Simulated Laparoscopic Appendicectomy Project (SLAP) & its effects on objective performance metrics

Joseph Toms, Gurpreet Beghal, Mohamed Sheikh, David Rawaf, Matt Harris,Ross Davies

Introduction

Advances in technology have led to laparoscopic surgery becoming a common part of surgical practice. The main benefits of laparoscopic surgery include decreased length of postoperative ileus; decreased postoperative pain and narcotic use, improved cosmesis and higher patient satisfaction (1). The main constraints of laparoscopy include loss of depth perception and haptic feedback (2); the fulcrum effect and the use of instruments with limited range of motion (3). Adverse patient outcomes can occur if surgeons are not given adequate training and this is constrained further by the medicolegal, fiscal and time limitations of teaching operative skills in the clinic setting(4). The covid-19 pandemic has been particularly disruptful for surgical trainees as can be demonstrated by a recent review of UK surgical trainee logbooks comparing 2019 with 2020 which showed a 50% reduction in operations with trainees as the primary operating surgeons (5). This has caused delays to training especially amongst senior UK surgeons, 12% of whom had their training recognised as "delayed due to covid-19" in their annual review of competency progression (6). This has created the need for formal training outside of the operating room.

A recent 2020 systematic review of the literature has shown that simulation based training is an effective way for trainees to acquire surgical skills before entering the operating room (7).

Simulation based training can incorporate low fidelity 'box trainers' or high fidelity 'virtual reality' simulators or a combination of both involving augmented reality. However it cannot be determined based on current data which of the simulators is the most effective (8). The current study has been designed to assess the impact of augmented reality training on improving laparoscopic appendectomy using objective performance metrics.

Figure 1: The Inovus LapAR

Method

Design:
Utilising the LapAR™ by Inovus Medical Ltd (UK), we supervised surgical trainees performing several Augmented Reality simulated appendectomies interspersed with LapPass® tasks*. Objective metrics measured include time to completion, distance travelled by instruments, instrument acceleration, hand dominance and instrument time in view.
Comparison was made with a benchmark score set by an experienced minimally invasive surgery (MIS) surgeon. Subjective performance feedback was also provided by experienced surgeons using the work-based assessment (WBA) framework.
*Activities including laparoscopically passing thread through a hoop, manipulating hoops between instruments, positioning hoops on posts, cutting simulated skin within guidelines and placing sutures laparoscopically.

Setting:
A National Health Service (NHS) University Teaching hospital in South London.
Patients or Participants:
Surgical trainees (Senior House Officers and Registrars) qualified doctors of at least 1 year.
Interventions:
During the course, benchmarks of both LapPass® tasks and Appendicectomies were set by each trainee in addition to an experienced MIS surgeon. Trainees were then asked to perform a series of tasks including further Appendicectomies and LapPass® tasks. Following this period of intervention, trainees were set a final benchmark to compare to their original.

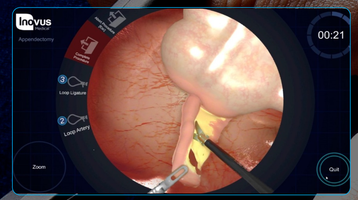

Figure 2: Simulated mobilisation of the appendix

Results

We found that the performance metrics improved when comparing initial & final benchmarks. In addition, the final benchmark metrics of the trainees were compared in a standardisation exercise to the benchmark set by the experienced MIS surgeon.

Of note, time to completion and distance travelled were both markedly reduced following the intervention period. WBA based review of performance demonstrated a marked improvement in surgical skill.

	Trainee 1	Trainee 2	Trainee 3	Trainee 4	Trainee 5	Cumulative
Completion Time (mins)						
Pre Laparoscopic Simulation	5.2	7.1	4.1	7.9	4.4	28.7
Post Laparoscopic Simulation	3.2	4.1	7.4	6	2.6	23.3
Distance Travelled (cm)						
Pre Laparoscopic Simulation	14.9	22.2	12.8	27.4	14.2	91.5
Post Laparoscopic Simulation	13	11.9	19	14.8	9.9	68.6

Table 1 displays the time taken to complete a simulated laparoscopic appendicectomy and the distance travelled by the laparoscopic surgical instruments during the simulated procedure, for 5 trainees prior to, and following competition of the LapPass tasks.

	Completion Time
Average improvement (mins)	1.08
Improvement (%)	19%
	Distance Travelled
Average improvement (mins)	4.58
Improvement (%)	25%

Table 2 displays the average improvement for the 5 trainees in time to complete the simulated laparoscopic appendicetomy and the distance travelled by the surgical instruments during the procedure with the average improvement displayed as a percentage.

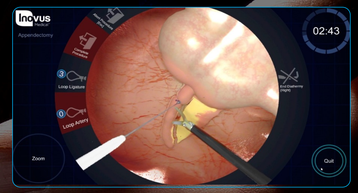

Figure 3: Simulated resection of the appendix

Conclusion

Augmented Reality task training using a high-fidelity Laparoscopic box trainer such as the LapAR™ improves objective and subjective performance in simulated appendicectomy completion. It can be inferred that this technique improves the surgical learning curve whilst safely taking it away from the live patient.

Discussion

Future studies should include faculty benchmarking, not only for comparison but also to see how long training on a LapAR™ is required to reach a consultant-level of performance. Furthermore, future studies can utilise likert scale based self-assessments to gauge trainee confidence levels prior to & after the intervention period.

Any future study will require a larger 'n' number which we will aim to facilitate via hospital trusts and training programs.

What benefits has the organization experienced as a result of the training?

How much did participants learn from the training and have their skills improved?

How much did participants learn from the training and have their skills improved?

How did participants respond to the training?

Figure 1. A Kirkpatrick Evaluation Pyramid highlighting outcomes 1 & 2 satisfied through this study.

In a concurrent study, we collected surveys prior to and after: including demographics, prior experience, and self-confidence scores for key laparoscopic tasks on a 1-10 scale, as well as operative skill data using Inovus AR simulation software. Every area of student's self-confidence improved, with a mean improvement of 3.82 (p=0.03). The more junior the student, the greater their increase in confidence (Mean Pre-FY = 5.23)."

References

1. Robert CG, Martin II, Kehdy Farid J, Allen Jeff W. Formal training in advanced surgical technologies enhances the surgical residency. The Am J Surgery. 2005;190:244–248.
2. Jones DB, Brewer JD, Soper NJ. The influence of three dimensional video systems on laparoscopic task performance. Surg Laparosc Endosc. 1996;6:191–192.
3. Gallagher AG, McClure N, McGuigan J, Ritchie K, Sheehy NP. An ergonomic analysis of the fulcrum effect in the acquisition of endoscopic skills. Endoscopy. 1998;30:617–622.
4. Hamdorf JM, Hall JC. Acquiring surgical skills. Br J Surg. 2000;87:28–37.
5. Joint Committee of Surgical Training, Association of Surgeons in Training, British Orthopaedics Trainees' Association, Confederation of Postgraduate Schools of Surgery. Maximising training: making the most of every training opportunity. 2021.
6. Health Education England. Guidance and principles for managing extensions to training during covid-19 (ARCP outcomes 10.1and 10.2). 2020. https://healtheducationengland.sharepoint.com/Comms/Digital/SharedDocuments/Forms/AllItems.aspx?id=%2FComms%2FDigital%2FShared Documents%2Fhee.nhs.uk documents%2FWeb site files%2FCovid19%2FCOVID-19_Managing_Extensions_to_Training.pdf&parent=%2FComms%2FDig
7. Spiliotis AE, Spiliotis PM, Palios IM. Transferability of Simulation-Based Training in Laparoscopic Surgeries: A Systematic Review. Minim Invasive Surg. 2020;2020:5879485. Published 2020 Aug 25. doi:10.1155/2020/5879485
8. Kalvach J, Ryska O, Ryska M. Laparoskopické simulátory a jejichsoučasný přínos pro chirurga [Existing laparoscopic simulators and their benefit for the surgeon]. Rozhl Chir. 2016 Jan;95(1):4-12. Czech. PMID: 26982186.

Acknowledgements

We are executives with Inovus Medical. In this response we have sought to avoid over-mentioning products or pushing sales. Our intention is to increase awareness of alternative augmented reality training options to drive surgical training away from the patient's bedside. We extend gratitude and thanks to SAGES for allowing us to present our findings.