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Substituting Virtual Reality Trainers for Inanimate Box Trainers Does Not Decrease Laparoscopic Skills Acquisition

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ABSTRACT

Objectives: Inanimate and virtual reality box training help in developing basic laparoscopic skills. The lack of tactile feedback and lack of reality may be a detriment when training with virtual reality trainers. This study examined the hypothesis that there is no difference in laparoscopic skills acquisition when virtual reality trainers are partially substituted for inanimate box trainers.

Methods: Medical students without laparoscopic experience were randomized into either Group A or Group B. Group A performed tasks on the LTS 2000 (an inanimate box trainer) alone for 10 sessions. Group B performed tasks on the box trainer as well as on the MIST-VR (a virtual reality trainer) for 10 sessions. Scores for 5 inanimate box trainer exercises (time and errors) for the first and tenth sessions were compared between both groups.

Results: No statistical differences were seen in any exercises in the first session between Group A (n=14) and Group B (n=18) in either time or errors (P=NS for all comparisons). Mean times decreased in both groups from the first session to the last session. At the last session, again both groups demonstrated no differences in any of the exercises (P=NS for all comparisons).

Conclusions: No difference was found in laparoscopic skills acquisition when incorporating virtual reality trainers into a curriculum based on inanimate box trainers. Ideally, laparoscopic training laboratories should include both virtual reality and inanimate trainers.

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Key Words: Virtual reality trainer, Laparoscopic skills acquisition, Inanimate box trainer.

INTRODUCTION

Most surgical educators today understand that basic laparoscopic skills need to be taught outside of the operating room initially and that novel techniques in surgical education are necessary.[1–5] Laparoscopic surgery requires a different set of skills compared with skills needed for open surgery. These sets of skills are required due to the diminished tactile feedback, the fulcrum effect by trocars, the varied eye-hand coordination, the translation of a 2-dimensional video into a 3-dimensional working area, the occasional mirror image effect, and the loss of depth perception that are a part of laparoscopic surgery.[6]

It is known that basic laparoscopic skills are best taught before actual surgical procedures are performed. The old dictum of "see one, do one, teach one" is not valid anymore. Ideally, training should be multifaceted and include didactic learning, inanimate skills laboratory, and animate laboratory procedures. The dexterity and coordination necessary to perform laparoscopic tasks can be initially taught in an inanimate training laboratory.[2,3,7,8]

Although we feel that an inanimate laboratory should include inanimate box trainers (BTs) as well as virtual reality trainers (VTs), it is obvious that resources may limit obtaining both types of trainers.[5] One VT that has been appropriately validated in the literature is the Minimally Invasive Surgery Trainer-Virtual Reality (MIST-VR; Medical Education Technologies, Inc., Sarasota, FL).[9] There are various BTs, one of which, the Laparoscopic Training Simulator 2000 (LTS 2000; Realsim Systems, LLC, Albuquerque, NM),[6] has been demonstrated to help with laparoscopic skills acquisition. One major obvious disadvantage of the MIST-VR is the use of virtual reality, which does not allow for tactile feedback. Novice users also feel that the MIST-VR is less realistic and interesting than BTs are.[10]

We chose to investigate whether the lack of tactile feedback and lack of realism in the VT result in any difference in training. To do this, we partially substituted the VT in place of the BT. This study was designed to test the hypothesis that this substitution results in no detrimental effect on laparoscopic skills acquisition compared with inanimate box training alone.

METHODS

Our Institutional Review Board granted exemption for this study. We utilized medical students who volunteered for this study. All students were either first- or second-year (preclinical) students. The students were randomized into 2 groups. Both groups were trained for 10 sessions.

Group A was trained on the LTS 2000 for only 10 sessions. Each session was 20 minutes total. Sessions 1 and 10 were observed and graded. Group B had 10 sessions as well. Half of the time (10 minutes) was spent with the LTS 2000. The second half of the time (10 minutes) was spent with the MIST-VR. In Group B, the subjects did not alternate full sessions between the LTS 2000 and MIST-VR; instead, they divided their practice time evenly between the MIST-VR and LTS 2000 during each practice session. All students were instructed to practice the tasks for the full session time. If they completed the session with time to spare, students were instructed to repeat the task until the session time was complete. Session 1 and 10 on the LTS 2000 were both observed and graded. All students were given an introductory session (before Session 1) to explain the tasks as well as the trainers. Students were also observed during another session in the middle of their training.

There were 5 tasks in this study. Task 1 was placing pegs on a pegboard with the dominant hand (1D) and then with the nondominant hand (1N). Task 2 involved transferring pegs from one hand to another and then to the pegboard first starting with the dominant hand (2D) and then starting with the nondominant hand (2N). Errors included dropping a peg or grasping a peg with the wrong hand. Task 3 involved placing a pipe cleaner through a tube. For this task, dropping the pipe cleaner was an error. Task 4 was placing a probe through 3 different colored rings. An error was defined as placing the probe in similar colored rings instead of 3 different ones. Task 5 included progressing from one end of the rope to the other. Errors included dropping the rope or crossing the graspers. All tasks were graded for time and errors by 1 evaluator.

The MIST-VR module I was utilized and included 6 different tasks in easy setting. These tasks included (1) Acquire and Place, (2) Transfer and Place, (3) Transversal, (4) Withdraw and Insert, (5) Diathermy, and (6) Manipulate and Diathermy. Two-tailed, unpaired *t* tests were used for statistical analysis (GraphPad InStat Version 3.05).

RESULTS

The study included 32 students. Group A comprised 14 students; Group B comprised 18. The first session scores showed no statistically significant differences between Group A and Group B in mean times or errors for any task **(Table 1)**. The mean times improved in both groups ($P<0.05$; Session 1 versus Session 10 for all tasks for both groups).

Table 2 demonstrates that in all 5 tasks there were no statistically significant differences in either time or error between Group A and Group B in Session 10. It is interesting to note that in some of the tasks Group A had better times; while in other tasks Group B had better times. Again, none of the differences between the groups were statistically significant.

Table 1.
Scores for Session 1

Group A			Group B		
Task	Time	Errors	Time	Errors	P Value
1D	135.7	0.7	107.8	0.5	NS
1N	127.6	0.7	112.0	0.8	NS
2D	296.4	4.6	268.3	4.1	NS
2N	253.8	3.6	217.4	3.1	NS
3	89.2	0	82.8	0.1	NS
4	79.4	0.1	81.0	0.1	NS
5	131.4	0	156.8	0.1	NS

Table 2.
Scores for Session 10

Group A			Group B		
Task	Time	Errors	Time	Errors	P Value
1D	48.1	0.1	40.6	0.2	NS
1N	51.2	0.1	52.3	0.3	NS
2D	89.7	0.9	96.4	1.6	NS
2N	99.7	0.9	99.3	1.2	NS
3	37.4	0.1	30.5	0.0	NS
4	33.7	0.0	35.1	0.0	NS
5	61.9	0.0	65.6	0.0	NS

DISCUSSION

There were no differences between Group A and Group B before or after training. Our data demonstrate the substitution of virtual reality training for inanimate box training had no demonstrable effect on laparoscopic skill acquisition.

This study had some obvious biases and limitations. One major study bias is the metrics; we chose to test the students with BT tasks. It can easily be suggested that because Group A practiced exclusively on the BT, this study was biased and the students in Group A should have performed better. A more "neutral" metric choice may have been appropriate and may have shown that Group B actually could have better scores. Thus, we feel comfortable concluding that substituting training on a VT for training on a BT has no detrimental effect on skills acquisition. VT may, in fact, provide better training.

Another limitation of this study is that we did not test electrocautery use, which is a skill necessary for laparoscopic surgery. It is difficult to truly teach electrocautery with a BT. If we had tested this skill, we may have found that Group B did better with electrocautery because it was taught with the MIST-VR.

This study helps demonstrate and adds to the literature that virtual reality training is useful in teaching basic laparoscopic skills. More specifically, the data suggest that the lack of tactile feedback may not be an issue. In fact, it may be that trainees need to focus more on visual cues than tactile cues while learning on a VT. Actually, this may help trainees develop eye-hand coordination purely on the visual cues. Another advantage of the VT is its function for rating laparoscopic trainees. This can decrease the manpower needed to rate as well as provide immediate feedback to the trainee. Other advantages include the assessment of baseline ability as well as the assessment of individual hand performance.[5,11] Although the VT may not be as realistic or interesting as the BT,[10] the VT does help in laparoscopic skills acquisition.

CONCLUSION

We feel that in any basic laparoscopic skills laboratory VTs are needed, despite the lack of tactile feedback. Ideally, both virtual reality and inanimate box trainers have a role to play in a laparoscopic skills laboratory. Virtual reality trainers that incorporate haptics may not be necessary.

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