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ORIGINAL ARTICLE

Influence of camera navigation training on team performance in virtual reality laparoscopy

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Abstract

Introduction: Virtual reality laparoscopic (VRL) simulation is a tool that can effectively reduce the learning curve of novices preparing to act as assistants in the operating room. This study was conducted to investigate whether a single session of VRL camera training for the camera assistant influences VRL team performance and team cooperation in novices. **Method:** Medical students (n = 145) were randomized to camera-training (CTG) or no-training (NTG) groups. Participants were blinded to group assignment. CTG students performed a session of virtual camera training prior to a grasping and placing task. NTG students directly started the manual task on a VRL simulator. Participants were grouped into teams of operator and assistant for the manual task. The virtual surgical performance of the operator with a CTG versus an NTG camera assistant was evaluated. **Results:** Higher rating of the other team partner, self-confidence when assisting with a basic laparoscopic procedure, and male gender were significantly correlated with better performance scores in CTG. No association with performance was obtained for NTG. The teams with a trained camera assistant showed a trend towards better performance. **Conclusion:** This randomized study found that VRL camera navigation training had a positive, but not statistically significant, effect on the operator's simulator performance in teams with a camera-trained assistant. Self-confident novices are able to assess their skill level more realistically.

Keywords: *Laparoscopic surgery; virtual reality; simulation; surgical education; camera assistant*

Introduction

Laparoscopic camera navigation (LCN) is often perceived to be the easier part of laparoscopic operations. Nonetheless, the role of the camera assistant is important in laparoscopy because an adequate view of the operating field is essential to ensure a continuous procedure flow and to avoid errors, time delays, and surgeon frustration.[1,2] Due to the European Working Time Directive[3] and an increasing shortage of surgeons, camera assistance is frequently entrusted to inexperienced residents or even medical students.[1,4] This has led to research regarding robotic camera assistance, and training certificates for medical students are also being discussed.[1,5] It is known that LCN improves when the assistant gains experience in a safe and time-efficient simulation setting.[2,6]

This study was conducted to investigate whether a single session of virtual reality laparoscopic (VRL) camera training for novice camera assistants influences VRL team performance. In particular, the resulting data were analysed with respect to evaluations of team cooperation and self-confidence when assisting with a laparoscopic procedure.

Methods

Participants

A total of 173 undergraduate medical students were enrolled in a curricular course of abdominal surgery from April to July 2013. Due to no course attendance by 28 students, 145 participants were consecutively included within eight sessions with 9–21 participants per course. The study was conducted during a mandatory teaching program required of all students in their fifth year of medical school in the Department of General, Visceral and Transplantation Surgery, University Hospital, Mainz, Germany. The study was approved by the local ethics board (Ethics Committee

The results of the study were presented at the American College of Surgeons Clinical Congress, San Francisco, CA, October 26–30, 2014.

of the Medical Association of Rhineland-Palatinate, Germany).

Study design

After an introduction to laparoscopic simulation and a presentation of the tasks, including correct handling and possible mistakes, which was identical for all students, participants were randomly assigned by the instructor to camera-training (CTG) or no-training groups (NTG). This was performed using the list of names on the course in order of matriculation number and alternatingly assigning the students to CTG and NTG. The participants were not informed about the study design at all and were thus blinded with respect to the group assignment. Intergroup exchange of knowledge was prevented by separating the groups in time. Two students were assigned as a surgical team (operator and camera assistant) for the bimanual task and alternated as operator and assistant. The CTG students completed a camera navigation training session prior to the bimanual manoeuvre, whereas the NTG students began the bimanual task directly. The virtual surgical performance of the operator was evaluated (Fig. 1).

Simulator

The virtual reality simulator used for the bimanual task was a LapSim, Software Version 2011, produced by Surgical Science (Göteborg, Sweden), with a 22-inch widescreen monitor, Simball 4D Joysticks, and a double footswitch. This type of simulator simulates team performance with one camera and two surgical interfaces (Fig. 2). Technical data for LCN simulation were acquired by a simulator from SimSurgery (SEP, Oslo, Norway), which included a highly adjustable operating surface with multiple positions for trocar placement, laparoscopic instruments, diathermy pedal, computer, 19-inch LCD flat screen monitor, and SEP software (SimSurgery Education Platform; SEP 3.0.1). Haptic feedback was not provided on either simulator type.

Camera navigation training

LCN tasks (0°-VR-LCN/30°-VR-LCN) consisted of performing procedures in an abstract environment using two differently angled laparoscopes, first with an angle of 0° and then with an angle of 30° to align a virtual object, as previously described.[7]

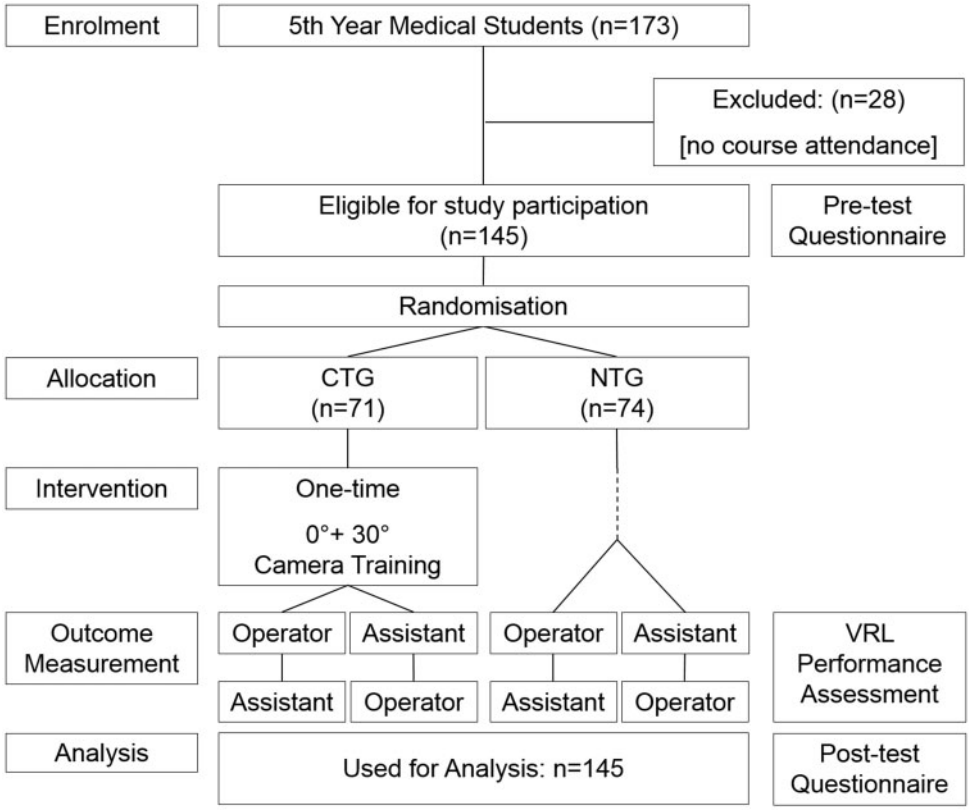

Figure 1 Study design. VRL, virtual reality laparoscopic simulation; CTG, camera-training group; NTG, no-training group.

Figure 2 Operator and camera assistant cooperating on the virtual reality laparoscopic simulator.

VRL team performance (grasping)

In a virtual environment, the camera assistant had to display a tube-shaped object, which was stretched with a defined grasper by the operator until it came away from the tissue; the object was then placed in an endoscopic bag. The assistant had to follow the object and grasper in order to keep them in sight while also keeping sight of the natural horizon. A total of six objects had to be placed in the bag with alternating graspers to complete the task (three left and three right).

Questionnaire

Prior to and after the course, each participant was asked to fill out a standardized questionnaire, which was constructed to identify personal characteristics, such as sex, age, handedness, video game experience, interest in surgery and surgical specialties, team spirit, communication skills, fine motor skills, and confidence in assisting with a simple laparoscopic procedure. Furthermore, course relevance for education, group size, training time, acquisition of problem solving, assumption of responsibility, self-evaluation, overall course evaluation, quality of supervision and assistance by the instructor, and requests for an additional VRL course were also evaluated. In particular, satisfaction concerning cooperation with the team partner was analysed.

Statistical analysis

All data were transferred to an SPSS database and processed anonymously. The statistician was blinded with respect to group assignment. To evaluate the students' performance, the z-score was calculated. The z-score is defined as $z = x - \mu/\sigma$, where x is the raw score, μ is the mean of the parameter, and σ is the standard deviation of the parameter. The z-score was calculated for each item measured by the VRL simulator; all z-scores were added to yield a global z-score for each task. For comparisons between the CTG and NTG, the Mann–Whitney U test was used. For questionnaire analyses, five-point Likert scales were dichotomized (1–2 and 3–5), and the Mann–Whitney U test and chi-square test were used. Statistical analysis was performed with SPSS Statistics 20 (Statistical Package for Social Sciences program, Chicago, IL).

Results

There were no significant differences between the groups with respect to age or gender. The CTG consisted of 71 students (27 men) with a median age of 25 years (range 23–34 years). The NTG comprised 74 students (32 men) with a median age of 25 years (range 22–33 years) ($P > 0.05$).

Overall analysis of procedural z-scores between the CTG (median 2.58, interquartile range [IQR] −2.75 to −6.31) and NTG (median 2.04, IQR −3.61 to 6.01) suggested a better performance for the CTG. However, this result did not reach statistical significance ($P = 0.754$).

The operators' satisfaction with the assistants' performance was higher in the CTG (49% in CTG versus 41% in NTG, $P = 0.465$). Evaluation of the assistants' satisfaction with the operator was also higher in the CTG (59% in CTG versus 47% in NTG, $P = 0.205$). Higher satisfaction with the team partner was associated with significantly better z-scores in the CTG (assistant, $P = 0.012$; operator, $P = 0.012$) (Table 1). No significant difference was found for team cooperation in the NTG (assistant, $P = 0.072$; operator, $P = 0.260$). Comparisons between CTG and NTG regarding gender, self-confidence in assisting prior to and after the course, and cooperation with the assistant or operator revealed no significant differences between the two groups.

The self-confidence of the participants prior to the training session with respect to assisting with a laparoscopic procedure was not associated with better performance in either the CTG or the NTG. Self-confidence after the course was associated with significantly better performance of the self-confident medical students in the CTG ($P = 0.001$) (Fig. 3). Male participants in the CTG reached significantly higher z-scores compared with female students ($P = 0.004$). No gender-related performance differences were identified in the NTG. All other questionnaire parameters were equally distributed between the CTG and NTG and showed no significant coherence with the global z-score of the bimanual task.

Table 1 Analysis of the operator's virtual performance in relation to questionnaire results in the camera-training group (CTG) and the no-training group (NTG)

Variables	*n*	CTG *z*-score, median (IQR)	*P*	*n*	NTG *z*-score, median (IQR)	*P*
Cooperation with the assistant						
Satisfied	35	3.71 (−0.08 to 7.56)		32	3.23 (−3.03 to 7.89)	
Unsatisfied	36	0.47 (−4.80 to 3.88)	**0.012**	42	0.91 (−5.25 to 4.35)	0.072
Cooperation with the operator						
Satisfied	42	3.51 (−0.08 to 6.78)		36	3.03 (−3.03 to 6.26)	
Unsatisfied	29	−0.01 (−5.40 to 2.86)	**0.012**	38	1.47 (−5.25 to 4.35)	0.260

IQR, interquartile range.

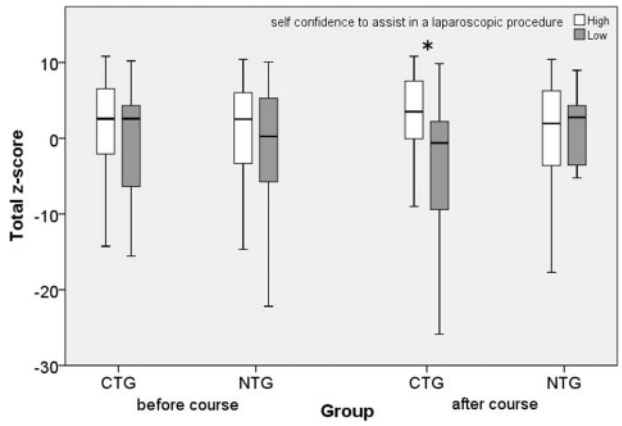

Figure 3 Comparison of self-confidence to assist in a laparoscopic procedure before and after the course in the camera-training group (CTG) and the no-training group (NTG). After the course, there was a significant difference in favour of confident students in the CTG (*$P = 0.001$).

Discussion

In the present study, better manual performance scores were obtained when the camera assistant had undergone a single session of VRL camera training. Although statistical significance was not reached, this single session appeared to enable assistants to provide better LCN. The role of the assistant in laparoscopic surgery was investigated by Chmarra et al.[6] on a box trainer with 46 participants (11 experts, 21 residents, and 14 novices). The influence on handling economics was measured by the TrEndo tracking system. According to the results of this previous study, the handling was more economical when the camera assistant had more experience. However, the best handling economics were obtained when the novice operators guided the camera by themselves. This underlines the influence of camera navigation in laparoscopic surgery, especially for novices who are unable to compensate for an inexperienced assistant.

In the present randomized approach, a better evaluation of the assistant by the operator was associated with a higher *z*-score in the CTG. This result implies that the operator's performance benefited from having a camera-trained assistant. In addition, higher evaluations of the operator by the assistant correlated with better performance scores, which suggests that there is better general team cooperation with less frustration if the assistant has been trained. However, the operating novices had previous knowledge of camera navigation in the CTG and were thus able to evaluate the quality of the assistant more accurately than in the NTG.

The use of untrained assistants has become increasingly common due to a shortage of young surgeons; during surgery, this can lead to a higher number of verbal commands, which may result in distraction and frustration for the surgeon and the assistant.[1] Cooperation and procedure flow are directly related and they influence surgical time.[1,2] Thus, both surgeons and patients should profit from trained camera assistants. These findings provide support for the goal of the German Society of General and Visceral Surgery to develop an operating room training certificate for medical students.[5]

The CTG participants who were confident of their ability to assist in basic laparoscopic surgery after the training reached significant higher scores compared with those who lacked confidence. The *z*-scores of the students in the NTG with or without self-confidence were not different. Prior to the training, there was no correlation between self-confidence and performance in either group (Fig. 3).

This suggests that the students in the CTG group were able to correctly evaluate their skill levels after the LCN simulation training to a higher degree than those in the NTG. This implies that VRL camera navigation training leads to a more correct estimation of self-confidence in trained participants to assist in a basic laparoscopic procedure. This corresponds

with the results of a previous study of 488 novices with no prior VRL experience. The ability to assist in a basic laparoscopic procedure was found to have an independent impact on virtual LCN performance.[8]

Our analysis of the participants' gender revealed that men performed better in the CTG. However, there was no significant difference in the NTG although male gender has previously been identified as a predictive factor for better initial virtual LCN performance.[7]

The lack of statistical significance regarding better virtual team performance in the CTG may be explained by the study design; a single session of camera training may be insufficient to yield significant effects. However, one-time training in laparoscopic surgery is better than no training,[9] and the difference in performance is highest at the beginning of the learning curve.[10] The current participants were exclusively novices; therefore, they were at the beginning of their learning curve.

The use of two different types of simulators may be a limitation of the current approach, although it has the advantage of eliminating a possible bias of familiarization with the simulator for the CTG. Further studies regarding the influence of camera navigation training on laparoscopic performance are required, especially investigations of teams composed of a novice camera assistant with a more experienced operator, since this scenario more closely resembles the situation in many operating rooms.

Conclusion

A single session of camera navigation training resulted in a better yet statistically not significant virtual reality team performance, which was recognized by the novice operator. Participants who underwent a single session of training were able to discriminate their skill level more accurately. Further investigations regarding the influence of virtual reality camera navigation training on laparoscopic performance are needed.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

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