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Surgical Resident Evaluations of Portable Laparoscopic Box Trainers Incorporated Into a Simulation-Based Minimally Invasive Surgery Curriculum

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Abstract

Introduction. Box trainers have been shown to be an effective tool for teaching laparoscopic skills; however, residents are challenged to find practice time. Portable trainers theoretically allow for extended hands on practice out of the hospital. We aimed to report resident experience with laparoscopic home box trainers. *Methods*. Over 2 years, all residents rotating through a minimally invasive service were given a portable trainer and access to a surgical simulation lab for practice. Each trainer contained a collapsible frame, a webcam with USB port, trocars, and laparoscopic instruments (needle driver, shears, Maryland and straight dissecting graspers) as well as Fundamentals of Laparoscopic Surgery skills testing materials. Residents were asked to log hours, usages, and their experience anonymously. *Results*. Twenty-three residents received a portable trainer. Fifty percent of the participants found the trainer useful or very useful, 25% said it was not useful, and 25% did not access the trainer. Those that used the trainer during their rotation did so 3.1 ± 3.0 times for 2.9 ± 3.0 hours/week. After completing their rotation, 5 of 12 residents used their trainer for an average of 10.2 ± 9.4 hours. Forty-two percent of the responders liked the accessibility of the home box trainers, while 25% criticized the camera–computer interface. *Conclusions*. Portable box trainers are useful and can effectively supplement a laboratory-based surgical simulation curriculum; however, personal possession of a portable simulator does not result in voluntarily long-term practice.

Keywords

simulation, surgical education, image guided surgery

Introduction

The meteoric rise of laparoscopy to the standard of care for many procedures over the past 20 years has significantly altered the practice of general surgery. At its advent, laparoscopy was not championed by surgeons at academic teaching hospitals, but instead by private practitioners who rarely participated in resident education.[1] Surgical resident education lagged further behind practice when instructors were forced to adapt didactic methods in the context of the 80-hour resident workweek and changing expectations of operating room (OR) efficiency and patient safety.

Teaching laparoscopic skills in the OR proved to be fraught with difficulties. The ergonomics of laparoscopy challenge the novice learner with paradoxical fulcrum instrument movement, as well as 2-dimensional viewing and loss of haptic feedback.[2] These hurdles to skill acquisition result in a steep learning curve.[3,4] Laparoscopic ergonomics also strain the learning dynamic in the OR when limited access to the site of surgery restricts the attending's ability to physically guide the resident and buffer against mistakes, resulting in a lower threshold for attending case takeover and fewer opportunities for the resident to acquire surgical skills. These learning challenges were quickly identified and addressed with an upsurge in related research as well as the formation of societal laparoscopic education committees, whose research findings catalyzed a paradigm shift in surgical education to include simulation-based learning outside of the OR.[5-8]

Simulation-based training was shown to be effective for teaching laparoscopic skills and formally integrated into resident surgical education in 2008 when the

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American Board of Surgery (ABS) mandated that all residents successfully complete the evidenced-based skills program, Fundamentals of Laparoscopic Surgery (FLS), before sitting for the ABS Certifying Examination.[7,9-15] Laparoscopic box trainers, on which FLS is conducted, virtual reality devices, and in vivo and ex vivo laboratory courses represent some of the most popular modules currently used in laboratory simulation centers. However, concerns about the ethics of in vivo models as well as the cost and schedule limitations of simulation centers have led to the development of low-cost portable box simulators.[16-18] In addition, recent evidence regarding laparoscopic skill acquisition suggests that portable box trainers may offer advantages over training on devices housed in simulation centers.[11,15,19]

We provided each resident with her own portable box simulator to facilitate laparoscopic skill learning during a skills laboratory-based MIS curriculum. Participants kept the trainer after completion of the rotation in hopes that the device would be beneficial to voluntary training initiatives later on in their surgical education. In this study, we sought to anonymously assess resident experience with portable laparoscopic box trainers both during their rotation and in the long term.

Methods

All general surgery residents rotating through a minimally invasive surgery (MIS) service received a portable laparoscopic box trainer as part of a MIS curriculum (Figure 1). Each portable trainer (TASKit; Ethicon Endo Surgery, Cincinnati, OH) contained a collapsible frame with a pegboard base, a webcam with USB port attachment, trocars, and laparoscopic instruments (needle driver, shears, Maryland and straight dissecting graspers). A setup guide DVD introduced assembly, webcam installation, and sample exercises. Also included were FLS skills testing materials, an instructional DVD for intracorporeal suturing techniques, and a skills kit containing plastic beads, rubber bands, metal posts of varying heights, and cards detailing skills tasks. Residents were encouraged to invent additional skills tasks.

The 8-week-long MIS curriculum included modules in open and laparoscopic surgical skills as well as basic and advanced endoscopy. Participants received an afternoon (4 hours) per week of protected training time to complete curriculum assignments in the skills laboratory as well as access to the skills laboratory from the hours of 9 AM to 5 PM Monday through Friday.

An anonymous, voluntary computer-based survey (SurveyMonkey; Palo Alto, CA) was administered to each resident via email. Only those who completed the evaluation survey were included in the analysis. The survey was designed to assess the hours of usage and number of practice sessions on the portable box trainer during their MIS rotation as well as in the time since the rotation ended. The survey included an open-ended, qualitative portion designed to assess the likes and dislikes of the portable box trainer system. Perceived usefulness of the trainer was assessed with a Likert-type scale. The time between completion of MIS rotation and evaluation of the portable trainer was recorded for each subject.

Descriptive statistical analysis including means, standard deviations, and ranges was conducted using SPSS version 19.0 (IBM Corp; Armonk, NY).

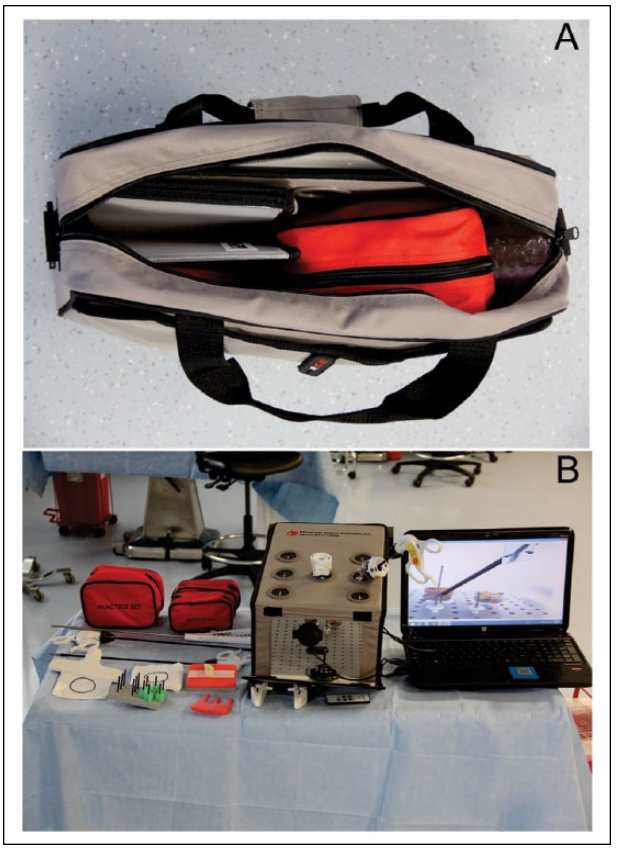

Figure 1. (A) The portable carrying bag containing the collapsed laparoscopic trainer and training materials. (B) The portable laparoscopic trainer deployed and running on a computer (not included in kit).
Depicted are the collapsible frame with a pegboard base, a webcam with USB port attachment, trocars, and laparoscopic instruments (needle driver, shears, Maryland and straight dissecting graspers) as well as FLS skills testing materials, a skills kit with plastic beads, rubber bands, metal posts of varying heights, and cards detailing skills tasks.

Results

Of the 23 residents who received the portable box trainer from May 2010 to July 2013, 12 completed the evaluation survey (52%). Residents reported using the portable

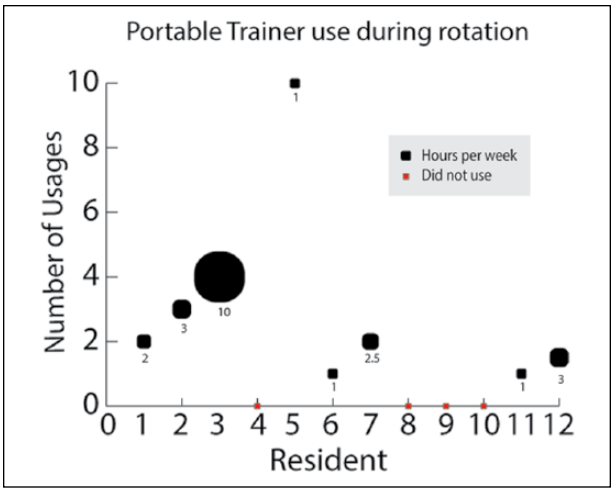

Figure 2. Portable trainer use during MIS rotation. Individual resident data are plotted against the number of times per week residents accessed the portable trainer during their rotation. The hours spent on the trainer per week is below each data point and represented by the area of the point.

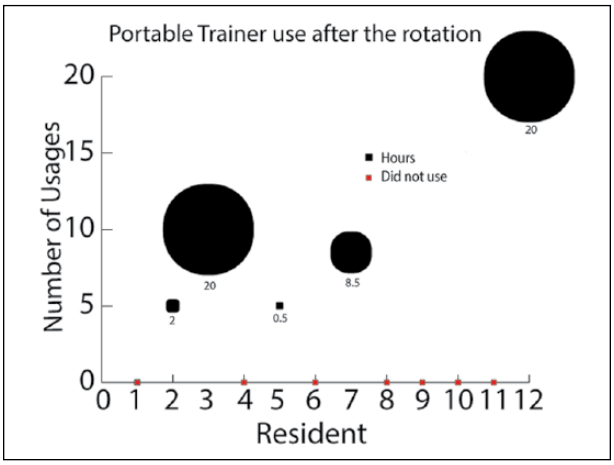

Figure 3. Portable trainer use after MIS rotation. Individual resident data are plotted against the number of times residents accessed the portable trainer after completion of their rotation. The total hours spent on the trainer after rotation is below each data point and represented by the area of the point.

box trainer 2.0 ± 2.8 times each week for 1.9 ± 2.8 hours per week during their MIS rotation. Twenty-five percent of residents did not access their portable trainer during their MIS rotation or afterwards. Those who used the trainer during their rotation did so 3.1 ± 3.0 times for 2.9 ± 3.0 hours per week (Figure 2).

At an average duration of 15.4 ± 11.9 months after completion of their MIS rotation, residents reported using their portable box trainer 4.0 ± 6.2 times for 4.3 ± 7.7 hours in total. Fifty-eight percent of the residents did not use the portable trainer after completing their MIS

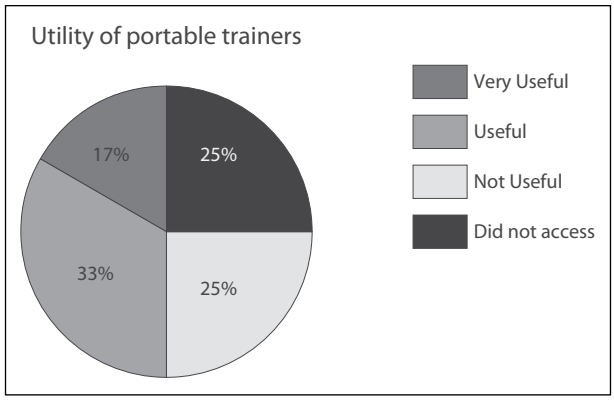

Figure 4. Perceived usefulness of the trainer. The graph summarizes responses collected with a Likert-type scale.

rotation, and the 38% of residents that used the trainer in that time did so an average of 9.7 ± 6.2 times for 10.2 ± 9.4 hours (Figure 3).

Fifty percent of the participants found the trainer useful or very useful, while 50% said it was not useful or did not access the trainer. Of those who accessed the portable trainer, 66% found it useful (44%) or very useful (22%), while 33% did not find the trainer useful (Figure 4). Forty-two percent of the residents liked the accessibility of the portable box trainers, while 25% criticized the camera or computer camera interface. Others felt that the portable trainer was "cumbersome to set up" and "did not have all of the instruments."

Discussion

With the expanding role of laparoscopy in general surgery, we hypothesized that access to a portable laparoscopic box trainer might be useful for surgical residents in conjunction with a simulation-based MIS curriculum and access to a skills laboratory. In addition, we hypothesized that ownership of a portable box trainer after a MIS rotation would be valuable for residents, perhaps for ongoing voluntary practice or FLS test preparation.

Even with access to a surgery skills lab and once-a-week mandatory lab training, residents reported using their portable trainer approximately 2 times for 114 minutes each week during their MIS rotation, which is, to the best of our knowledge, the highest rate of portable trainer usage in the literature. Korndorffer et al randomized residents to *home practice with a portable trainer* versus *skills laboratory trainer usage* and found no difference in time spent on the simulators.[15] Despite receiving encouragement to train for 1 hour per week, goal-directed learning standards, and video auditing of reported practice time, surgical residents used the portable trainer for a weekly average of 1.5 times and 50 minutes.[15] Another

study by van Empel et al found that residents used portable trainers for 49 minutes per week as part of an advanced laparoscopic suturing course.[19] Of the aforementioned studies, ours was the only one to include mandatory laboratory practice, which we expected to deter home portable trainer usage. However, the time of usage in our study was more than double reports from the other studies, suggesting that skills laboratory practice may catalyze greater home training on the portable simulator. Future comparative studies should address this possibility.

The majority of residents who used the trainer found it useful or very useful. We found that portable trainers, when integrated into rotations, bring an aspect of culpability to training that facilitates attending–resident mentorship. If the trainee is deficient in a skill area, the surgeon can request additional practice using the portable trainer. As the resident schedule often conflicts with typical working hours of the skills laboratory, access to a portable trainer better accommodates the day-to-day demands of a surgical residency. Indeed, residents most commonly praised the accessibility of the device, which facilitated an "ability to practice at any hour of the day or night." In Korndorffer and colleagues' comparative study, 80% of those who trained on a portable box trainer stated that they avoided doing so when fatigued, while all skills lab trainees reported training in a fatigued state.[15] By avoiding fatigue, which is known to negatively affect neurophysiologic function, mood, and performance on laparoscopic simulators, residents may have enjoyed more engaging practice sessions on the portable trainer.[20-24]

When averaged across all evaluations in this study, the usage of the portable trainer suggests a promising role in laparoscopic skills education; however, it is important to consider that a quarter of participants never used their portable simulator. In addition, the true percentage of residents who never used the trainer might be even higher as nonusers may have been less likely to respond to the survey. We believe that discriminating between those who will and will not use the portable trainer would be difficult given our anecdotal experience with residents of uniform excitement on receiving the simulator. Though it would require further assessment, we agree with others who feel strongly that goal-setting is important and may be critical for self-study, such as use with portable trainers.[25] Perhaps provision of FLS time goals or mandatory return of completed suturing practice items would have increased use of the box throughout residency.

While the frame, viewing platform, and camera of portable trainers are significantly lower in price than standard laboratory-based models, laparoscopic instruments represent a substantial cost for each unit.[18,26] In addition, although face and content validity has been demonstrated on other types of portable trainers, residents in our study raised concerns about the poor simulation quality of the portable trainer.[26] The most common criticism involved the computer/camera interface, which was described as "slow and awkward" with one responder stating that "the thing might actually make me worse at laparoscopic surgery." As high-resolution imaging is a definitive aspect of laparoscopy, the design of future portable simulators should focus improving the quality of the computer–camera interface.

This study represents the first evaluation of long-term portable laparoscopic box trainer usage by residents. We expected that access to a portable trainer would facilitate distributed, ongoing practice, which is known to prevent the erosion of laparoscopic skills and procedural competency.[12-14] However, we found that most residents do not voluntarily engage in ongoing training, as the majority of participants did not access the simulator in the 15 months on average after their MIS rotation. While we found little value in the distribution of portable trainers to surgery residents for long-term possession, perhaps studies using long-term, goal-directed curricula will better define the role of portable trainers in laparoscopic surgical education.

This study was limited by its small sample size. Over the course of 2½ years, 23 residents rotated through our service, but as the portable box trainer evaluation survey was anonymous and voluntary, there was little incentive for completion, and only 12 participated in the study. Although our study was not comparative in nature, the small sample size still limits the external validity of our experience and prevents us from conducting meaningful subgroup analysis. As small sample size is a common issue in surgical educational research, multi-institutional studies may more efficiently accrue large numbers of participants and reduce institutional effects. Another potential limitation to this study involves the self-report of resident portable box trainer usage. Many participants completed the survey a year or more after finishing their MIS rotation and thus the accuracy of those reports may be questioned. However, we analyzed the self-report of portable trainer usage during MIS rotation between residents who recently completed MIS rotation and longer-term participants and found no differences in responses.

Conclusions

Portable box trainers are useful and can effectively supplement a laboratory-based surgical simulation curriculum; however, personal possession of a portable simulator does not result in voluntarily long-term practice.

Authors' Note

This study was presented as a poster at the Society of American Gastrointestinal and Endoscopic Surgeons 2013 Annual Meeting in Baltimore, Maryland.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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