The use of Augmented Reality Simulators in Laparoscopic Surgical Training

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Introductions

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)

Aim

To validate Augmented Reality for surgical simulation.

Method

Utilising a high-fidelity laparoscopic simulator (the LapAR by Inovus Medical (6), we validated efficacy through multiple studies targeting level 1 and 2 evidence. We then performed a health economics paper satisfying level 4 evidence alongside an appropriate systematic review of literature.

Results

A pilot benchmarked (7) two appendicectomies or vaginal cuff's with two rounds of intervening LapPass . One hour on the simulator found 'time' savings of 19% and 36.9%, and 'distance(m)' savings of 25% and 56.5% respectively.

A multi-centre has shown that 10 appendectomy benchmarks, with three LapPass rounds in two weeks can reduce 'time' by 55-66% and 'distance' by 39-72%.

Self-confidence scores on a day course indicated that all areas improved by amean of 3.82 (likert, p=0.018).

A BMJ peer-reviewed health economics review8 was then performed using estimated costs. The potential ROI for the NHS was deduced. At 100% translation rate with validation data, we save £455 per patient through reduced anaesthetic time and shorter inpatient stay.

Finally, a SR (n=26) of literature on the main four (AR vs VR vs traditional vs cadaveric) demonstrated that AR is preferred, improves procedural success & faster skill acquisition.

Conclusion

Reduced complication rates, anaesthetic time and ability to reduce waiting list burden would form future scopes of study.

However, we can now infer that AR-based laparoscopic training with the LapAR is not only preferred, but it is more effective at providing clinically translatable, and scalable cost-effective laparoscopic training as a potential new gold standard.

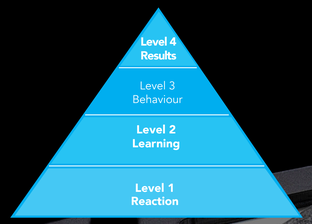


Figure 1. A Kirkpatrick Evaluation Pyramid highlighting outcomes 1, 2 and 4 satisfied through this study.

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)."



Figure 1: The Inovus LapAR

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Graph 1



Graph 2

Completion Time	19 - 36.9%
Distance Travelled	25 - 56.5%
Self Confidence	3.82 (p=0.018)

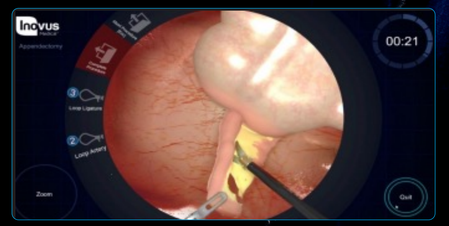


Figure 2 Simulated mobilisation of the appendix

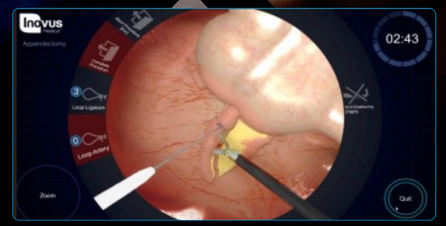


Figure 3 Simulated resection of the appendix

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