The American Journal of Surgery (2010) 200, 537–541

The American Journal of Surgery

Surgical Education

Transfer of training in the development of intracorporeal suturing skill in medical student novices: a prospective randomized trial

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KEYWORDS:
Laparoscopic suturing;
Surgical training;
Skills transfer

Abstract

BACKGROUND: To help optimize the use of limited resources in trainee education, we developed a prospective randomized trial to determine the most effective means of teaching laparoscopic suturing to novices.

METHODS: Forty-one medical students received rudimentary instruction in intracorporeal suturing, then were pretested on a pig enterotomy model. They then were posttested after completion of 1 of 4 training arms: laparoscopic suturing, laparoscopic drills, open suturing, and virtual reality (VR) drills. Tests were scored for speed, accuracy, knot quality, and mental workload (National Aeronautics and Space Administration [NASA] Task Load Index).

RESULTS: Paired *t* tests were used. Task time was improved in all groups except the VR group. Knot quality improved only in the open or laparoscopic suturing groups. Mental workload improved only for those practicing on a physical laparoscopic trainer.

CONCLUSIONS: For novice trainees, the efficacy of VR training is questionable. In contrast, the other training methods had benefits in terms of time, quality, and perceived workload.

Over 2 decades, laparoscopy has gone from a technique of controversial merit to one that undoubtedly has brought about a revolution in surgery, reshaping surgical practice. Performing surgery in a laparoscopic environment has brought benefits to the surgeon of improved visualization through magnification but also new challenges: loss of depth perception, limited haptic feedback, the fulcrum effect of instrument tips moving in directions opposite to hand movements, and restricted movement effects as a result of trocar placement. Even experienced surgeons struggle when faced with these constraints for the first time, highlighting the steep learning curve of laparoscopy.

Although training programs already were struggling to accommodate laparoscopy's growing prominence, the establishment of the 80-hour resident work week in the United States in 2003 brought more challenges. Within this context, providing adequate training proved more difficult than ever, especially because open surgical skills possessed by trainees were found not to transfer well to the laparoscopic environment.[1] With both laparoscopic and open surgery to teach, today's surgical curriculums need to be particularly efficient

Presented at the 11th World Congress of Endoscopic Surgery, September 2–5, 2008, Yokohama, Japan.

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Manuscript received July 15, 2009; revised manuscript December 11, 2009

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doi:10.1016/j.amjsurg.2009.12.018

and effective in their delivery of education to trainees. As programs try to move beyond the apprenticeship model of surgical teaching, increasing interest has been evident in the movement to apply science to surgical education and training. New models, technologies, and teaching strategies now are scrutinized appropriately by educators and leaders within the academic community. Demonstrated validity and transfer of training must now be in evidence to ensure widespread acceptance of any new teaching modality.

The slow, cautious, and still limited acceptance of virtual reality (VR) trainers exemplifies the examination that such new technologies receive. Numerous studies– best summarized in the systematic review by Sutherland et al[2]— have compared the efficacy of VR training with other training methods. Some studies support acquisition of skills through VR simulation; others contend that traditional box trainers produce a greater acquisition of or improvement in skills, and others show no difference between the two. The disparity in findings indicates trainer and task variation as well as the difficulty of measuring the value of something without easily defined outcome measures. In investigating whether VR practice improves intracorporeal suturing, one aim of this study was to contribute to the ongoing debate regarding the validity of these expensive machines, particularly when compared with other training modalities.

Laparoscopic suturing—much as is the case with open suturing—is without question a vital skill of any laparoscopic surgeon. In fact, suturing proficiency is required to attain the increasingly validated and accepted Fundamentals of Laparoscopic Surgery certification,[3] which as of July 1, 2009, must be completed successfully by all surgeons seeking board certification.[4] What is in question is the best method with which to teach this skill. On a broad scale, suturing can be broken down into 2 different learner processes. One is the cognitive aspect of the task, requiring an understanding of what conceptually must be done to place and secure a suture. The other is the physical, psychomotor aspect, whereby the trainee learns the movements and coordination necessary for task completion. Understanding how these 2 aspects interact and eventually lead to task mastery results in an efficient and effective approach to teaching a trainee. Because laparoscopic task mastery is reflected not only in performance but also in improved mental workload,[5] measures of both were chosen as important outcomes in this study through which we sought to determine an effective and efficacious means to train novice clinicians to perform laparoscopic suturing.

Methods

Intracorporeal suturing, a basic laparoscopic task, was taught under various training conditions to first- through fourth-year medical students with no significant prior open suturing experience and no prior laparoscopic suturing experience. Before entering the study, participants were required to indicate on a scale of 1 to 10 both what previous experience, if any, they had with suturing and what their comfort level was in terms of executing open suturing. The mean comfort level was 1.9, with only 11 participants indicating that they had any previous suturing experience.

Our experiment was composed of 3 distinct phases. The first phase included familiarization with intracorporeal suturing and baseline testing. The second phase included subjects practicing using 1 of 4 different training methods. The third phase included post-training testing for transfer of training and comparison of the relative efficacies of the different training methods. Phases 1 and 3 were identical for all subjects.

Initially, all subjects in groups of 2 to 6 received a 1-hour hands-on training given by the same minimally invasive surgery fellow who taught the same basic movements for securing a laparoscopic suture. In this first session subjects were educated in the use of laparoscopic graspers and needle drivers to suture a sponge in a laparoscopic video training box. At this session's end, the fellow showed intracorporeal suturing on a porcine intestine enterotomy model. The model consisted of a 6-inch section of porcine intestine secured onto a polystyrene plate. A transverse 10-mm enterotomy was made, and 2 targets for needle placement were drawn onto the intestine 5 mm away from each side of the enterotomy. After the demonstration, each subject was given a baseline test consisting of the successful placement and tying of a single suture on the model.

Four parameters—total time, knot quality, suture placement accuracy, and mental workload—were used to assess student performance. Subjects began with needles preloaded in the needle driver and instruments inserted into the training box. This was done because needle loading is a complex task on its own, and requiring novices to master it in addition to suturing would have changed the task focus and study. Total time was measured beginning from an audible signal that initiated the task to the time that the needle was cut off after placement of a suture and securing it with 3 throws. Students were instructed that for best quality the first throw should be a surgeon's knot, followed by 2 throws in alternate directions. The quality of suture placement was assessed using a quantifiable 5-point scale that was designed internally (Table 1). Accuracy was determined by measuring the distance (mm) between suture placement and the marked targets at the entry and exit sites.

Table 1 Scoring system used for knot quality assessment

Quality assessment	Available points
No visible gaps between stacked throws	1
Knot tight at base	1
Only edges are opposed (no extra tissue in knot, eg, back wall)	1
Knot holds under tension	2
Maximum points	5