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Structured box training improves stability of retraction while multitasking in colorectal surgery simulation

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ABSTRACT

Background: Laparoscopic colorectal surgery has an established role. The ability to multitask (use a retraction tool with one hand and navigate a laparoscopic camera with the other) is desired for efficient laparoscopic surgery. Surgical trainees must learn this skill to perform advanced laparoscopic tasks. The aim was to determine whether a box-training protocol improves the stability of retraction while multitasking in colorectal surgery simulation.

Materials and methods: Fifty-eight medical students were recruited to attend a basic laparoscopic box-training course. Ability to perform steady retraction with and without multitasking was measured initially and at the conclusion of the course.

Results: Before training, students demonstrated a decrease in performance while multitasking with a greater maximal exerted force, a greater range of force, and a greater standard deviation for traction and minimal exerted force, range of force and a greater standard deviation for countertraction. Statistically significant improvement (lower maximal exerted force and lower range of force) was observed for traction while multitasking after training. After the training, no statistically significant differences were found when the student performed a single task *versus* multitasking, both for traction and countertraction.

Conclusions: A structured box-training curriculum improved the stability of retraction while multitasking in this colorectal surgery simulation. Although it did not improve stability of retraction as a single task, it did improve stability of retraction while multitasking. After training, this enables the trainee to retract as efficiently while operating the camera as they retract when only focusing on retraction as a single task.

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Introduction

Colorectal surgery has evolved into an important branch of surgery due to the increasing incidence of colorectal cancer[1-3] and inflammatory bowel disease.[4] The laparoscopic approach has proven beneficial in these operations[5,6] with a shorter hospital stay, lower pain scores, lower incidence of surgical site infections, and an acceptable safety profile in elderly patients.[7-9] However, this technique also presents new challenges for the surgical staff. Colorectal surgery is plane-based making it crucial to display the proper planes for precise dissection.[10,11] Typically, the assistant plays a major role during laparoscopy navigating the laparoscopic camera and creating traction and countertraction of the tissues.[12,13] In many settings, that assistant is a young surgeon in training. This person must use their instruments to apply a precise amount of force so neither the field collapses nor the intestines or surrounding organs are injured. Because both hands are traditionally used, the assistant may be required to simultaneously retract and navigate the camera. Therefore, an advanced ability to multitask is required to adequately perform these maneuvers while avoiding unfavorable results such as perforations, prolonged operating time, and others.[14,15] This skill must be acquired without compromising patient safety or creating additional costs. The role of simulation and box trainers in learning and assessing laparoscopic skills is well established.[16-18] Because laparoscopic colorectal surgery is a demanding technique with long learning curve,[19-21] we hypothesized that a box-training protocol would improve the learners' ability to effectively and safely retract while manipulating the camera during simulation colorectal laparoscopic surgery (i.e., multitask using both hands). The aim of this study was to test this hypothesis.

Materials and methods

To test this hypothesis, we recruited 58 senior medical students (35 males, 23 females) from The Medical University of Gdansk with no previous formal surgical training. We chose this group as it has previously been suggested that there is no difference between using senior medical students or surgical residents as subjects in a study such as this.[22] Participation was voluntary, and written consent for the participation in the study was obtained. Waiver from the local bioethical committee was obtained.

Our simulation laboratory uses two standard Karl Storz (Tuttlingen, Germany) laparoscopic box trainers. We assessed force of traction with and without simultaneously manipulating a laparoscopic camera before and after the students had completed a previously published protocol in laparoscopic skills training.[23] This protocol consists of five exercises repeated in seven sessions throughout the year with 4-wk intervals.[23] An overview of the exercises is shown in Appendix 1. To assess traction and countertraction, measurements were taken at the beginning and at the end of the course using an FB50 Axis force gauge and Axis FM software (Axis Ltd Gdansk, Poland). Surgical scenario reproduced in the experiment is illustrated in Figure 1A and Figure 1B, which depict, respectively, traction and countertraction of the intestine, which are necessary to visualize the plane for dissection. The impact of the training was measured in four tasks: traction (1a), traction and operating the camera—multitasking (1b), countertraction (2a), countertraction and operating the camera—multitasking (2b). A description of each of these tasks is summarized in Table 1. The tasks were performed in a single attempt at the initial meeting (baseline measurements) and at the conclusion of the course (i.e., after training).

Students were instructed to pull or push with 5N force as steadily as possible for 120 s using the laparoscopic tool with their left hand. The target value of 5N was based on data available in literature, which was further tested with an experiment.[24] It has been previously suggested that 5N is a cutoff force after which relationship between force and tissue strain changes. Therefore, we hypothesized that 5N might be the value of force that is actually used in the operating room. To test this hypothesis, we asked five senior surgeons to perform tasks designed for this study while trying to recreate the force used in the clinical setting, and we calculated average force they used. As the calculated force was 4.91N, which correlates with literature data, we decided to round the target value up to 5N for the purpose of keeping the tasks of the main experiment simple. The students were able to check and adjust their amount of force before measurements were taken. After initiating the tasks, the gauge was not visible for students to correct or adjust the amount of force they were applying. Readings from the force gauge were recorded at 1-s intervals for further analysis.

Table 2 details the standardized steps used for obtaining measurements. The measurements included standard deviation (SD) of the force, minimal and maximal forces, and force range for 120 s for each of the four tasks. Data were compared using *t*-tests with statistical significance considered for $P < 0.05$. Statistica 12 software (StatSoft, Inc 2014, Tulsa, USA) was used for all calculations.

Results

Traction

Before training, we found statistically significant decrease in performance of traction stability when multitasking (retracting as well as operating camera). This was observed as a greater SD (0.66 *versus* 0.85 $P = 0.01$), greater maximal exerted force (6.03 N *versus* 7.02 N $P = 0.0004$), and greater range of force (2.77 N *versus* 3.6 N $P = 0.01$). Statistically significant improvement was observed for traction while multitasking after training. This was observed as a lower maximal exerted force (7.02 N *versus* 6.35 N $P = 0.03$) and in lower range of force (3.6 N *versus* 2.83 N $P = 0.03$). Results are summarized in Figure 2A. For aforementioned results, that were statistically significant, the *P*-values are marked in red. No statistically significant differences were observed for all