Assessment of laparoscopic skills before and after simulation training with a canine abdominal model

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Objective—To determine whether scores for basic laparoscopic skills were significantly associated with extent of laparoscopic experience and compare basic laparoscopic skills obtained before and after 2 laparoscopic training sessions incorporating a canine abdominal model.

Design—Evaluation study.

Sample Population—8 experienced and 25 novice individuals.

Procedures—Novice participants were randomly assigned to control (n = 10) and training (15) groups. Individuals in the experienced and novice training groups were required to undergo 2 training sessions with a canine abdominal model. Basic laparoscopic skills were assessed twice on the basis of 3 tasks included in the McGill Inanimate Simulator for Training and Evaluation of Laparoscopic Skills (MISTELS).

Results—For the novice training group, laparoscopic skills scores were significantly higher after training than before, but for individuals in the novice control group, scores did not differ significantly between the first and second assessments. The increase in score for the novice training group was significantly higher than increases for the experienced group and for the novice control group, but the increase in score for the experienced group was not significantly different from the increase in score for the novice control group.

Conclusions and Clinical Relevance—Results suggested that basic laparoscopic skills scores obtained with the MISTELS were associated with extent of laparoscopic experience and that training with a canine abdominal model could increase skills scores for individuals without previous laparoscopic experience. (J Am Vet Med Assoc 2010;236:1079–1084)

Laparoscopic surgery has become well established as a diagnostic and treatment modality in veterinary medicine. Benefits of this minimally invasive technology include high diagnostic accuracy and shorter recovery times and a decreased requirement for analgesic drugs, when compared with traditional open surgical procedures.1–3 Several laparoscopic and laparoscopic-assisted techniques for various clinical applications in dogs and cats have recently been described,4–11 and advanced laparoscopic surgical techniques, including intraperitoneal suturing and needle clipping, have been used clinically in horses11–13 and dogs.7

In human laparoscopic surgery, serious surgical complications, such as injuries to the common bile duct during laparoscopic cholecystectomy, have been attributed to inexperience on the part of the surgeon.15 The American College of Surgeons concluded several years ago that simulation practice for surgeons is necessary to increase the safety of patients undergoing laparoscopic procedures,16 and a number of recent studies17–28 evaluating various laparoscopic training and assessment modalities, including the use of simulation training for surgeons, have been published.

The MISTELS is a system that was developed and validated for training in and assessment of a set of basic laparoscopic skills.15,18,25–28 This system has been incorporated into the FLS program, which provides surgeons, surgery residents, and fellows in human medicine an opportunity to acquire fundamental laparoscopic skills and to test their proficiency in those skills in a scientifically accepted format.29 To date, this type of training opportunity has not been available for veterinarians, and the current literature reflects a relative paucity of information related to training and assessment of laparoscopic skills among veterinary surgeons. At our institution, we have initiated a laparoscopic skills training program...
laboratory with the long-term goal of developing and validating a skills training program for veterinary surgeons. The objectives of the study reported here were to determine whether scores for basic laparoscopic skills, assessed with the MISTELS system, were significantly associated with the extent of laparoscopic experience of veterinary surgeons and to compare basic laparoscopic skill scores obtained by experienced veterinary surgeons and inexperienced individuals before and after 2 laparoscopic training sessions incorporating a canine abdominal model. We hypothesized that basic laparoscopic skill scores would significantly increase with training for both experienced veterinary surgeons and novice individuals.

Materials and Methods

Study subjects—The study protocol was approved by the Washington State University Institutional Review Board. Veterinary students in the preclinical years of their education (years 1 through 3) with no or minimal exposure to or experience in VS were recruited to participate in the study (novice group) on a voluntary basis. A call for a maximum of 30 participants was made, and the volunteers were divided randomly, by lottery, into a novice control group and a novice training group. A similar call for volunteers was made within our institution for ACVS board-certified small animal or equine surgery specialists, for individuals who either had completed or were in the final year of a 3-year small animal or equine ACVS residency program, and for other veterinarians at our institution with experience (> 2 years) performing laparoscopic surgery in clinical practice.

All subjects enrolled in the study provided informed consent prior to their participation and completed a questionnaire requesting information on gender, age (20 to 30 years, 31 to 40 years, > 40 years), dominant hand, VS experience, and video game experience. Videoendoscopic surgical experience was determined by use of a VAS consisting of a 100-mm-long line with qualifiers partially based on previously used experience levels at 0 mm (novice), 50 mm (have performed 5 to 10 VS procedures as primary surgeon), and 100 mm (ACVS diplomate with regular weekly to monthly experience) for at least 3 years. Video game experience was determined with a similar VAS consisting of a 100-mm-long line with qualifiers at 0 mm (none), 50 mm (have occasionally played video games within the past 3 years or have regularly [daily to weekly] played video games ≥ 5 years ago but not within the past 5 years), and 100 mm (daily to weekly video game play within the past 3 years). For both VASs, participants were asked to place a mark on the line indicating their level of experience. Scores were calculated by measuring the distance (mm) from the 0-mm qualifier to the mark; potential scores ranged from 0 to 100.

Basic skills assessment—For participants enrolled in the study, basic laparoscopic skills were assessed by use of 3 exercises selected from MISTELS: pegboard transfer, pattern cutting, and ligature loop application on a foam appendix. The 3 exercises were chosen based on the basis of skills used in current clinical practice; intra- and extracorporeal suturing are skills that are currently relatively infrequently used in clinical veterinary surgery and therefore may not have related well to VS experience of study participants and were excluded. The assessments were performed in a portable laparoscopic video trainer connected to a laptop computer. All skills assessments were overseen by an individual who recorded the following details: time, pegs dropped outside the visual field, area outside and inside the circle, and distance of the ligature loop from mark.

Prior to the skills assessment, each participant was required to watch 3 video clips that demonstrated the tasks and to read the accompanying instructions. If a participant had questions about the tasks or instrumentation, the observer would answer these questions immediately prior to the skills assessment. However, once the assessment had started, no further communication or questions were allowed. Up to 5 minutes of instrument handling outside the video trainer was allowed prior to the skills assessment.

For the pegboard transfer task, the participant was required to use a laparoscopic, 3-mm grasping forceps in the nondominant hand to individually transfer 6 pegs from a pegboard to a laparoscopic needle holder held in the dominant hand, place them on a second pegboard, and then reverse the entire exercise (Figure 1). The task was scored on the basis of time (seconds) for completion, with a 300-second cutoff time and a penalty for pegs dropped outside the view of the camera (ie, score = 300 – time for completion of task – [10 × number of dropped pegs]). If time exceeded 300 seconds, the exercise was stopped and a score of 0 assigned. Pegs dropped inside the visual field were not penalized other than the added time required to pick up the peg with the instrument that dropped it and to complete the exercise. If a peg was dropped outside the field, it was returned by the observer to the original peg pin, and the participant was required to repeat the exercise for this peg.
For the pattern-cutting task, the participant was required to cut a 4-cm-diameter circle that was marked on a 10 × 15-cm piece of instrument-wrapping material suspended between alligator clips. With laparoscopic grasping forceps held in the nondominant hand placing the material under tension, the participant used laparoscopic scissors in the dominant hand to cut the pattern (Figure 2). The task was scored on the basis of time (seconds) for completion, with a 300-second cutoff time and a penalty determined according to the percentage area that the cut pattern deviated from the marked circle (ie, score = 300 – time for completion – percentage deviation from marked circle). If time exceeded 300 seconds, the exercise was stopped and a score of 0 assigned.

For the ligature loop placement task, the participant was required to place a ligature loop of size 0 polymerized caprolactam pretied with a 4S modified Roeder knot to produce a 10-cm-diameter loop over a mark indicated on a foam appendix (Figure 3). The task was scored on the basis of time (seconds) for completion, with a 180-second cutoff time and a penalty based on the distance in millimeters of the loop away from the mark (ie, score = 180 – time to completion – distance from mark). If time exceeded 180 seconds, the exercise was stopped and a score of 0 assigned.

The total skills assessment score for each participant was calculated by one of the authors (BAF) after completion of the testing. The final score was obtained by normalizing the raw score to an expert score. The timing and error for the expert score have been previously presented. The total score was the mean of the 3 task scores. Thus, a normalized total score of 100 theoretically entailed an “expert level” or a skill level that was equivalent to 100% likelihood of passing the FLS certification examination for the 3 tasks assessed in the present study. For all participants, all tasks were overseen and documented by a single observer. The results were not provided to the observer or study participants.

Simulation training sessions—Individuals in the novice group were randomly assigned to a training or control group. All individuals in the novice training group as well as all individuals in the experienced group underwent simulation training. Simulation training consisted of 3 exercises performed twice with the MESI canine abdominal model and standard operating-grade laparoscopic equipment and instruments. Participants used both hands for instrument manipulation; the laparoscope was positioned on a laboratory stand. Completion of the 2 training sessions was separated by a minimum interval of 48 hours with a maximum interval of 7 days between sessions. The maximum time allowed for each training session was 45 minutes. A training time was scheduled for the novice training group, to ensure all individuals opportunity to train. This group had in-suite technical assistance, and training sessions were monitored to ensure that training time was not exceeded. For the experienced group, a similar schedule was not possible owing to concurrent clinical activities, and information on date and duration of simulation training were self-reported by individuals in the experienced group to the authors.

The first training exercise required ligation of a 25-mm-wide, 100-mm-long Penrose drain, adhered at 1 end with a hook and loop fastener to the spleen of the MESI model, mimicking an appendix. The Penrose appendix was marked with a target for application of the ligature loop. The participant ligated the drain appendix on the target with a ligature loop of size 0 polymerized caprolactam pretied into a 4S modified Roeder knot with a loop size of 10 cm.

The second training exercise required cutting along a pattern marked both in a longitudinal and in a circumferential fashion on the same Penrose drain used for the first training exercise.

The third training exercise required sequential grasping and manipulation of the MESI intestine. The model intestine was sequentially marked with the letters A through Z on the mesenteric and antimesenteric surfaces at 100-mm intervals from the duodenum to the ileum. The participant was required to manipulate the bowel until all letters had been clearly visualized on the screen in consecutive order.
Reassessment of basic laparoscopic skills—For individuals in the novice training group and in the experienced group, basic laparoscopic skills were reassessed within 48 hours after the second training session. However, training as a warm-up exercise prior to testing was not allowed. For individuals in the novice control group, basic laparoscopic skills were reassessed at the same time as the novice training group (ie, within 7 days after the previous assessment).

Statistical analysis—Descriptive statistics were calculated for continuous data and are provided as median and IQR (ie, 25% to 75% percentile). Differences in demographic variables and scores between all 3 groups (ie, novice control, novice training, and experienced groups) before and after training were analyzed by use of a Kruskal-Wallis ANOVA. For variables where differences were detected between groups, results were pairwise compared by use of a Wilcoxon rank sum test, whereas paired comparisons (ie, scores before and after training) were performed by use of a Wilcoxon matched pairs signed rank test. A Bonferroni procedure with adjusted significance level to 0.0167 (0.05/3) was used to detect differences between groups. The Spearman correlation procedure was used to determine whether the basic laparoscopic skills score was significantly associated with VS experience score or video game experience score. All analyses were performed with standard software.1 Values of P ≤ 0.05 were considered significant for ANOVA and correlation testing.

Results

Novices—A total of 25 individuals volunteered and were enrolled in the novice group, of which 15 were assigned by name lottery to the novice training group and 10 were assigned to the novice control group. The novice training group consisted of 3 males and 12 females; the novice control group consisted of 4 males and 6 females. All individuals in the novice group were in year 1 or 2 of the veterinary curriculum and they were all 20 to 30 years old. Twenty-three of the 25 individuals in the novice group were right-handed; 1 person each in the novice training and novice control groups was left-handed.

Experienced—Eight individuals were enrolled in the experienced group, including 5 individuals board-certified by the ACVS (2 small animal surgeons and 3 equine surgeons), 1 individual who had completed a 3-year small animal surgery residency program, 1 individual in the third year of a small animal surgery residency program, and 1 diplomate of the American College of Veterinary Internal Medicine who had previous extensive (> 2 years) experience performing laparoscopic ovariohysterectomy and laparoscopic diagnostic procedures in an urban general practice with a high case volume. The experienced group consisted of 3 males and 5 females. Seven of the 8 individuals in the experienced group completed the training and both assessments. One individual had conflicting clinical commitments that interfered with participation in the training and follow-up assessment, and this person was excluded from the analysis. There were no significant differences in gender distribution between the novice training and novice control groups or between the novice and experienced groups. No one in the experienced group was < 30 years old. Five individuals in the experienced group were between 30 and 40 years old, and 3 were > 40 years old. Individuals in the experienced group were all right-handed. The median VS experience score was 0 (0 to 3) for individuals in the novice control group, 0 (0 to 0) for individuals in the novice training group, and 74 (66 to 79) for individuals in the experienced group. Median video game experience score was 20 (3 to 33) for individuals in the novice control group, 30 (10 to 65) for individuals in the novice training group, and 9 (7 to 18) for individuals in the experienced group. Videodendoscopic surgery and video game experience scores did not differ significantly between the novice control and novice training groups. Videodendoscopic surgery experience was significantly higher in the experienced group (P < 0.001), but video game experience did not differ between the novice and the experienced groups (P = 0.08).

Prior to VS training sessions with the MISTELS by individuals with (experienced group; Table 1) VS experience. For each of the 3 VS tasks (pegboard transfer, P = 0.001; pattern cutting, P < 0.001; ligature loop placement, P = 0.003) and total laparoscopic skills scores (P < 0.001) differed significantly between the novice and experienced groups. For individuals in the novice training group, total laparoscopic skills scores and scores for each of the 3 VS tasks were significantly higher after training, compared with scores obtained prior to training (Table 1). For individuals in the experienced group (n = 7), total laparoscopic skill scores (P = 0.016) and scores for the pattern-cutting task (P = 0.016) were significantly higher after training, compared with scores

Table 1—Scores for basic laparoscopic skills obtained for 3 tasks included in the MISTELS by individuals with (experienced group; n = 8) and without (novice control group [10] and novice training group [15]) VS experience.

<table>
<thead>
<tr>
<th>Task</th>
<th>Novice control</th>
<th>Novice training</th>
<th>Experienced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peg transfer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First assessment</td>
<td>0 (0–0)</td>
<td>0 (0–0)</td>
<td>36 (8–50)*</td>
</tr>
<tr>
<td>Second assessment</td>
<td>0 (0–3)*</td>
<td>46* (27–52)</td>
<td>0 (38–66)*</td>
</tr>
<tr>
<td>Pattern-cutting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First assessment</td>
<td>30 (22–50)*</td>
<td>16 (4–29)*</td>
<td>61 (55–81)*</td>
</tr>
<tr>
<td>Ligature loop placement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First assessment</td>
<td>39 (0–44)*</td>
<td>29 (0–57)*</td>
<td>99 (78–109)*</td>
</tr>
<tr>
<td>Second assessment</td>
<td>52 (26–74)*</td>
<td>100* (83–106)*</td>
<td>75 (120–131)*</td>
</tr>
<tr>
<td>Total</td>
<td>24 (12–32)*</td>
<td>14 (10–21)*</td>
<td>53 (40–72)*</td>
</tr>
<tr>
<td></td>
<td>32 (16–41)*</td>
<td>63* (42–65)*</td>
<td>83* (68–91)*</td>
</tr>
</tbody>
</table>

Data are given as median (IQR [25% to 75%]); raw scores were normalized by calculating them as a percentage of the score associated with a 100% pass rate for the FLS certification examination. Scores were assessed before and after 2 training sessions with a canine abdominal simulator (experienced group and novice training group) and 7 days apart (novice control group). For the experienced group, only 7 individuals completed the second assessment. *Significantly (P < 0.05) different from value obtained at the first assessment.

**In each row, values with different superscript letters were significantly (P < 0.05) different.
obtained prior to training. For individuals in the novice control group, laparoscopic skills scores did not differ significantly between the first and second assessments.

The increase in the total laparoscopic skills score for the novice training group was significantly higher than the increase for the experienced group ($P = 0.012$) or for the novice control group ($P = 0.002$). Scores for the peg-board transfer task ($P < 0.001$) and ligature loop placement task ($P = 0.015$) and total laparoscopic skills scores ($P = 0.004$) obtained by the novice training group after training were significantly higher than scores obtained during the second assessment for the novice control group. Scores for the pattern-cutting task ($P = 0.002$) and for the ligature loop placement task ($P = 0.012$) obtained after training were significantly higher for the experienced group than for the novice training group.

Total laparoscopic skills scores and scores for each of the 3 tasks after training for the experienced group were significantly higher than scores obtained during the second assessment for the novice control group. However, the increase in total scores for the experienced group was not significantly different from the increase in total scores for the novice control group.

There was a moderate positive association ($r = 0.59; P < 0.001$) between initial total laparoscopic skill score and VS experience score. There was no significant association between initial total laparoscopic skill score and video game experience score ($r = –0.33; P = 0.07$).

**Discussion**

Results of the present study suggest that 3 tasks from the MISTELS could be used to assess basic laparoscopic skills in experienced veterinary surgeons and inexperienced veterinary students at our institution, and that basic laparoscopic skills could be improved with simulation training. Scores for the novice training group in the present study improved significantly more than did scores for the experienced group, and the increase in total laparoscopic skills score for the experienced group was not significantly different from the increase for the novice control group, which did not undergo simulation training. It has previously been reported that even without training, reassessment of laparoscopic skills will yield higher scores the second time. This is likely a result of familiarity with the instruments and testing methods on repeated assessment.

We speculate that there may be several reasons for the less dramatic training effect for the experienced participants in the present study, compared with the novice participants that underwent simulation training. Individuals in the experienced group had significantly higher baseline scores for each individual task and significantly higher total scores than individuals in the novice training and novice control groups. Therefore, greater training time and effort would likely have been required to see the same level of improvement as was seen for participants that had no familiarity with the equipment at the beginning of the study. Standard laparoscopic surgery instruments were used during assessments, and all of the experienced participants had used similar equipment prior to initiation of the study. Thus, the experienced group did not get the benefit of a rapid score increase associated with highly increased instrument familiarity. However, it was beyond the scope of the present study to determine the reasons for improvement in each group.

The moderate association between VS experience score and initial basic laparoscopic skills score in the present study may encourage further investigation of the use of this type of skills assessment in veterinary surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery. A number of previous studies have found that results of MISTELS testing relate to clinical surgery.

In the present study, we did not detect any association between video game experience and laparoscopic skills score. This is in contrast to findings of a recent study, in which a high correlation was reported for surgeons and surgery residents in the human medical field. In that study, video game play $> 3$ hours per week led to fewer errors and faster completion of laparoscopic suturing. Future studies may shed more light on the question of whether video game play benefits veterinary laparoscopic surgeons.

The present study had several limitations. The number of participants was small, especially in the experienced group. Only 2 training sessions were allowed, and the 45-minute time limit for training sessions was not strictly enforced. It is possible that individuals in the experienced group elected to adhere less rigorously to the 45-minute training time than did individuals in the novice group. However, any effect of this on the results cannot be determined. Future studies in this area should involve a larger number of experienced and inexperienced individuals, as well as strict adherence to all aspects of the study protocol. Further investigations of laparoscopic training methods for veterinary surgeons are suggested.

a. Laptrainer with SimuVision, Simulab Corp, Seattle, Wash.
b. Dissecting and grasping forceps, Karl Storz Veterinary Endoscopy, Goleta, Calif.

c. Koh Macro Needle Holder, 33 cm, jaws curved left, Karl Storz Veterinary Endoscopy, Goleta, Calif.
References


