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Original research

Acquisition of fundamental laparoscopic skills: Is a box really as good as a virtual reality trainer?

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ABSTRACT

Background: Laparoscopic surgery requires working in a three-dimensional environment with a two-dimensional view. Skills such as depth perception, hand to eye co-ordination and bimanual manipulation are crucial to its efficacy.
Aim: To compare the efficiency of training in laparoscopic skills on a VR simulator with a traditional box trainer.
Method: Twenty medical students were recruited. An initial training session on the relevant anatomy and steps of a laparoscopic cholecystectomy was given. Baseline skills were recorded using a pre-training laparoscopic cholecystectomy on the VR trainer. Parameters measured were: (1) total time taken (mins); (2) number of movements right and left instrument; (3) path length (cms) of right and left instrument was recorded.
Ten students trained on a VR simulator, and ten on a box trainer, for three hours each. The box trainer group exercises were based on the Royal College of Surgeons core laparoscopic skills course, and the VR trainer exercises were based on the Simbionix LapMentor basic skills tasks. Following this both groups were reassessed by a laparoscopic cholecystectomy on the VR trainer.
Results: Both groups showed improvement in all measured parameters. A student *T*-test at 95% confidence interval showed no statistically significant difference between the two groups pre and post training.
Conclusion: Both the VR and box trainer are effective in the acquisition of laparoscopic skills.
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1. Introduction

1.1. Surgical simulation and training

When first introduced, laparoscopic surgery was associated with many complications. Surgeons who were experts in their relative fields found that when they performed the same operations laparoscopically, their open surgery skills did not transfer to the new technique.[1] This led to the development of skills laboratories that allowed surgeons to develop basic laparoscopic skills without putting patients at risk.

Simulation training has been used within the aviation industry, with similar requirements for high levels of technical skill, small margins for error and significant consequences for decades, with obvious benefits.[2]

1.2. Skills required for laparoscopic surgery

It is important for a trainee to develop manoeuvres required to manipulate instruments and tissue to the desired effect. Laparoscopic surgery demands very specific skills and capabilities that require initial learning of cognitive and motor skills followed by refinement of those skills. The prerequisites for skilled laparoscopic work include:

1) Depth perception. The surgeon is required to manoeuvre tissues and instruments in a three-dimensional environment with two-dimensional view.[3–5] 2) Adjustment to fulcrum effect. This creates conflict between visual and proprioceptive feedback.[3–5] 3) Hand-eye co-ordination 4) Bimanual manipulation 5) Handling of laparoscopic instruments and 6) Ambidexterity.

Methods to develop these skills outside the operating theatre would enhance training, safety and reduce operator stress.[6,7] Although in the past patient-based training with a mentor had been an acceptable way of learning, with pressure of service, reduced training and shallow learning curve of laparoscopic

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surgery requires novel, non-mentor based training. Simulators such as VR, box trainers allow this to happen. VR training has been proven to be an effective form of training; however, the cost of VR trainers and their maintenance limits the availability to trainees.

AIM: The aim of this study is to compare the efficiency of the VR simulator with the box trainer as a method of training in basic laparoscopic skills.

2. Method

Twenty laparoscopic novices were recruited, (ten male and ten female).

An introductory video of a laparoscopic cholecystectomy was shown and a demonstration on how to use the laparoscopic simulator – LapMentor-was given (Fig. 2).

Subjects carried out an index assessment using a laparoscopic cholecystectomy simulation; *Case 1 – Normal biliary anatomy, with variations in the cystic artery position,* on LapMentor™ (Simbionix, USA Corp) (Fig. 2). Baseline measurement of 1) total time taken (mins); 2) Path length of right instrument (cms), 3) path length of left instrument (cms) 4) number on movements right instrument, 5) number of movements left instrument was measured.[8] After training the volunteers were reassessed on the index laparoscopic simulation task using the same parameters.

Volunteers were split into two groups of ten, and trained on either the VR simulator (VR group), or box trainer (box group) for a total of three hours training time. The VR group trained on the LapMentor™ (Simbionix USA Corp.) on basic tasks: hand-to-eye co-ordination tasks (basic task 3), clipping and grasping (basic Task 5), two-handed manoeuvres (basic Task 6), cutting task (basic Task 7), electrocautery task (basic Task 8), translocation of objects (basic Task 9).

Box group trained on Large Body MITS (TRLCD05) (Fig. 1). Tasks were based on the Royal College of Surgeons' core laparoscopic skills course: 1) Moving rings between poles, 2) Moving beads between dishes, 3) building sugar cube towers (up to 7 cubes), 4) Suturing.

2.1. Analysis and statistics

Data using SPSS 13.0 and groups compared using a two-tailed *T*-Test with a 95% confidence interval.

3. Results

3.1. Total time taken

Before training, the VR group took an average of 25.42 min (range 13.26–36.55 min) versus the box group average 25.16 min (range 10.23–38.05 min) ($p > 0.5$). After training, the VR group took an average of 13.31 min (range 7.26–21.39 min) versus the box group average 16.48 min (range 6.26–26.42 min) ($p < 0.5$).

Fig. 1. Box Trainer: Large Body MITS (TRLCD05).

3.2. Number of movements with right instrument

In the VR group, the average number of movements of the right instrument in the initial procedure was 827.9 (range 480–1236); and the box group average was 905.2 (range 421–1503) movements ($p > 0.5$). After training, the VR group average was 482.7 (range 295–721) and the box group average was 599.8 (range 266–881) movements ($p < 0.5$).

3.3. Number of movements with left instrument

Prior to training, VR group made an average of 381.8 (range 185–538) movements with the left instrument; and the box group average was 361.2 (range 136–681) movements ($p > 0.5$). After training, the VR group average was 265.2 (range 124–484) and the box group was 288.5 (range 93–577) movements ($p > 0.5$).

3.4. Path length right instrument

In terms of path length of the right instrument, both groups performed to a similar Pre-training, the VR group average path length of the right instrument was 1849.75 cm (range 1142.8–2627.4 cm) versus the box group average of 1822.65 cm (range 1068.8–2804.8 cm), ($p > 0.5$). After training, the VR group average path length of the right instrument was 1257.25 cm (range 635.9–1826.9 cm), the box group average was 14944.7 cm (range 768.9–2142.4 cm) ($p < 0.5$).

3.5. Path length left instrument

The VR group's average left path length was 593.99 cm (range 219.3–913.6 cm) and the box trainer group average was 574.01 cm (range 166.9–1233.8 cm) with left instrument ($p > 0.5$). After training, the VR group's left instrument path length average path length was 508.05 cm (range 461.43–929.5 cm), compared to the box group's average 530.93 cm (range 165.8–954.1 cm) ($p > 0.5$).

4. Discussion

Although the set up costs of simulators is relatively high, the long-term use of simulators in training in the aviation industry has been shown to be cost effective. This is largely by way of a reduction in the learning curve that exists when training. It also increases the overall safety of training as initial mistakes are made on simulators as opposed to real life situations involving patients. The use of simulators in surgical training promises similar results.

Training on virtual reality simulators versus 'standard' laparoscopic training (the traditional apprenticeship model), did not reveal a difference in the overall operating time and complication rates (measured by number of cases converted to open).[9] There was however, a significant difference in overall 'safe' performance with the trainees from the VR simulator group performing significantly better. Performance was assessed by parameters such as tissue handling, path length of instruments and keeping instruments in field of vision.[9]

Studies suggest that simulator training is useful for acquiring psychomotor skills and for focused training.[10] To provide effective training for laparoscopic surgery, a combination of simulation and Halstedian apprenticeship model is required. Simulation training can be used to teach fundamental laparoscopic skills and safe practice when handling instruments. This would help reduce the

Fig. 2. LapMentor: (Simbionix, USA Corp).

learning curve for procedures as trainees can concentrate on the knowledge-based aspect required for performing surgeries. The usefulness of a virtual reality simulator can be increased by prior experience of actually handling the camera and endoscopic equipment, whereas the training box is more effective when training is performed under a supervisor who is familiar with the surgical procedure. A combination of both methods probably will achieve effective training for laparoscopic surgery.[10]

5. Conclusion

In conclusion, the acquisition of Basic Laparoscopic skills is effective on both the Box trainer and VR trainer.

Conflict of interest

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Ethical approval

Not required.

Author contribution

Parveen Vitish-Sharma – 1st Author. I designed and carried out the study. I also collected and analysed the data and wrote the article and am the corresponding author.

Jonathon Knowles – 2nd Author. Kindly help edit the final article.

Mr Bijendra Patel – Was my supervisor for the study and helped guide the design and progress of my study.

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