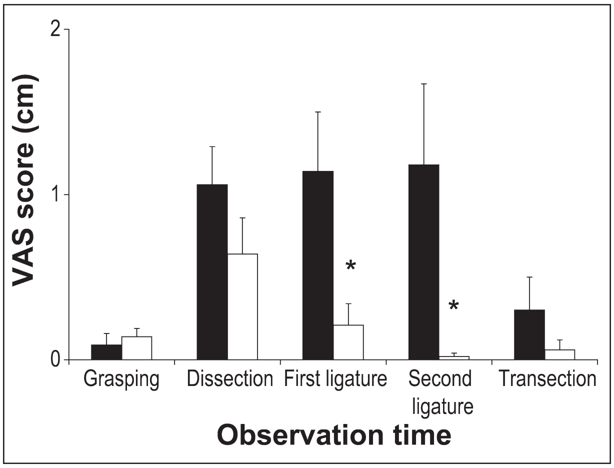

Figure 2—Mean visual analogue scale (VAS) scores at each of 5 observation times in 15 horses undergoing standing laparoscopic ovariectomy. Scores were determined by averaging scores assigned by 2 observers who each placed a mark on a 10-cm-long line, where 0 represented no signs of pain and 10 represented signs of pain so severe that the procedure could not be continued without additional sedation or analgesia, to indicate severity of signs of pain. Error bars represent SEM. *See* Figure 1 for remainder of key.

first and second loop ligatures, VAS score was significantly lower following mesovarian injection of lidocaine than following intraovarian injection of lidocaine (**Figure 2**). The VAS scores were not significantly different between treatments at the other observation times.

Discussion

Results of the present study suggest that mesovarian injection of lidocaine is associated with significantly lower pain responses, compared with intraovarian injection, in horses undergoing laparoscopic ovariectomy. During 4 of the 5 observation periods, significantly fewer mares had signs of pain following mesovarian injection of lidocaine, and during 2 of the 5 observation periods, VAS score was significantly lower. Complete anesthesia was not achieved with either technique in all mares at all observation times; however, our results should assist clinicians in making decisions regarding intraoperative pain management.

A possible reason why mesovarian injection of lidocaine resulted in better analgesia than did intraovarian injection could be the greater consistency of administration with mesovarian injection. With mesovarian injection, the anesthetic agent is deposited directly into the tissue containing the ovarian nerve plexus. In contrast, intraovarian injection relies on uptake of the anesthetic into the vasculature to indirectly desensitize the ovarian pedicle, and such uptake may be inconsistent or unreliable. When injecting lidocaine into the ovary, the surgeon may inject the drug into a follicle or the parenchyma. This was observed in the present study, in that in some instances, minimal pressure on the syringe was needed and a follicle would appear to expand during injection. In contrast, when lidocaine was injected into the ovarian parenchyma, a considerable amount of pressure was needed on the syringe and no gross enlargement of a follicle occurred. The parenchymal tissue is highly vascular, and injection of lidocaine into the ovarian parenchyma would be expected to result in substantial uptake by the ovarian vasculature. In contrast, the basement membrane and granulosa layers of the follicle are avascular,[13] which could limit uptake of lidocaine following injection into a follicle.

A VAS was used in the present study in an effort to quantify the severity of intraoperative pain experienced by the horses, and VASs are commonly used in human surgery to evaluate postoperative pain associated with various treatment regimens.[14-16] In the present study, we found significant reductions in VAS scores during placement of the first and second loop ligatures when lidocaine was injected into the mesovarium, rather than the ovary. However, significant differences were not found at other observation times. Overall, VAS scores were low, and statistical differences that were found may, therefore, have questionable clinical importance. In people, a relationship between clinical and statistical significance has been reported for VAS scores evaluating pain, nausea, and sleep quality,[17-19] and in children admitted to an urban pediatric emergency hospital, a 1.0-cm change in VAS score (95% confidence interval, 0.7- to 1.2-cm change in score) was associated with a clinically significant difference in pain.[17] In the present study, the change in VAS score was 1.16 cm during placement of the first ligature and 0.93 cm during placement of the second ligature. Although these changes were in the range of changes reported to be clinically significant in humans, caution must be used when extrapolating across species.

In an effort to minimize the potential for bias, the 2 observers in the present study were blinded to which treatment was administered and to each other's observations throughout the duration of the study. To minimize any potential bias associated with acting as the primary surgeon versus acting as an assistant, 1 observer performed ovariectomy on all left ovaries and the other performed ovariectomy on all right ovaries. We believe that these efforts at minimizing bias were successful because there was no significant association between presence of pain and observer and no significant difference in raw VAS scores between observers at any observation time.

Epidural administration of detomidine is routinely used at Colorado State University to provide sedation when performing laparoscopic surgery in standing mares. Although unlikely, epidural administration of detomidine could potentially have influenced sensation to the ovary. Skarda and Muir[20] reported that epidural administration of detomidine at a dose of 60 µg/kg (27 µg/lb) in a total volume of 10 mL induced variable bilateral analgesia ranging from the first coccygeal to the third sacral and from the first coccygeal to the 14th thoracic dermatome areas. Epidural administration of detomidine at doses < 40 µg/kg, however, did not consistently induce measurable caudal analgesia. Sensory nerve fibers from the human ovary course within the ovarian nerve plexus, enter the sympathetic nerve chain near L4, then enter the spinal cord near the superior (cranial) mesenteric ganglion at T9-10.[9] Detailed information regarding exact sensory tracts of the ovary in horses is limited. However, it has been reported that the ovarian nerve plexus enters the caudal mesenteric ganglion, which is located ventral to L3.[21] To the authors' knowledge, no data exist regarding intra-abdominal analgesia following epidural administration of detomidine, but because epidural administration of detomidine at doses < 40 µg/kg was found to be unreliable in providing analgesia to the perineum, it appears unlikely that similar doses would result in substantial analgesia of the ovary.

Although neither technique eliminated all pain responses, results of the present study indicate that infiltration of the mesovarium with 2% lidocaine provides better pain relief during laparoscopic ovariectomy than does administration of 2% lidocaine directly into the ovary. Edema within the mesovarium associated with this procedure appears to be clinically unimportant.

a. Jorgensen Laboratories Inc, Loveland, Colo.
b. Storz Veterinary Endoscopy, Culver City, Calif.
c. Richard Wolf Medical, Vernon Hills, Ill.
d. Surgical Direct Inc, Deland, Fla.

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