ORIGINAL ARTICLE
pISSN 2234-778X • eISSN 2234-5248
J Minim Invasive Surg 2020;23(3):134-138

JMIS Journal of Minimally Invasive Surgery

The Usefulness of a 180° Rotatable Monitor for an Assistant to Overcome the Hand-Eye Discordance in Laparoscopic Colorectal Surgery

Sungjin Kim, M.D., Sung Il Kang, M.D., So Hyun Kim, M.D., Ph.D., Jae-Hwang Kim, M.D., Ph.D.

Department of Surgery, College of Medicine, Yeungnam University, Daegu, Korea

Purpose: Hand-eye discordance during laparoscopic colon surgery is an obstacle to the assistant. We evaluated the usefulness of a 180° rotatable laparoscopic monitor for the colorectal surgery assistant to overcome hand-eye discordance.

Methods: Twenty-six residents of the department of surgery (novice group, n=13; experienced group, n=13) participated in this study. They performed grasping a ring and transferring it to standing bars on a laparoscopic training kit under the conventional view and a 180° rotated monitor view. We defined successful performance when this procedure was completed in 3 minutes.

Results: The number of successful performance was higher under the 180° rotated monitor view than under the conventional view monitor (6.88±2.79 vs. 0.92±0.80, $p<0.01$). Under the 180° rotated monitor view, the experienced group had a higher number of successful performances than the novice group (8.31±2.59 vs. 5.46±2.26, $p=0.009$). However, no statistically significant difference was found between the two groups under the conventional view (1.23±0.93 vs. 0.62±0.51, $p=0.091$).

Conclusion: This study shows the usefulness of a 180° rotated monitor view to overcome hand-eye discordance, which adversely affects the laparoscopic performance of the colorectal surgery assistant.

Keywords: Laparoscopy, Laparoscopic view, Colorectal surgery, Hand-eye discordance

Received May 25, 2020
Revised August 5, 2020
Accepted August 20, 2020

Corresponding author
Jae-Hwang Kim
Department of Surgery, Yeungnam University Medical Center, 170 Hyeonchung-ro, Nam-gu, Daegu 42415, Korea
Tel: +82-53-620-3580
Fax: +82-53-624-1213
E-mail: jhkimgs@ynu.ac.kr
ORCID:
https://orcid.org/0000-0002-8556-6315

INTRODUCTION

Since the first reported laparoscopic colon resection in 1991,[1] laparoscopic equipment and techniques for colon surgery have undergone rapid evolution. Currently, laparoscopic surgery has become the mainstream operation for colonic resection because of the several advantages of short-term surgical outcomes owing to its minimal invasiveness and acceptable long-term oncological outcomes.[2-4] In Korea, especially, the rate of laparoscopic surgery for colorectal disease reached up to approximately 70% in 2013.[5]

The cooperation of operators and assistants in laparoscopic surgery is important for successful surgery. In the conventional laparoscopic surgery, the surgical assistant plays a role in performing the appropriate counter-traction when the tissue is dissected by the surgeon. For doing this, the operative field of view projected on the video monitor must be as comfortable for the assistant as the surgeon.[6] However, the same view appears on both monitors even if the operator and assistant stand facing each other and look at their monitors such as left hemicolectomy, anterior resection, or low anterior resection. This creates hand-eye discordance, which causes surgical difficulty for an assistant.[7-9]

The basic image on the monitor should be set for the operator.

Therefore, the scopist must stand in the same direction as the operator to show the operative field, and the laparoscopic camera cannot rotate to fit the vision of the surgical assistant. Instead, we thought that a 180° simple rotation of the monitor for the assistant might offer a comfortable vision for hand-eye coordination during surgical assistant. Based on this idea, we designated this study to investigate the usefulness of a 180° rotated monitor view for the operative assistant in laparoscopic colorectal surgery.

MATERIALS AND METHODS

This study was conducted for two periods, 2015 and 2019, at Yeungnam University Medical Center. The training residents of the department of surgery during these periods participated in the study. A laparoscopic training kit that consisted of the standard laparoscopic instruments was used for this study (Fig. 1). We used a laparoscopic camera and monitor used in actual surgery. The monitor was a device that can rotate 180° around the center of the screen. We created a situation similar to that of the assistants in actual laparoscopic colon surgery as follows: The scopist inserted the laparoscopic camera into the center of the training kit to show standing bars in a floor of training kit. A participant stood on the opposite side of the scopist and performed a simple laparoscopic procedure using a common laparoscopic training kit (Fig. 2A). In this situation, the view that this participant sees is called the conventional view, which is the view set for the operator standing on the opposite side of the assistant. We rotated the monitor 180° around the center of the screen. A 180° rotated monitor forms a reversed image of the conventional view (Fig. 2B). We called this view the 180° rotated monitor view.

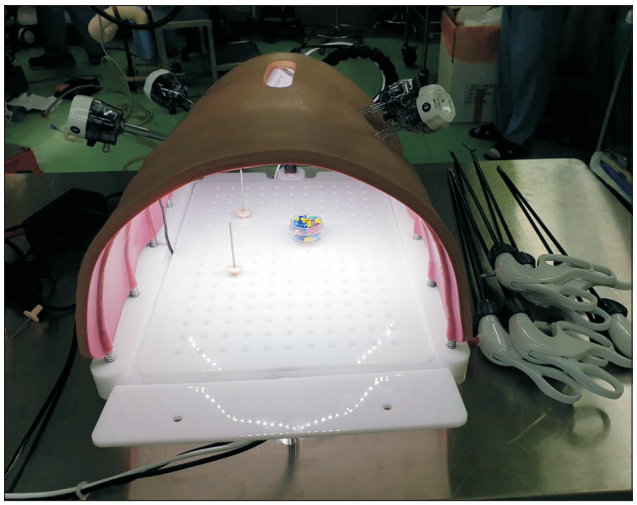

Fig. 1. Laparoscopic training kit used in the study.

The participant received a request for the procedure, which consisted of laparoscopic grasping and transferring red and blue rings on standing bars in a training kit. The procedure consisted of three steps. The first step was to grasp the ring on the floor. As the second step, each color ring is brought to the specified bar position. The third step was to place the ring in the bar exactly to the bottom. This is for evaluating the ability of the counter traction from the right position to the right direction and right depth, the assistant's ability required in actual surgery.

The situations under the conventional view and 180° rotated monitor view were analyzed by comparing the number of successful performances for 3 minutes in the final test. We mea-

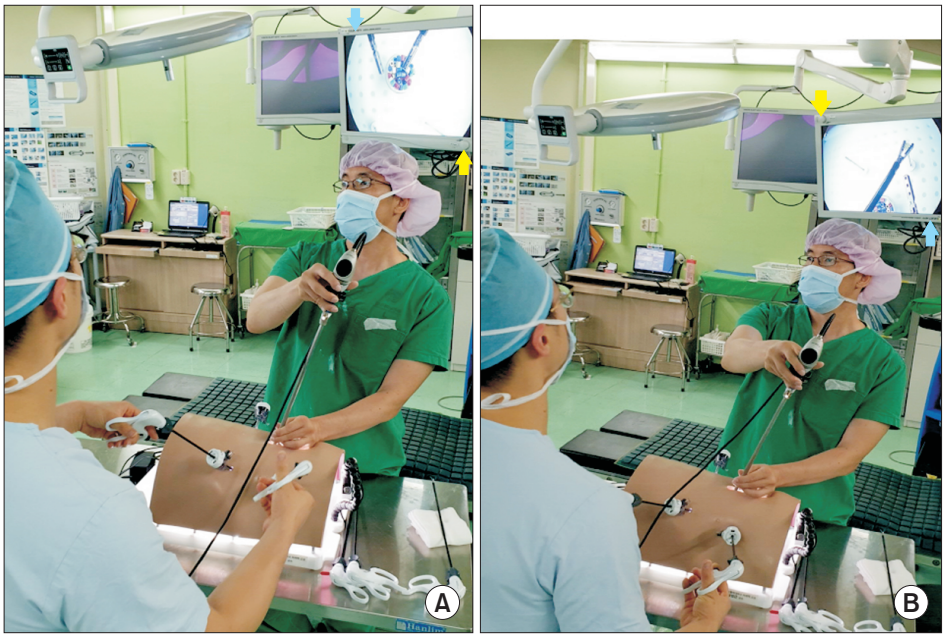

Fig. 2. Laparoscopic procedure used in the study. (A) This is the conventional view observed by this participant. (B) Process underlying the 180° rotated-monitor view. As we can see from the positions of the yellow and blue arrows and laparoscopic instruments, the view was changed by rotating the laparoscopic monitor.

Table 1. Numbers of laparoscopic colorectal surgery experienced

	Novice group (n=13)	Experienced group (n=13)	*p* value
Right hemicolectomy	4.62±1.06	33.75±4.52	
Anterior resection	6.12±1.24	34.13±2.99	
Low anterior resection	5.37±0.92	26.00±2.20	
Average	5.38±1.20	31.29±5.00	<0.01

sured time using a standardized stopwatch by the research team from when two laparoscopic graspers were visible on the video monitor. The procedure was performed twice (one practice and one final test) under the conventional and 180° rotated monitor view.

The numbers of successful performances for each view and the performances under both views were compared between the two groups. The comparative analysis consisted of the Wilcoxon test and Mann-Whitney *U* test. The values are expressed as mean±standard deviation. A *p* value of <0.05 was considered statistically significant. The statistical analysis was performed using the IBM SPSS version 22.0 (IBM Co., Armonk, NY, USA).

This study was approved by the ethics committees of the institution (IRB No. YUMC 2020-06-024).

RESULTS

Twenty-six residents participated in the study. Sixteen and 10 residents participated in this study in 2015 and 2019, respectively. The participants were dichotomized into the novice and experienced groups according to their resident grade. Table 1 shows the number of laparoscopic colorectal surgeries experienced by the two groups. The experienced group had more operative experience than the novice group (31.29±5.00 vs. 5.38±1.20, $p<0.01$).

The comparison results between the two views were as follows; the numbers of successful performances in the 180° rotated monitor view was higher than that in the conventional view (6.88±2.79 vs. 0.92±0.80, $p<0.01$; Fig. 3).

The comparison results between the two groups were as follows; the number of successful performances of the experienced group was higher than that of the novice group in the 180° rotated monitor view (8.31±2.59 vs. 5.46±2.26, $p=0.009$; Table 2). The difference in the number of successful performances between the two groups was not statistically significant in the conventional view (1.23±0.93 vs. 0.62±0.51, $p=0.091$). The number of successful performances in the 180° rotated monitor view of the novice group was higher than that in the conventional view of the experienced group (5.46±2.26 vs. 1.23±0.93, $p=0.009$).

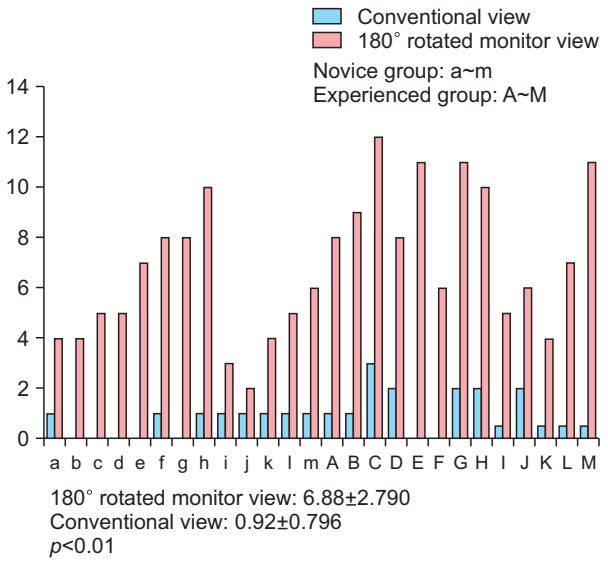

Fig. 3. Numbers of successful performances in the conventional view (blue bar) and 180° rotated monitor view (red bar).

Table 2. Numbers of successes performance

	Experienced group	Novice group	*p* value
Conventional view	1.23±0.93	0.62±0.51	0.091[a]
180°rotated monitor view	8.31±2.59	5.46±2.26	0.009[b]
p value	<0.01[c]	<0.01[d]	0.009[e]

[a,b]Comparison of the experienced and novice groups using the Mann-Whitney U test. [c,d]Comparison of the conventional view and 180° rotated-monitor view using the Wilcoxon test. [e]Comparison of the conventional view of the experienced group and the 180° rotated-monitor view of the novice group using the Wilcoxon test.

DISCUSSION

The laparoscopic view is an important aspect of laparoscopic surgery. If the assistant stands in front of the operator, a monitor for the assistant and another for the operator are needed. The screen of the monitor for the assistant usually shows the same image as the operator's view. However, an image set to the operator causes hand-eye discordance to the assistant, making it difficult for the assistant to manipulate the instrument.

Several studies have been conducted on the view for laparoscopic surgery.[8-13] All these studies demonstrated a limitation of the laparoscopic performance of the assistant in the conventional view, and mental rotation, digital mirror-image technology, or monitor rotation is suggested as an alternative. In the study by Gill et al.,[12] surgical task performance improved by digitally flipping or inverting the laparoscopic view. However, we report

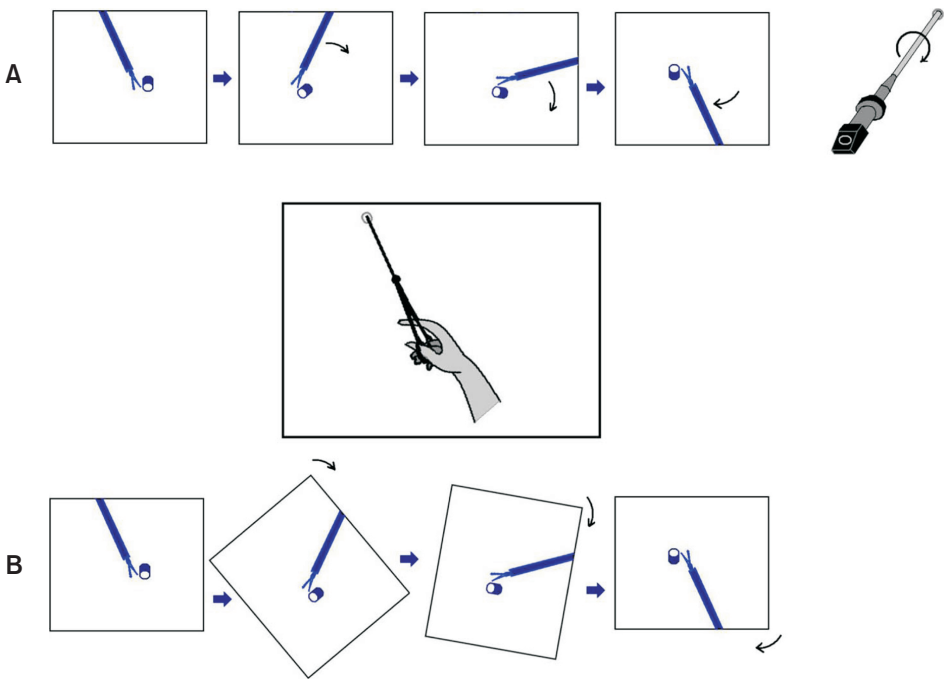

Fig. 4. The effects of the rotating telescope (A) and rotating monitor (B) are the same.

a difference in that hand-eye discordance was eliminated by changing both the top and bottom and left and right, by rotating the laparoscopic view not just up and down or left and right.

The strength of this study lies in the nature of its novelty, to the best of our knowledge, no other study has been conducted before. On the basis of the results of this study, the 180° rotatable monitor may be considered useful for the training of surgical assistants in actual laparoscopic surgery. In this setting, residents can be trained in laparoscopic surgery in the same way as in open surgery. Therefore, open surgery and laparoscopic surgery can be performed using the same surgeon and assistant settings. Hence, the assistant can perform ergodynamic performance by having a comfortable view for himself; therefore, the training of residents in laparoscopic surgery can be facilitated.

We found that when the conventional view was created, it became a comfortable view for the assistant as we rotated the scope (Fig. 4A). We also found that the rotating monitor itself had the same effect (Fig. 4B). Based on this idea, we developed a 180° rotatable monitor and used it in laparoscopic colorectal surgery, allowing the assistant to perform the laparoscopic procedure easily.

In this study, we showed that rotating the assistant's monitor by 180° could facilitate the laparoscopic procedure by removing the assistant's hand-eye discordance that occurred in the conventional view. When the assistants see the conventional view set to the operator, the assistants mentally reinvert the image prior to attempting manipulations.[14-16] This requires longer time to correct for rotational changes and associated memory scanning.[17,18]

Previous studies showed that an average of ≥30 surgical experiences are needed to overcome the hand-eye discordance in laparoscopic colorectal surgery.[10] In this aspect, the experienced group in this study can be said to have overcome the learning curve. Nevertheless, in the experienced group, the number of successful performances was higher in the 180° rotated monitor view than in the conventional view. Furthermore, the number of successful performances of the experienced group in the conventional view was lower than that of the novice group in the 180° rotated monitor view. This demonstrates that hand-eye discordance can have a significant impact on surgical manipulation, even if the learning curve is overcome.

This study has several limitations. First, the number of participants in the study was too small to make generalizations. Second, the results were obtained only from a two-dimensional (2D) monitor, not from the currently widely available three-dimensional (3D) monitor. We do not know how the results will differ in the 3D monitor, which have advantages over the 2D monitor for depth perception and spatial orientation. Third, the research period was divided into two because of the supply and demand problems of the general surgery residents. Fourth, no application was made for actual laparoscopic colorectal surgery. However, the strength of this study is that the attempt to rotate the monitor is an original concept that has not been implemented or reported in previous studies; and this concept can be easily applied during surgery.

CONCLUSION

This study shows the usefulness of the 180° rotated monitor to overcome hand-eye discordance, which adversely affects the

laparoscopic performance of colorectal surgery assistants. Further studies with a larger sample size and real clinical studies are required to fortify our results.

ORCID

Sungjin Kim, https://orcid.org/0000-0002-3773-3799
Sung Il Kang, https://orcid.org/0000-0002-4751-5779
So Hyun Kim, https://orcid.org/0000-0002-8625-329X
Jae-Hwang Kim, https://orcid.org/0000-0002-8556-6315

AUTHORS' CONTRIBUTIONS

Conceptualization: Sungjin Kim. Formal analysis: Jae-Hwang Kim. Methodology: So Hyun Kim and Sungjin Kim. Writing–original draft: Sung Il Kang and Sungjin Kim. Writing–review and editing: Jae-Hwang Kim and Sungjin Kim.

CONFLICT OF INTEREST

None.

FUNDING

None.

ACKNOWLEDGMENTS

None.

REFERENCES

1) Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). Surg Laparosc Endosc 1991;1:144-150.
2) Weeks JC, Nelson H, Gelber S, Sargent D, Schroeder G. Short-term quality-of-life outcomes following laparoscopic-assisted colectomy vs open colectomy for colon cancer: a randomized trial. JAMA 2002;287:321-328.
3) Fleshman J, Sargent DJ, Green E, et al. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. Ann Surg 2007;246:655-662; discussion 662-654.
4) Vennix S, Pelzers L, Bouvy N, et al. Laparoscopic versus open total mesorectal excision for rectal cancer. Cochrane Database Syst Rev 2014;15:CD005200.
5) Park SJ, Lee KY, Lee S-H. Laparoscopic Surgery for Colorectal Cancer in Korea: Nationwide Data from 2008~2013. J Minim Invasive Surg 2015;18:39-43.
6) 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.
7) Gould JC, Frydman J. Reverse-alignment surgical skills assessment. Surg Endosc 2007;21:669-671.
8) Conrad J, Shah AH, Divino CM, et al. The role of mental rotation and memory scanning on the performance of laparoscopic skills: a study on the effect of camera rotational angle. Surg Endosc 2006;20:504-510.
9) Johnston WK, 3rd, Low RK, Das S. Image converter eliminates mirror imaging during laparoscopy. J Endourol 2003;17:327-331.
10) 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.
11) Gallagher AG, Al-Akash M, Seymour NE, Satava RM. An ergonomic analysis of the effects of camera rotation on laparoscopic performance. Surg Endosc 2009;23:2684-2691.
12) Gill RS, Al-Adra DP, Mangat H, Wang H, Shi X, Sample C. 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.
13) Abodeely AA, Cheah YL, Ryder BA, Aidlen JT, Luks FI. Eliminating the effects of paradoxic imaging during laparoscopic surgery. J Laparoendosc Adv Surg Tech A 2010;20:31-34.
14) Enns JT, Shore DI. Separate influences of orientation and lighting in the inverted-face effect. Percept Psychophys 1997;59:23-31.
15) Michel CM, Kaufman L, Williamson SJ. Duration of EEG and MEG α Suppression Increases with Angle in a Mental Rotation Task. J Cogn Neurosci 1994;6:139-150.
16) Wohlschläger A. Mental object rotation and the planning of hand movements. Percept Psychophys 2001;63:709-718.
17) Rypma B, Berger JS, D'Esposito M. The influence of working-memory demand and subject performance on prefrontal cortical activity. J Cogn Neurosci 2002;14:721-731.
18) Sirigu A, Duhamel JR. Motor and visual imagery as two complementary but neurally dissociable mental processes. J Cogn Neurosci 2001;13:910-919.