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Laparoscopy Instructional Videos: The Effect of Preoperative Compared With Intraoperative Use on Learning Curves☆

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OBJECTIVE: Previous studies have shown that the use of intraoperative instructional videos has a positive effect on learning laparoscopic procedures. This study investigated the effect of the timing of the instructional videos on learning curves in laparoscopic skills training.

DESIGN: After completing a basic skills course on a virtual reality simulator, medical students and residents with less than 1 hour experience using laparoscopic instruments were randomized into 2 groups. Using an instructional video either preoperatively or intraoperatively, both groups then performed 4 repetitions of a standardized task on the TrEndo augmented reality. With the TrEndo, 9 motion analysis parameters (MAPs) were recorded for each session (4 MAPs for each hand and time). These were the primary outcome measurements for performance. The time spent watching the instructional video was also recorded. Improvement in performance was studied within and between groups.

SETTING: Medical Center Leeuwarden, a secondary care hospital located in Leeuwarden, The Netherlands.

PARTICIPANTS: Right-hand dominant medical student and residents with more than 1 hour experience operating any kind of laparoscopic instruments were participated. A total of 23 persons entered the study, of which 21 completed the study course.

RESULTS: In both groups, at least 5 of 9 MAPs showed significant improvements between repetition 1 and 4. When both groups were compared after completion of repetition 4, no significant differences in improvement were detected. The intraoperative group showed significant improvement in 3 MAPs of the left—nondominant—hand, compared with one MAP for the preoperative group.

CONCLUSION: No significant differences in learning curves could be detected between the subjects who used intraoperative instructional videos and those who used preoperative instructional videos. Intraoperative video instruction may result in improved dexterity of the nondominant hand. (J Surg Ed ∎:∎∎∎-∎∎∎. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: instructional video, learning curve, laparoscopy, skills training

COMPETENCIES: Practice Based Learning and Improvement

INTRODUCTION

In the past, surgical residents attained all their surgical skills in the operating room supervised by an experienced surgeon for direct feedback. Increased pressure on efficient use of operating rooms, work-hour restrictions, and patient safety matters have led to the need for training skills outside the operating room.[1,2] Nowadays, simulators play an important role in surgical skills training. Ex vivo technical skills training leads to improved technical performance as well as cognitive learning.[3] It allows surgical residents to complete a part of their learning curve without putting patients at risk.[4] Advantages of training on simulators are its continuous availability, portability of equipment, and re-use of materials.[5] Also, practicing specific procedural steps

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instead of whole procedures can lead to more efficient acquisition of skills.[6]

Basic laparoscopic skills, such as eye-hand coordination and adjusting to impaired depth perception, can be practiced as often as desired using box trainers, virtual reality (VR) trainers, or augmented reality (AR) trainers.[7] VR trainers use virtual instruments in a virtual work space. Working in virtual space, the main drawback of VR trainers is the lack of realistic haptic feedback.[8] Box trainers however, do provide realistic haptic feedback because real instruments and organs or tissues can be used.[5] AR trainers combine the advantages of VR and box trainers by placement of a motion-tracking system on a box trainer.[9]

Eventually, surgical residents would perform procedures on patients. This is done under direct supervision of an experienced surgeon, the so-called "master-apprentice" model, that is, the surgeon provides instructions to the surgical resident and temporarily takes over the instruments when necessary. The disadvantage of the master-apprentice model is that, with every intervention by the surgeon, the surgical resident loses a learning opportunity as every step of the procedure can only be performed once.[10]

To limit the number of interventions by the surgeon and to maximize the operating time for surgical residents, Van Det et al.[11] developed a new method of training, called INtraoperative Video-Enhanced Surgical procedure Training (INVEST). This training method includes a short instructional video, demonstrating anatomical and technical points of interest for each phase of the procedure, which is shown intraoperatively in the operating room, step-by-step and on-demand. INVEST showed a positive effect on the learning curve of surgical residents performing laparoscopic cholecystectomies in the operating room.[10] Also, compared with the master-apprentice model, INVEST was found to increase effectiveness and efficiency in learning laparoscopic procedures inside the operating room, without affecting operating room time efficiency.[10] The question that remains is whether the timing of video instruction is of influence.

The aim of the present study is to compare the effects on the learning curve of watching an instructional video preoperatively or intraoperatively. We hypothesized that an intraoperative instructional video would lead to faster improvement in learning a laparoscopic skill than a preoperative instructional video.

MATERIALS AND METHODS

Study Population

Study subjects were recruited by e-mail. Inclusion criteria were right-hand dominance and successful completion of a training curriculum for basic laparoscopic skills on a validated VR trainer, the SIMENDO (Simendo, Rotterdam, The Netherlands)[12,13] to ensure equal levels of skill at baseline. Exclusion criterion was noteworthy (>1 hour) experience operating laparoscopic instruments, be it any kind of simulator, including the SIMENDO, or on real patients.

Study Protocol

After successful completion of the training curriculum, subjects were randomized in group "PO" (preoperative use of instructional video) or group "IO" (intraoperative use of instructional video) by drawing sealed envelopes. Before the first of 4 repetitions of the standardized task ("task 1-4"), all subjects had 1 hour to study (parts of) the instructional video as often as they pleased. Subjects of the preoperative group prepared themselves in this way for the other 3 repetitions of the task as well. Subjects of the intraoperative group however, were only allowed to watch (parts of) the video on-demand intraoperatively, but as often as desired (Figure 2). The results of task 1 served as baseline measurements, with which results of task 4 were compared.

TrEndo

Repetitions of the standardized task were performed using the TrEndo AR trainer (Training in Endoscopy, Delft University of Technology, Delft, The Netherlands).[14] The TrEndo works like a trocar, through which laparoscopic instruments can be inserted. It records movement of instruments in 4 degrees of freedom: *X*-, *Y*-, and *Z*-axes and rotation (Figure 3).[9] Five motion analysis parameters (MAPs) are registered independently for the right and left hand at a frequency of 100 Hz: pathlength (cm; total distance covered by an instrument's tip), insertion (mm; distance between minimal and maximal insertion along the instrument's axis), angular area (degr^2; related to the distances between the farthest positions of the instrument during a task), volume (mm^3; the three-dimensional space used), and time (s).[15]

Standardized Task and Instructional Video

Using inorganic materials a standardized task was created. The materials were fabricated to identical dimensions and fit into a custom-made frame to ensure a consistent set-up during repetitions of the task. It consisted of 4 clearly separate steps that stimulated bimanual instrument use (Figure 4). Although the task does not mimic (part of) a laparoscopic procedure, it does require several commonly used laparoscopic skills and techniques. Step 1 was to cut out a marked figure out of a piece of bandage. Step 2 was to cut open a second layer, made up of a noninflated balloon and partially cut the lumen of 1 of 2 underlying tubes to complete steps 3 and 4. The tubes were composed of modeling balloons (2 were used to provide a spare, in case the first tube was completely cut through). Step 3 was to