OPEN

Analysis of the Positional Relationship Among the Operator, Camera, and Monitor: Overcoming the Difficulties of Mirror-image Conditions During Laparoscopic Surgery

Yuriko Inagaki, MD, Kazushige Kawai, MD, PhD, Takeshi Nishikawa, MD, PhD, Hiroaki Ishii, MD, PhD, Shigenobu Emoto, MD, PhD, Koji Murono, MD, PhD, Manabu Kaneko, MD, PhD, Kazuhito Sasaki, MD, PhD, Hiroaki Nozawa, MD, PhD, and Soichiro Ishihara, MD, PhD

Background: Although methods to overcome difficulties associated with mirror-image conditions have been investigated, the ideal spatial relationship among the operator line of sight, monitor location, and camera location remains unclear. Moreover, the best training method for improving laparoscopic surgical skills under varying operator line of sight, camera, and monitor positions is unknown. We aimed to investigate the role of laparoscopic training under mirror-image conditions in improving surgical efficiency and whether prior surgical experience affects such training.

Methods: This prospective study was conducted at the Department of Surgical Oncology, Tokyo University, Japan. Twenty-five surgeons participated. Novice (n = 14), trained (n = 7), and expert (n = 4) participants performed the simulated task in a box trainer while varying the positional relationships among the surgeons, camera, and monitor. Five patterns were repeatedly performed 5 times per day for 4 days over 2 weeks.

Results: The most significant differences in terms of the time required to complete the task under mirror-image conditions among the 3 groups were on day 1 (novices: 185.8 s, trained: 79.7 s, and experts: 46.5 s, $P = 0.009$). However, after 4 days of training, the corresponding times did not differ among the 3 groups (26.0, 30.7, and 23.1 s, respectively; $P = 0.415$). Laparoscopic training was sufficiently effective under mirror-image conditions.

Conclusions: Mirror-image surgical conditions provided the most difficult setting, because surgeons and assistants often became disoriented, and task performance was most degraded. However, just 4 days of training was found to be sufficient to overcome the difficulties encountered while performing laparoscopic procedures under mirror-image conditions.

Key Words: laparoscopic training, mirror-image, colorectal cancer, training method

(*Surg Laparosc Endosc Percutan Tech* 2021;31:513–518)

Received for publication January 26, 2021; accepted March 17, 2021.

From the Department of Surgical Oncology, Faculty of Medicine, University of Tokyo, Tokyo, Japan.

The authors declare no conflicts of interest.

Reprints: Yuriko Inagaki, MD, Department of Surgical Oncology, University of Tokyo Hospital, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan (e-mail: yokomizo-sur@h.u-tokyo.ac.jp).

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website, www.surgical-laparoscopy.com.

Laparoscopic surgery is increasingly being used to treat colon cancer.[1,2] Patient short-term outcomes after laparoscopic resection for colorectal cancer are better than those after conventional open resection, with less blood loss and postoperative pain as well as shorter hospital stays and faster recoveries. Moreover, randomized trials of colon cancer treatments have shown that performing laparoscopic surgery in lieu of open surgery does not reduce overall survival or disease-free interval rates.[3–8]

However, performing laparoscopic surgery remains technically difficult because it requires special skills using unfamiliar devices and is performed while the surgeon or assistant observes a video monitor with little tactile feedback and limited freedom of movement afforded by the fixed trocars. One of the challenges of laparoscopic surgery is that a surgeon or assistant may encounter a situation in which his/her line of sight does not align along the same axis as that of the camera and monitor; this can render coordination during the surgery difficult. For example, if the surgeon and assistant observe the monitor in front of them during parts of the procedure involving the rectum, they encounter circumstances in which the camera and working instruments are not aligned along the same axis.

The ideal situation is achieving a coaxial image, and the worst is that the camera is placed on the surgeon's or assistant's opposite side to create a mirror image (reverse alignment; ie, a paradoxical viewpoint).

There are at least 2 methods that can be used to overcome the problems associated with mirror-image situations. The first is related to device use; for example, Tokunaga et al[9] suggested that a Broadview camera system installed just above the experimental table and capable of providing a wider view of the internal organs during laparoscopic surgery could improve surgeons' performance under mirror-image conditions. Gill et al[10] also suggested that rotating the view of the monitor for the assistant by 180 degrees (left-right reversed and upside-down image) with an image converter or by turning the camera by 180 degrees improves task performance in mirror-image situations.

However, devices required for this type of solution are expensive, which limits their general use in laparoscopic surgery. The second method to overcome problems associated with mirror-image conditions is to provide adequate training for these situations. However, there has been no uniform methodology for providing such training to date.

Hwang et al[11] suggested that participation in 30 to 40 laparoscopic colorectal surgeries is needed for the surgeon

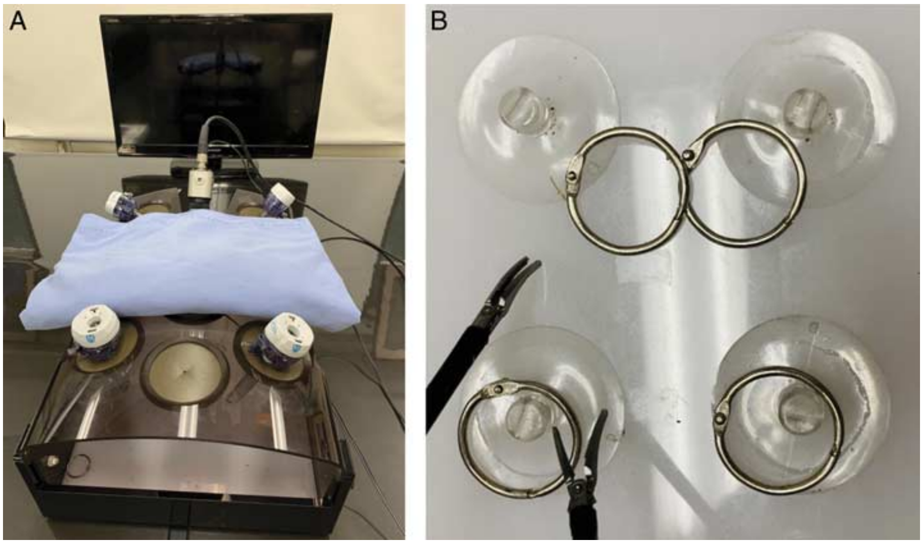

FIGURE 1. A photograph of the laparoscopic box trainer. A, The laparoscopic box trainer. B, A representation of the training system. The participants hooked 4 metallic rings onto 4 plastic stakes in the square shape by manipulating the laparoscopic instruments.

and assistant to gain adequate surgical skills for working with a mirror image. Moreover, Gould et al[12] suggested that acquiring surgical skills when working with mirror images could improve with laparoscopic experience and training with mirror-image conditions.

However, there have been no investigations of the suboptimal spatial relationship between the surgeon's line of sight and the direction of the camera, location of the monitor with respect to the surgeons and assistants, and the best training method for improving laparoscopic surgical skills while varying the alignments of the surgeon's line of sight, camera, and monitor.

Previous studies have only showed that expert laparoscopic surgeons perform better than nonexpert surgeons when working off the laparoscope viewing axis. The effects of surgical skills training under mirror-image conditions with varying laparoscopic surgical skills and experience have not been explored.

Hence, we developed a "training box" model for sigmoidectomy or anterior resection (ie, left-sided colorectal surgery) to standardize the operative procedure. We then performed this study to investigate the influence of laparoscopic training under mirror-image conditions on surgical efficiency and explored whether prior laparoscopic operative experience influences the outcomes of training under these varying conditions.

PARTICIPANTS AND METHODS

Participants

Twenty-five surgeons who were used at the Department of Surgical Oncology in April 2019 at the Tokyo University participated in this study. The "novice" ($n=14$), "trained" ($n=7$), and "expert" ($n=4$) groups included participants with postgraduate year experiences of ≤ 10, >10 and ≤ 20, and >20 years, respectively.

Materials

All tasks were performed using the laparoscopic box trainer (Innomedics Medical Instruments Inc., Tokyo, Japan), laparoscopic forceps (Endopath, Ethicon Endo-Surgery, Tokyo, Japan), a monitor (LED Aquos, LC-24K9; Sharp, Osaka, Japan), and a camera (WAT-250D2; Watec, Yamagata, Japan) (Fig. 1A).

Procedure

In the laparoscopic box trainer, the participants hooked 4 metallic rings with a diameter of 3 cm on 4 plastic stakes in a square shape (Fig. 1B). The participants could perform the procedure with either one or both hands using laparoscopic forceps. The training began by inserting the laparoscopic forceps into laparoscopic ports and ended once the fourth ring was hooked onto the last stake [see Video, Supplemental Digital Content 1, http://links.lww.com/SLE/A289, which shows the task performance of the reverse-alignment condition (pattern 2) performed with difficulty by a novice surgeon before training and without difficulty by an expert surgeon after 4 days of training].

The study task was performed with 5 patterns (based on changing the locations of the operator, camera, and monitor) as follows (Figs. 2, 3):

In pattern 1, participants stood in front of a monitor and on the same side of the camera; this corresponded with abdominal laparoscopic left-sided colorectal surgery procedures under coaxial imaging conditions. The surgeon stood in front of monitor 1 and on the same side of the camera (Fig. 3A).

In pattern 2, participants stood in front of a monitor and on the other side of the camera; this corresponded with abdominal laparoscopic left-sided colorectal surgery under mirror-image conditions. The assistant stood in front of monitor 2 and on the other side of the camera (Fig. 3B).

In pattern 3, participants stood in front of a monitor, and the camera was positioned to their left; this corresponded with pelvic laparoscopic left-sided colorectal surgery. The surgeon stood in front of monitor 1, and the camera was positioned on the left side of the surgeon during parts of the procedure that involved the rectum (Fig. 3C).

In pattern 4, participants stood in front of a monitor, and the camera was positioned to their right; this corresponded with pelvic laparoscopic left-sided colorectal surgery. The assistant stood in front of monitor 2 and the

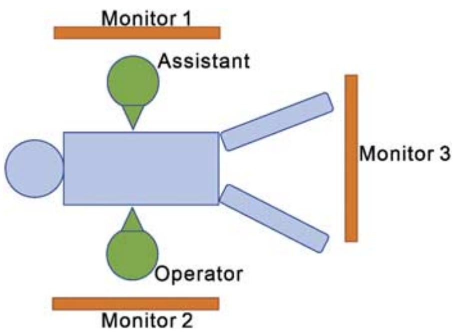

FIGURE 2. Typical setup model for laparoscopic left-sided colorectal surgery. The surgeon usually stands on the right side of the patient, and the assistant stands on the left side. The surgeon and assistant each have a monitor placed in front of them, and a third monitor is placed by the patient's legs.

camera was positioned on the left side of the surgeon during parts of the procedure that involved the rectum (Fig. 3D).

In pattern 5, participants stood on the other side of the camera while the monitor was placed on the left side of participants; this corresponded with abdominal laparoscopic left-sided colorectal surgery. The assistant stood on the left side of the patient and on the other side of the camera and observed monitor 3 that was in front of the patient's legs (Fig. 3E).

Participants practiced each pattern repeatedly 5 times and completed all of them in 1 day; this training was performed for 4 days over 2 weeks. We then calculated the average time required to complete each pattern on each day. The Institutional Review Board approved this study (2019060NI), and all participants provided informed consent for their performance data to be used for research purposes.

Statistical Analysis

Continuous variables were compared using one-way analysis of variance. Statistical analyses were conducted using the JMP Pro software version 14 (SAS Institute Inc., Cary, NC). A P-value <0.05 was considered statistically significant.

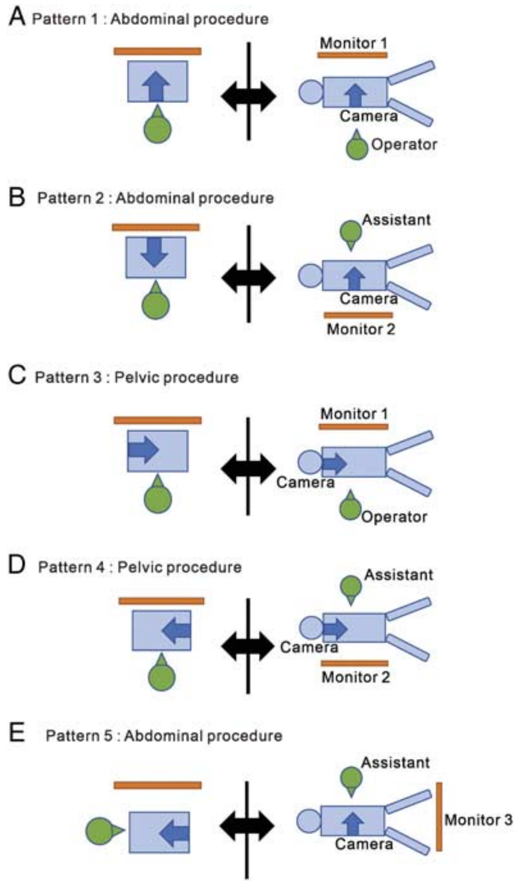

FIGURE 3. Models of training patterns 1 to 5. Setup models of training patterns 1 to 5 are shown. Figures on the left side show the training pattern models in this study as follows: orange line, monitor; light blue box, laparoscopic box trainer; blue arrow, direction of the positioned camera; and green circle/triangle, the participant. Figures in the right side show the model for laparoscopic left-sided colorectal surgery as follows: orange line, monitor (1 to 3); light blue circle and boxes, the patient; blue arrow, the direction of positioned camera; and green circle/triangle, the surgeon or assistant.

RESULTS

Table 1 shows the characteristics of the surgeons who participated in this study. The mean age of participants in the novice, trained, and expert groups were 33.5, 42, and 49.5 years, respectively. The novice group included one woman; the remainder of the participants in all groups were men. There were no left-handed participants, although the novice and expert groups each included one ambidextrous participant.

Figure 4A shows the results of training on day 1. The time required for completing pattern 1 task, which involved a coaxial image, was ~12.0 ± 1 s with no significant differences among the 3 groups ($P=0.855$). In contrast, the time required to complete pattern 2 task, a mirror-image situation, was 46.5 s for the expert group; this was ~4 times longer than the time this group required to complete pattern 1 task. The times required by the trained and novice groups to perform pattern 2 task were 79.7 and 185.8 s, respectively. The novice group required the longest time among the 3 groups ($P=0.009$), taking ~14 times longer than they needed to complete pattern 1 task.

The average times required to complete pattern 3 and pattern 4 tasks were 35.2 and 29.1 s, respectively. Although the subjects were predominantly right-handed, the times required to complete pattern 3 and 4 tasks were ~2.3 to 2.5 times as that required to complete pattern 1 task irrespective of the symmetrical setting. The times required for performing pattern 3 and 4 tasks were not significantly different among the 3 groups ($P=0.458$ and 0.416, respectively).

The time required for completing pattern 5 task was 57.7 s for all subjects, which was half the time needed to complete pattern 2 task. In decreasing order, the times required for the novice, trained, and expert groups to complete this task were 73.8, 40.1, and 28.6 s, respectively ($P=0.020$).

Figure 4B shows the results from day 4 of performing the tasks, and Figure 5 shows the learning curve for laparoscopic surgical training over 4 days. The time for completing pattern 1 task on day 4 was ~11 s for all 3 groups, indicating no improvement over 4 days of training. The times required for each group to complete the task were not significantly different ($P=0.143$).

TABLE 1. Characteristics of Surgeons

	Novice, n = 14	Trained, n = 7	Expert, n = 4
Age (y)*	33.5 (31-39)	42 (38-43)	49.5 (45-52)
Sex			
Male	13	7	4
Female	1	0	0
Surgical experience, years*	7 (5-8)	14 (10-16)	22.5 (18-25)
Dominant hand			
Right	13	7	3
Left	0	0	0
Ambidextrous	1	0	1

*Median (range).

In contrast, after 4 days of training, the times required by the novice, trained, and expert groups to complete pattern 2 task decreased by 86%, 61.5%, and 50.3%, respectively (26.0, 30.7, and 23.1 s, respectively, with no significant difference among the groups; $P=0.415$). The novice group showed the most marked benefit of surgical skill training when working with mirror images among the three groups.

After 4 days of training, the times required for completing pattern 3 and 4 tasks were reduced by 26.7% and 31.6%, respectively, on an average among all groups. The effect of training was not as pronounced for pattern 3 and 4 tasks as it was for pattern 2. There were no differences among the three groups in terms of the effect of training on completing pattern 3 and 4 tasks ($P=0.210$ and 0.240, respectively).

Furthermore, after 4 days of training, there were no differences among the 3 groups in terms of the time required for completing pattern 5 task ($P=0.868$); the time required for completing pattern 5 was reduced in the novice, trained, and expert groups by 64.2%, 37.4%, and 25.5%, respectively. The novice group benefitted the most from training on pattern 5 task.

The times for completing patterns 2 and 5 tasks did not differ among the groups (novice, $P=0.791$; trained, $P=0.270$; and expert, $P=0.984$).

The times the novice, trained, and expert groups required to complete pattern 2 task on day 4 were 26.0, 30.7, and 23.1 s, respectively; the corresponding times required to complete pattern 5 were 26.4, 25.1, and 23.1 s, respectively. There were no differences among the 3 groups in terms of the time required for completing the tasks of patterns 2 and 5 on day 4 ($P=0.415$ and 0.868, respectively).

DISCUSSION

Laparoscopy-assisted colectomy was first reported in 1991,[13–15] although it is difficult to perform for transverse colon cancer; therefore, the port location and procedure with respect to transverse colon cancer vary across facilities.[16,17] In contrast, the port location and procedure when performing a sigmoidectomy or anterior resection (left-sided colorectal surgery) have now been standardized.[2,18,19]

Therefore, we studied the port position and orientations of the surgical team and monitor when performing general laparoscopic surgery for left-sided colorectal surgery, and showed the benefit of laparoscopic training under mirror-image conditions. Each participant underwent laparoscopic training involving 5 patterns in a training box for

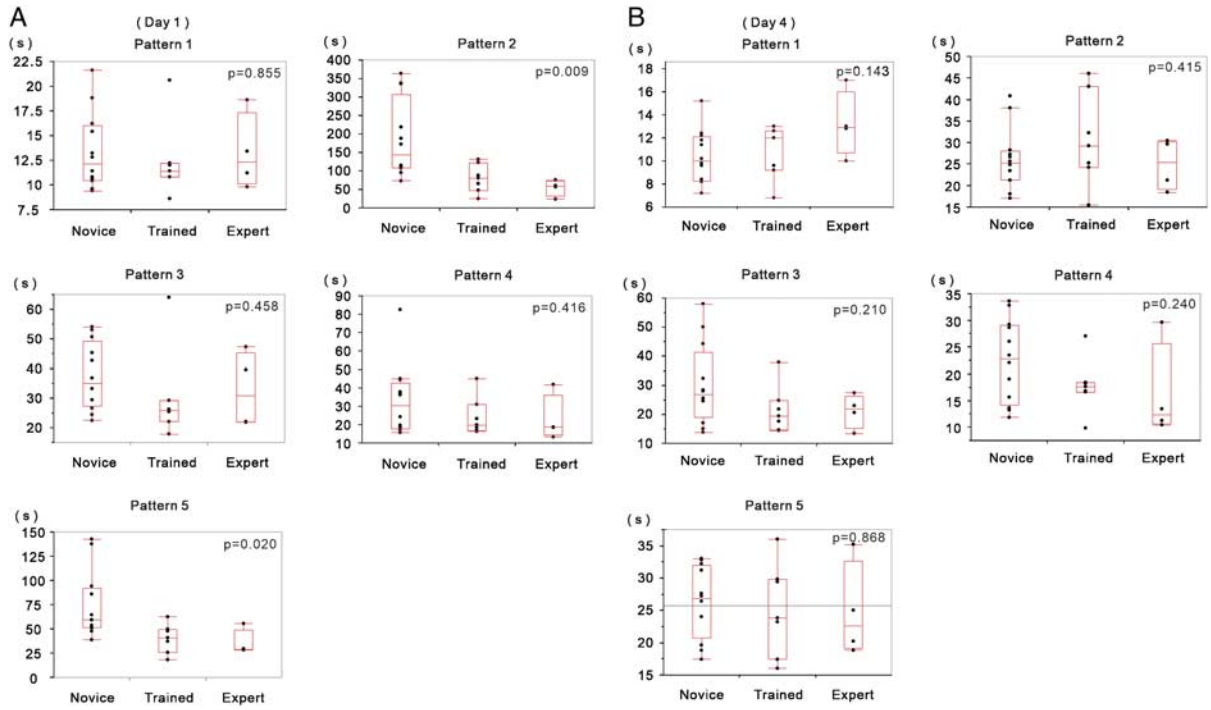

FIGURE 4. The average times for completing each task on days 1 and 4. The average times for completing tasks of patterns 1 to 5 on day 1 (A) and on day 4 (B) are shown. Black dots represent the average times, and red horizontal lines within the boxes, the boxes themselves, and the whiskers represent median, interquartile range, and range, respectively. Continuous variables were compared using one-way analysis of variance.

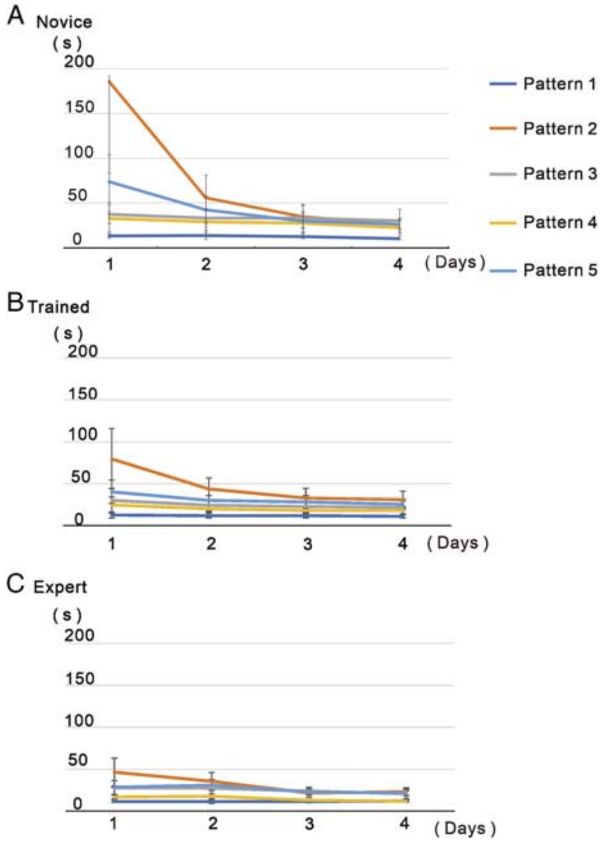

FIGURE 5. Differences in the laparoscopic training learning curves among the groups over 4 days. Learning curves for laparoscopic training undergone by the novice (A), trained (B), and expert (C) groups. Error bars represent SD.

4 days over 2 weeks. The setup was devised to simulate clinical laparoscopic surgery for sigmoidectomy or anterior resection (left-sided colorectal surgery). We found no significant differences between the times required to complete pattern 3 and 4 tasks on day 1 despite the positions of the surgical team and monitor being symmetrical. Furthermore, there were no significant differences on day 4.

Haveran and colleagues showed that the optimal setup is for the camera to be directly in front of the surgeons while the monitor is directly across from them. Alternatively, the monitor/camera could be placed opposite the surgeon's nondominant hand.[20] Emam et al[21] showed that off-optical axis manipulation is especially impaired when the camera is located on the same side as the dominant hand because the display angles are decidedly different from the actual physical angles. In contrast to prior reports, the participants in our study could use both their dominant and nondominant hands; therefore, many of them used their nondominant hand when the camera was positioned on the nondominant side. Hence, task performance may have improved when using their dominant hand.

The peg transfer task that is used in the Fundamentals of Laparoscopic Surgery course offered by the Society of American Gastroenterologic and Endoscopic Surgeons (www.flsprogram.org) is often used for laparoscopic training because it includes basic required manipulations such as grasping, moving, and releasing.[10,19,22–24] However, the simulated laparoscopic task used in this study required placing metallic rings on plastic stakes on the 4 corners of the monitor (Fig. 1). Performing the task on the 4 corners of the monitor forced a change in the angle of the forceps; therefore, participants do not make the same move when performing the same task. We posited that this model would improve the effects of laparoscopic training. Despite performing the same task under mirror-image conditions, the angles of the mirror images varied. We also considered the tasks that we designed to be adequately representative of laparoscopic training, because we simulated various abdominal situations in clinical surgery.

We found no significant differences between the times required among the 3 groups to perform pattern 1 task on day 1 despite having different levels of surgical experience. In contrast, surgeons with experience in laparoscopic procedures completed pattern 2 task (a mirror-image condition) more rapidly than did their less-experienced counterparts. Gould and Frydman[12] showed that reverse-alignment surgical skills can be improved with experience and that reverse image skills are not derived from surgical skills developed while using a video trainer with forward orientation. Haveran and colleagues showed that experienced subjects demonstrated performance that was superior to that of novice participants under all monitor/camera positions[21]; their findings were thus consistent with ours.

Pattern 5 training involves a situation in which the participants observed the monitor on the participant's left side with a mirror image. As with pattern 2, experienced subjects demonstrated performance that was superior to that of nonexperienced subjects; the average times the 3 groups required to complete pattern 5 task were longer than those required to complete pattern 1 (coaxial condition) task. However, the average time the 3 groups required to complete pattern 5 task was shorter than that required to complete pattern 2 (mirror-image condition) task. This may be attributable to most participants being right-hand dominant when the camera was located on the left side. This result is also consistent with that of previous studies.[20,21]

We found no differences among the groups in term of the times required to complete pattern 1 task on day 4 regardless of the surgical experiences within each group. Furthermore, there were no differences among the groups in the times required to complete pattern 1 task on days 1 and 4. This showed that laparoscopic training did not influence the time required to complete the procedure under standard forward-alignment conditions. Holznecht et al[22] found that training in the forward orientation resulted in some improvements in reverse-alignment task performance; this might simply reflect an improvement in motor skills and increased familiarity with the equipment. The reason for this minor discrepancy between their study and ours may be the difference in the participants' surgical experiences. The participants of our study had some experience in laparoscopic surgery; hence, they had attained surgical skills under coaxial imaging by the time our study was conducted. In other words, forward-alignment surgical skills appear to be relatively easily attainable with a few years of laparoscopic surgical training.

As shown in Figure 2, we depend on the monitor location during laparoscopic left-sided colorectal surgery at our facility. On the basis of our results, lymph node dissection around the inferior mesenteric artery should be performed while the surgeons observe the monitor in front of them, and the assistant also does the same or else observes the monitor in front of the patient's legs when undergoing laparoscopic training under mirror-image conditions. During segments of the procedure that involve the rectum, the surgeon and assistant should observe the monitor by the patient's legs.

Limitations

The present study had some limitations. First, the expert groups comprised only 4 surgeons with > 20 years of surgical experience. Second, we could not investigate the differences between male and female surgeons because only one woman participated in the entire study. Third, there were no left-handed surgeons; only 2 were ambidextrous, and the remainder were right-handed. Therefore, we could not investigate whether the surgeon's dominant hand affected laparoscopic performance with various monitor setups and camera position angles. As such, further studies are required.

CONCLUSIONS

We clearly demonstrated that mirror-image surgical conditions provided the most difficult setting, because surgeons and assistants often became disoriented, and task performance was most degraded. However, our study also showed that, with only 4 days of practice under mirror-image conditions, surgeons and assistants can overcome mirror-image disorientation during laparoscopic left-sided colorectal surgery with relative ease.

REFERENCES

1. Lim SB, Choi HS, Jeong SY, et al. Feasibility of laparoscopic techniques as the surgical approach of choice for primary colorectal cancer. *Surg Endosc*. 2008;22:2588–2595.
2. Buchanan GN, Malik A, Parvaiz A, et al. Laparoscopic resection for colorectal cancer. *Br J Surg*. 2008;95:893–902.
3. van der Pas MH, Haglind E, Cuesta MA, et al. COlorectal cancer Laparoscopic or Open Resection II (COLOR II) Study Group. Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. *Lancet Oncol*. 2013;14:210–218.
4. Lacy AM, García-Valdecasas JC, Delgado S, et al. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet*. 2002;359:2224–2229.
5. Clinical Outcomes of Surgical Therapy Study Group, Nelson H, Sargent DJ, Wieand HS, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med*. 2004;350:2050–2059.
6. Colon Cancer Laparoscopic or Open Resection Study Group, Buunen M, Veldkamp R, Hop WC, et al. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. *Lancet Oncol*. 2009;10:44–52.
7. Yamamoto S, Inomata M, Katayama H, et al. Japan Clinical Oncology Group. Colorectal Cancer Study Group. Short-term surgical outcomes from a randomized controlled trial to evaluate laparoscopic and open D3 dissection for stage II/III colon cancer: Japan Clinical Oncology Group Study JCOG 0404. *Ann Surg*. 2014;260:23–30.
8. Sato T, Watanabe M. The present status and developments of laparoscopic surgery for colorectal cancer. *J Anus Rectum Colon*. 2017;1:1–6.
9. Tokunaga M, Egi H, Hattori M, et al. Improving performance under mirror-image conditions during laparoscopic surgery using the Broadview camera system. *Asian J Endosc Surg*. 2014; 7:17–24.
10. Gill RS, Al-Adra DP, Mangat H, et al. Image inversion and digital mirror-image technology aid laparoscopic surgery task performance in the paradoxical view: a randomized controlled trial. *Surg Endosc*. 2011;25:3535–3539.
11. Hwang MR, Seo GJ, Yoo SB, et al. Learning curve of assistants in laparoscopic colorectal surgery: overcoming mirror imaging. *Surg Endosc*. 2010;24:2575–2580.
12. Gould JC, Frydman J. Reverse-alignment surgical skills assessment. *Surg Endosc*. 2007;21:669–671.
13. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc*. 1991;1: 144–150.
14. Redwine DB, Sharpe DR. Laparoscopic segmental resection of the sigmoid colon for endometriosis. *J Laparoendosc Surg*. 1991;1: 217–220.
15. Schlinkert RT. Laparoscopic-assisted right hemicolectomy. *Dis Colon Rectum*. 1991;34:1030–1031.
16. Nakanishi M, Kokuba Y, Murayama Y, et al. A new approach to laparoscopic lymph node excision in cases of transverse colon cancer. *Digestion*. 2012;85:121–125.
17. Egi H, Nakashima I, Hattori M, et al. Surgical techniques for advanced transverse colon cancer using the pincer approach of the transverse mesocolon. *Surg Endosc*. 2019;33:639–643.
18. Cheung HY, Chung CC, Li MK. Laparoscopic anterior resection. *Tech Coloproctol*. 2010;14:45–49.
19. Miura S, Oshikiri T, Miura Y, et al. Optimal monitor positioning and camera rotation angle for mirror image: overcoming reverse alignment during laparoscopic colorectal surgery. *Sci Rep*. 2019;9:8371–8376.
20. Haveran LA, Novitsky YW, Czerniach DR, et al. Optimizing laparoscopic task efficiency: the role of camera and monitor positions. *Surg Endosc*. 2007;21:980–984.
21. Emam TA, Hanna G, Cuschieri A. Comparison of orthodox versus off-optical axis endoscopic manipulations. *Surg Endosc*. 2002;16:401–405.
22. Holznecht C, Schmidt T, Gould J. The impact of training under different visual-spatial conditions on reverse-alignment laparoscopic skills development. *Surg Endosc*. 2012;26:120–123.
23. Rhee R, Fernandez G, Bush R, et al. The effects of viewing axis on laparoscopic performance: a comparison of non-expert and expert laparoscopic surgeons. *Surg Endosc*. 2014;28:2634–2640.
24. Abdelrahman AM, Yu D, Lowndes BR, et al. Validation of a novel inverted peg transfer task: advancing beyond the regular peg transfer task for surgical simulation-based assessment. *J Surg Educ*. 2018;75:836–843.

