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Evaluation of Laparoscopic Performance with Alteration in Angle of Vision

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ABSTRACT

***Background and Purpose*: Optimal placement allows intuitive laparoscope positioning between two working trocars (0° angle). However, this configuration may require the assistant to operate in an awkward position. We evaluated the effect of alteration of laparoscope position on surgeon performance and correlated this with surgical experience.**

***Subjects and Methods*: Participants were stratified by laparoscopic experience. Group 1 (N = 10) was naïve (no surgical experience), group 2 (N = 7) had moderate laparoscopic experience (1–100 cases), and group 3 (N = 6) was laparoscopically experienced (>100 cases). Participants were timed performing a simple laparoscopic task three times in a trainer with camera angles randomized along the horizontal plane: 0°, 45°, 90°, 135°, and 180°.**

***Results*: All participants showed progressive deterioration in performance as the angle deviated from baseline. The mean time required to complete the tasks was significantly higher for group 1 *v* groups 2 and 3 at 135° (158 *v* 77 and 73 seconds) and 180° (153 *v* 89 and 86 seconds). Performance curves for each group revealed more pronounced deterioration of performance with alteration in the angle of vision in group 1 than in groups 2 and 3 ($P < 0.01$). There was no difference between groups 2 and 3 ($P = 0.19$).**

***Conclusions*: Even modest alteration in laparoscopic perspective results in deterioration of performance for all levels of surgical experience. Experienced laparoscopists adapt more quickly to complexities presented by alteration in camera angles. Novice surgeons should focus on trocar positioning to maintain intuitive surgical perspective and should refrain from working with alterations in camera angles until significant laparoscopic experience has been gained.**

INTRODUCTION

HUMAN ANATOMY demands that traditional open surgical procedures be performed with the surgeon's visual field (eyes) directly between his/her hands. In contrast, the visual field and angle of vision during laparoscopic and endoscopic surgery can be altered by the position of the endoscope. Optimal trocar placement during laparoscopy typically places the camera trocar between the two working instruments to simulate the standard 0° angle of vision characteristic of open surgery and allows intuitive tissue manipulation. However, the 0° angle of vision can also be challenging, as the laparoscopic assistant is sometimes forced to operate in awkward and uncomfortable positions. As a result, alternative laparoscope positions have been suggested, such as to position the laparoscope outside the working trocars along either the vertical or the horizontal axis. Such alternative perspectives can significantly alter the appearance of the field.

Previously, Hanna and colleagues[1] evaluated the effect of axis-to-target alterations in perspective on surgical task performance. Patil and coworkers[2] demonstrated that alteration in the optical angle of the endoscope and the instrument plane resulted in deterioration of surgical performance. Similarly, Emam and associates[3] demonstrated reduced performance and increased muscle work and fatigue with a 30° alteration in the angle of vision. To date, however, the effects of sequential alteration in the horizontal axis of vision on task performance have not been evaluated.

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TABLE 1. STUDY PARTICIPANTS

Group	*Laparoscopic experience*	*Description*	N
1	None	Surgically naïve	10
2	1–100	Moderately experienced	7
3	>100	Experienced	6

We studied the effect of alteration of laparoscope position along the horizontal axis on surgeon performance in an *in-vitro* model. Additionally, we stratified the data by surgical experience to determine how alterations in the angle of vision differentially impacted the performance of surgeons with different levels of laparoscopic experience.

SUBJECTS AND METHODS

Twenty-three participants with different levels of surgical experience were incorporated into the study. Participants were stratified into three groups according to their laparoscopic surgical experience (Table 1). Participant data collected also included handedness and measures of manual dexterity with two- and three-dimensional task performance. Specific questions included video-game experience and experience with tasks requiring significant manual dexterity (playing an instrument, sewing, or model building).

Participants were timed performing a simple *in-vitro* laparoscopic task in a trainer box: placing a ring on a peg. Each participant performed the task three times for each angle, and the time required was recorded with the horizontal camera angle of vision at 0° (baseline), 45°, 90°, 135°, and 180° (mirror image), as depicted in Figure 1. The sequence of event performance with the different angles of vision was randomized for each participant.

The trainer box and other equipment used was manufactured by Karl Storz (Tuttlingen, Germany). A 0° laparoscope was used in each case, and each participant was given Maryland graspers to perform the task. The horizontal angle of vision was established by placing the laparoscope through the appropriate defect in the trainer box and anchoring the instrument and camera with an Adjustable Laparoscopic Holder (Fig. 1). The vertical angle of vision was fixed at 45° in all cases. The working instruments were fixed in position 25 cm apart with the target being located 30 cm from the middle of the trocars.

As the data were normally distributed, we used the repeated-measures ANOVA technique to test the angle effect, case group effect, and interaction effect of angle and case group. We employed the mixed-model technique to quantify the magnitude of angle effect, case group effect, and interaction effect.

RESULTS

All participants showed deterioration in performance as the angle of vision deviated from baseline (0°). Although the mean performance time for group 1 (inexperienced) was higher than that for groups 2 (moderate) and 3 (experienced) at 0°, 45°, and 90°, the difference was not statistically significant (Fig. 2). The mean time required to complete the tasks was significantly higher for group 1 than for groups 2 and 3 at 135° (158 *v* 77 and 73 seconds) and 180° (153 *v* 89 and 86 seconds). The performance curve for each group (as demonstrated by the slope of each line in Figure 3) reveals that deterioration of performance with alteration in angle of vision was more pronounced in group 1 than in groups 2 and 3 ($P < 0.01$). There was no

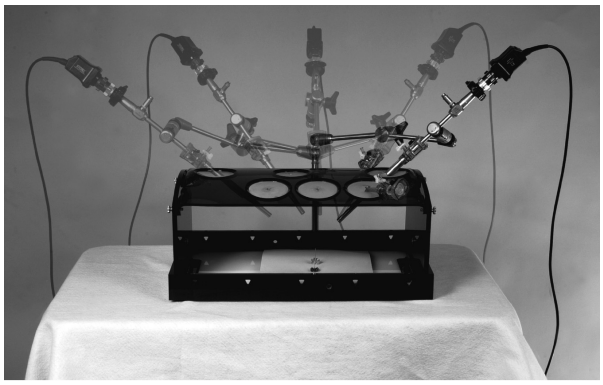

FIG. 1. Experimental configuration. Horizontal angle of laparoscope in relation to surgeon was changed randomly from 0° (baseline) through 180°.

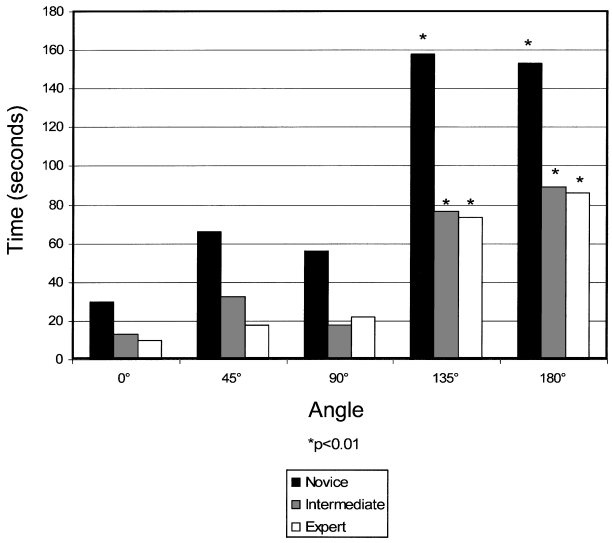

FIG. 2. Time required to complete task at each angle (raw data).

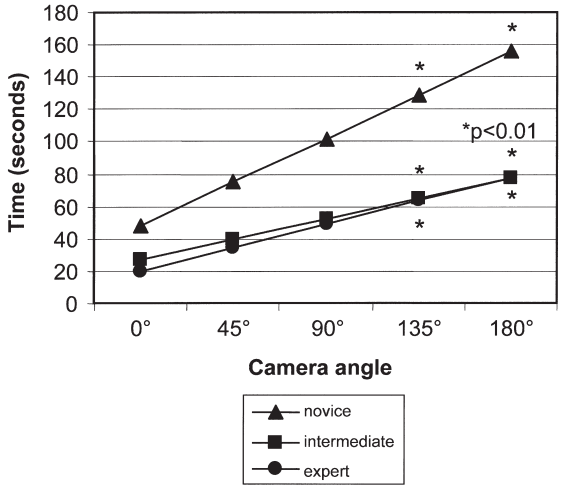

FIG. 3. Model of performance and deterioration according to surgeon experience. Slope of each line represents performance curve for subjects in group.

difference between groups 2 and 3 ($P = 0.19$). There was no difference among the groups in terms of left or right handedness or the frequency of hobbies involving manual dexterity.

DISCUSSION

Others have reported that the angle between trocars for working instruments plays on the ergonomic position of the surgeon, especially in procedures such as appendectomy, where the general surgeon may be required to reach across the patient's midline in order to operate.[4] The authors reported that of the three trocar configurations evaluated, the most ergonomically beneficial allowed at least a 60° angle between working trocars. However, all three of the authors' configurations involved the laparoscope being outside the working field. In a Letter to the Editor regarding this study,[5] it was suggested that an improvement in ergonomics is achieved when the optical axis (laparoscope) is placed between the two working axes instead of outside the "working angle." Patil and colleagues[2] evaluated the effects of changes in the vertical axis of the endoscope and the instrument plane and found that significant changes resulted in deterioration of surgical performance as the laparoscope moved away from baseline along the vertical plane. In contrast, we evaluated surgical performance with optical changes as the laparoscope moves along the horizontal plane. However, there is a paucity of peer-reviewed literature on the objective impact that changes in the horizontal angle of the camera in relation to the working instruments will have on the surgeon, whether novice or experienced. In the current study, we demonstrated that even modest alteration in laparoscopic perspective results in deterioration of performance for all levels of surgical experience.

The extent of surgical experience was an important factor in the extent of deterioration of surgical performance in this study. Experienced laparoscopists were able to adapt more quickly to alteration in camera angles than were novice surgeons. This is likely the result of practice in the interpretation of a two-dimensional image (as seen on the video screen) in relation to the known three-dimensional anatomy of the abdomen.

Although alteration in the angle of vision will clearly result in deterioration of performance, it should be noted that all procedures in the current study were performed with a 0° lens. For minor changes in camera position, an experienced camera driver will likely be able to help the surgeon compensate by using the optimal angle of rotation of the lens. This parameter was not evaluated in the current study.

CONCLUSION

Even modest alteration in laparoscopic perspective results in deterioration of performance for all levels of surgical experience, although experienced laparoscopists adapt more quickly to alterations. As such, surgeons should strive for an intuitive positioning of laparoscopic trocars, with the "eyes" (i.e., the laparoscope) between the two "hands" (i.e., the working instruments). Intuitive optical trocar positioning is particularly important for sugeons early in their laparoscopic experience.

REFERENCES

1. Hanna GB, Cushieri A. Influence of the optical axis-to-target view angle on endoscopic task performance. Surg Endosc 1999;13:371–375.
2. Patil PV, Hanna GB, Cushieri A. Effect of the angle between the optical axis of the endoscope and the instruments' plane on monitor image and surgical performance. Surg Endosc 2004;18:111–114.
3. Emam A, Hanna G, Cushieri A. Comparison of orthodox vs off-optical axis endoscope manipulations. Surg Endosc 2002;16:401–405.
4. Kollmar O, Z'graggen K, Schilling MK, Buchholz BM, Büchler MW. The suprapubic approach for laparoscopic appendectomy. Surg Endosc 2002;16:504–508.
5. Ng WT, Sze SY, Hui SK. Port placement for laparoscopic appendectomy with the best cosmesis and ergonomics. Surg Endosc 2003;17:166–167.

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