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Research Article

Pre-course instructional videos and home-based laparoscopic suturing simulation enhances the educational impact of a laparoscopic training course

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ABSTRACT

Introduction: We developed a home-based laparoscopic suturing simulation (HBLSS) technique, which is intended to improve the impact of a structured laparoscopic training course.
Method: A group of sixteen students were provided with the educational video, and after two weeks, all students were observed and timed performing a laparoscopic reef knot. The students were then randomized into two cohorts. The exclusive video group continued using the video for a further two weeks. The second group were shown the HBLSS technique and told to use this in conjunction with the video for a further two weeks.
Results: The entire cohort had an initial median time to form an intracorporeal reef knot of 190 s (range 459, IQR 128). After two additional weeks of using the educational video exclusively, the median time was reduced to 85 s (range 282, IQR 125), whereas the HBLSS and educational video group had a median post-training time of 28.5 s (range 36, IQR 18.5). There was a clear statistical difference between the exclusive video group and the HBLSS and video group ($P = 0.008$). There was also an improvement from the movement of both instruments to one instrument, reduced crossing of instruments and reduced transverse movement in the HBLSS and video group.
Conclusion: A combination of video-based teaching and HBLSS was associated with improved laparoscopic intra-corporeal knot-tying skills in comparison to the exclusive video-based teaching. This reflects the importance of imparting both cognitive and psychomotor skills to students practising laparoscopic surgery.

Introduction

Several factors have had a cumulative impact on surgical training over the last three decades. The heightened concern around patient safety has led to simulation models being used for technical surgical training. In addition, increased emphasis on resource usage and efficiency, as well as the impact of increased sub-specialization on the exposure of surgical trainees to operative procedures, means that trainees are expected to achieve and demonstrate surgical competency before being allowed to operate on a patient. Minimal access surgery (MAS) is a core component of modern surgical care, and ensuring competency in MAS is now a major objective of all modern surgical training programs. Obtaining competence in MAS prior to operating room exposure is now heavily dependent on the use of surgical simulation. Surgical simulation has been shown to be reliable and effective in imparting competency in MAS [1,2]. There is a global discrepancy in the availability of surgical simulators and training models around the world. In developing countries, there is a huge unmet burden of surgical disease and a lack of access to surgical care. This has been well highlighted by the Lancet Commission on Global Surgery [3]. What has been perhaps less emphasized is that there is also a global imbalance in access to surgical training, and this applies to access to surgical simulation [4,5]. In response to this, our unit has developed a laparoscopic suturing simulation course and has published on our initial experience with this course [6]. However, there is a high demand for this course, which is oversubscribed, with places on the course being at a premium. In light of this, improving the educational impact of this course by enhancing the efficacy of pre-course self-study material is a priority. In response to this need, we have developed a home-based

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Abbreviations

Home-based laparoscopic suturing simulation (HBLSS)
Minimal access surgery (MAS)
Interquartile range (IQR)

laparoscopic surgical simulation (HBLSS) technique for use by all students enrolled for the course. This paper describes our experience with the development and use of this (HBLSS) technique. It goes on to quantify the impact of this HBLSS on the efficacy of the laparoscopic simulation course.

Course development

As previously described, our unit has access to six fully independent, functional MAS simulation stations with modified box trainers, and the skills laboratory can house twelve students. (Fig. 1) The course is run four times a year. Prior to attending the laparoscopic training course, all students are expected to view an instructional video. This video has been specifically created by the faculty and demonstrates intra-corporeal reef knot tying. The video highlights specific principles of intra-corporeal reef knot tying. These include the non-crossing of instruments, the primacy of vertical over the horizontal movement of instruments and the movement of one instrument at a time during loop formation. The course consists of a five-hour session on intracorporeal reef knot-tying simulation. Students commence using a wooden block and shoestrings and progress to intra-corporeal reef knot-tying simulation in box trainers on suture pads and eventually on animal tissue.

A home-based laparoscopic surgical simulator (HBLSS), which makes use of everyday household items, has been developed to help students acquire both surgical cognitive and psychomotor skills prior to undertaking the course. It is envisaged that the HBLSS will be used by the students in conjunction with the instructional videos and self-study material. Trainees use the index and middle fingers of both hands to simulate the jaws of needle holders. Strings are used to simulate sutures, which are tied to a solid arm such as the handle of a kettle. Fig. 2 demonstrates how this simple model allows for the simulation of intra-corporeal reef knot tying. The HBLSS is expected to be used in conjunction with the intracorporeal reef knot-tying video. We set out to investigate the efficacy of the HBLSS using a randomized observational approach.

Study

Ethical approval was obtained from the University of KwaZulu Natal Biomedical Research Ethics Committee. A group of sixteen candidates who were awaiting a slot on the laparoscopic training course were the study participants of this study. All candidates were given the standard course video demonstrating how to perform a laparoscopic intra-corporeal reef knot. All candidates were encouraged to watch the video daily for two weeks, after which all candidates were observed performing intra-corporeal reef knots on a synthetic suture pad with marked points in a modified box trainer and Karl Storz Tele Pack stack. Each candidate's time to complete an intracorporeal reef knot satisfactorily was video recorded. Following this, the participants were then randomized into two groups of eight. The control group (video exclusive) continued to watch the instructional video daily. The test group (HBLSS and video), in addition to the instructional video, were shown the HBLSS technique and instructed to perform the HBLSS at home as part of their self-study program. Attempts were made to standardize potential confounding factors by keeping the time of exposure to both groups constant. After a further two weeks, all students were observed and video recorded performing laparoscopic intra-corporeal reef knots.

Fig. 1. Karl Storz Tele pack with box trainer.

Data documented was task completion time and the ability to follow the principles of no crossing instruments, more vertical versus horizontal movement of the instruments and the movement of one instrument at a time were collected.

Statistics

Three independent consultants assessed the data. The data was annotated on an Excel sheet, and statistical analysis was done using Jamovi.

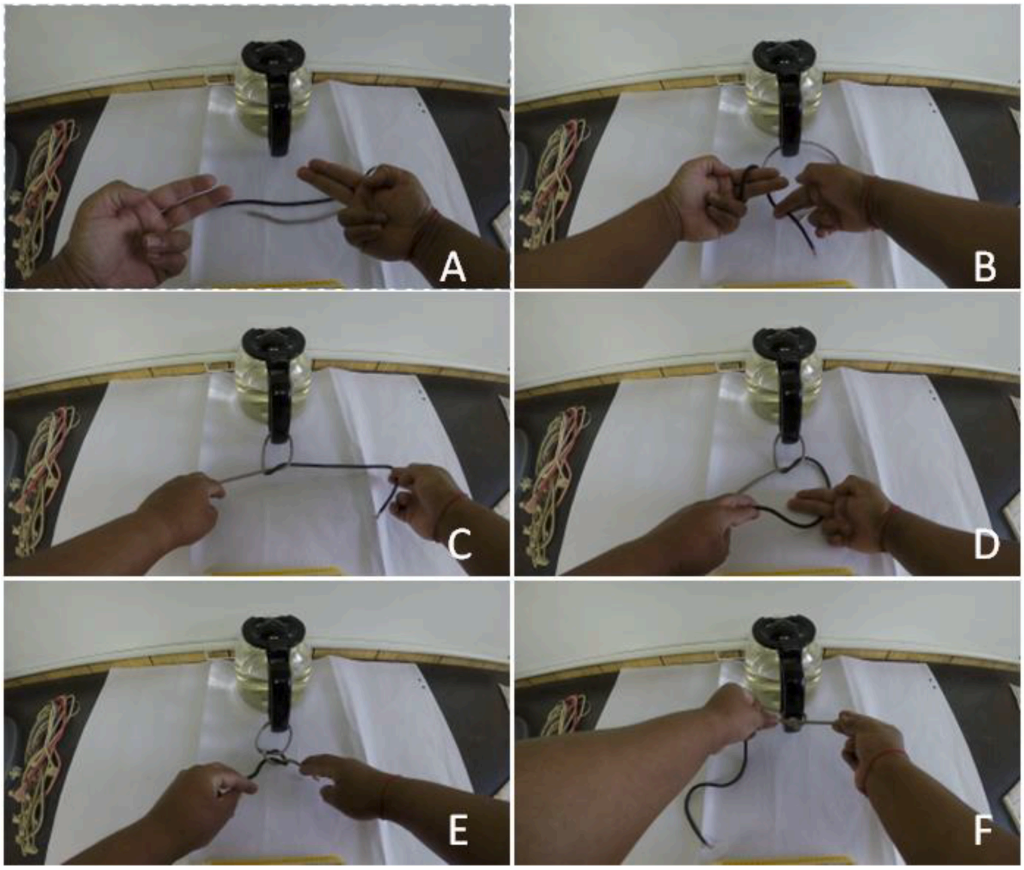

Fig. 2. Simulation of an intra-corporeal reef knot making use of hands and fingers as needle holders (A-F).

Results

An opportunistic group of sixteen surgical students were enrolled. There were seven female and nine male students. All were right-hand dominant, had worked in the department for less than a year, and were similarly matched in terms of previous MAS experience and training. (Fig. 3) The entire cohort had an initial median time to form an intracorporeal reef knot of 190 s (range 459, IQR 128). After two additional weeks of using the educational video exclusively as a form of training, the median time was reduced to 85 s (range 282, IQR 125), whereas the HBLSS and educational video group had a median post-training time of 28.5 s (range 36, IQR 18.5). (Table 1) In Fig. 4, the range of the times is demonstrated with the exclusive video group having a wide range compared to a very narrow range in the HBLSS and video group. There was a statistically significant difference in the HBLSS and video group ($P = 0.008$) compared to the exclusive video group. (Table 2) There was a marked improvement, 25–100 %, in the change from moving both instruments to one instrument at a time in the HBLSS and video group. The exclusive video group improved slightly by 12.5 % regarding moving both to one instrument at a time. Crossing of instruments was also markedly improved in the HBLSS and video group compared to the exclusive video group. The change from horizontal to vertical movement of the instruments to form loops also improved to 100 % in the HBLSS and video group, with only a moderate improvement of 50 % noted in the exclusive video group. (Table 3)

Discussion

Surgical simulation is a well-established part of modern surgical training. However, access to surgical simulation is unevenly distributed worldwide. Low- and middle-income countries have a huge need and demand for surgical simulators with limited access to these devices [7,8]. Access to surgical simulators in our setting is limited, and places on the formal MAS courses are at a premium [9,10]. This means that faculty need to ensure that the educational impact of the formal course is maximized. Developing innovative and inexpensive methods to enhance the educational impact of the laparoscopic training course is a priority. Appropriate pre-course self-study material must act synergistically with the course and ensure that all candidates have already acquired an appropriate level of skills before commencing the course.

The use of educational videos as a part of self-study is now widespread, and these videos can be housed on dedicated websites as well as on commercial sites such as YouTube. The use of instructional videos as part of the pre-course study material is cheap and repeatable. There is no doubt that students do make use of these videos as part of their self-study programs [11]. Unfortunately, these videos will provide theoretical knowledge but may not be able to impart appropriate psycho-motor skills [12]. The use of simulators provides an opportunity to acquire psycho-motor skills by teaching sensory perception and depth awareness. This has been demonstrated repeatedly using surgical simulators. Rosser et al. showed that progressive drills to perform laparoscopic intracorporeal suturing resulted in improved knot-tying time [13]. Other authors have also successfully taught laparoscopic intracorporeal suturing using simulators over multiple days [14]. Access to these sophisticated simulators is limited in our environment. We have shown improved skill acquisition using a home study program of educational videos and HBLSS over a two-week period. This appears to be a cost-effective solution where access to more sophisticated surgical simulators is at a premium. The use of HBLSS and educational videos allows students to improve their psychomotor skills prior to completing a formal course on a surgical simulator. A combination of an instructional video and HBLSS is effective in terms of both educational impact and cost and should be increasingly used as part of our educational pedagogies.

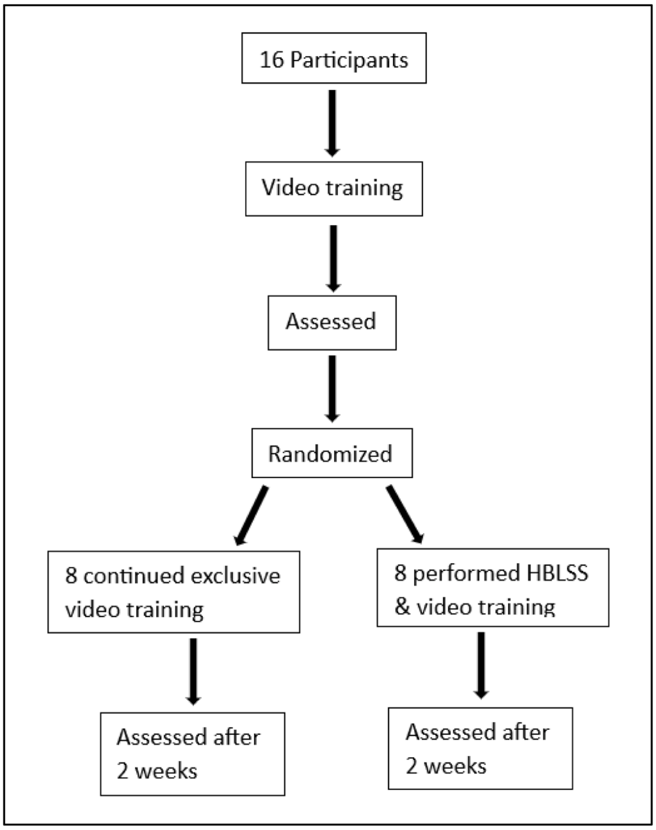

Fig. 3. Flow diagram depicting how the candidates were exposed to the two different training methods and assessed.

Table 1
Descriptives of data collected.

	Pre	Post Video	Post HBLSS
N	16	8	8
Mean	189	147	27.4
Median	190	85.0	28.5
Standard deviation	120	111	13.1
IQR	128	125	18.5
Range	459	282	36
Minimum	55	48	10
Maximum	514	330	46

The limitations of our study include small comparative groups and the performance of laparoscopic intracorporeal suturing using simulation on suture pads. This could serve as a pilot for a larger study and long-term follow-up with the trainees.

Conclusion

A combination of video-based teaching and HBLSS as part of a pre-course self-study program improves laparoscopic intra-corporeal knot-tying skills significantly more than exclusive video-based teaching. This reflects the importance of teaching both cognitive and psychomotor skills.

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CRediT authorship contribution statement

Hansraj Mangray: Conceptualization, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Sanele Madziba:** Conceptualization, Data curation, Investigation, Writing – original draft.

Table 2
Paired Samples T-Test of the control & test groups.

			Statistic	p
Pre	Post Video	Wilcoxon W	25.0	0.383
	Post HBLSS	Wilcoxon W	36.0	0.008

Note. H_a μ Measure 1 - Measure 2 $\neq$ 0.

Table 3
Comparison of other factors that were observed in the video and HBLSS groups.

	Pre-Video only	Post-Video only	Pre-HBLSS & video	Post-HBLSS & video
Movement of one instrument	0	12.5 %	25 %	100 %
Movement of two instruments	100 %	87.5 %	75 %	0
Crossing of instruments	100 %	87.5 %	87.5 %	0
More vertical movement	75 %	50 %	25 %	100 %
More horizontal movement	25 %	50 %	75 %	0

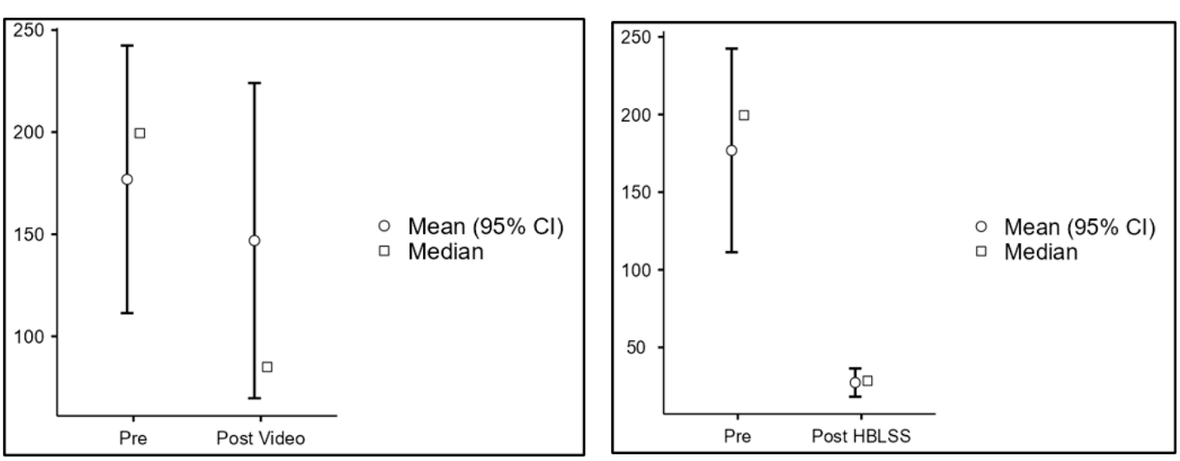

Fig. 4. Pre & post timing descriptive plots of the Video and HBLSS groups.

Shamaman Harilal: Conceptualization, Data curation, Investigation, Methodology. **Yashlin Govender:** Data curation, Investigation, Methodology, Writing – original draft. **Amanda Ngobese:** Data curation, Investigation, Methodology, Writing – original draft. **Damian L Clarke:** Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Al-Kadi AS, Donnon T, Oddone Paolucci E, Mitchell P, Debru E, Church N. The effect of simulation in improving students' performance in laparoscopic surgery: a meta-analysis. Surg Endosc 2012;26(11):3215–24. Nov.

[2] Al-Kadi AS, Donnon T. Using simulation to improve the cognitive and psychomotor skills of novice students in advanced laparoscopic surgery: a meta-analysis. Med Teach 2013;35(sup1):S47–55. Apr.

[3] Meara JG, Leather AJM, Hagander L, Alkire BC, Alonso N, Ameh EA, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. Lancet North Am Ed 2015;386(9993):569–624. Aug 8.

[4] Koto Z. Minimal access surgery training in South Africa - changing philosophy and enabling the future. S Afr J Surg 2020;58(4):174–5. Dec.

[5] Patel N, Leusink AL, Singh N, Koto MZ, Luvhengo T. Registrar perceptions on general surgical training in South Africa: a report by the South African society of surgeons in training (SASSiT). South Afr J Surg Suid Afr Tydskr Vir Chir 2018;56 (2):10–4. Jun.

[6] Mangray H, Madziba S, Harilal S, Govindasamy V, Govender M, Ferndale L, et al. Developing a novel laparoscopic training model during the COVID-19 pandemic in a resource-limited setting. Surg Pract Sci 2023;13:100170. Jun 1.

[7] Wilkinson E, Aruparayil N, Gnanaraj J, Brown J, Jayne D. Barriers to training in laparoscopic surgery in low- and middle-income countries: a systematic review. Trop Doct 2021;51(3):408–14. Jul.

[8] Andreatta P, Perosky J, Klotz J, Gamble C, Ankobea F, Danso K, et al. Pilot study outcomes from a resource-limited setting for a low-cost training program for laparoscopic surgical skills. Int J Gynecol Obstet 2014;125(2):186–8. May.

[9] Stevens PS, Villiers MD, Niekerk MV. A survey on the current status of laparoscopic training in paediatric surgery in South Africa. SAJS 2011;49(1):3.

[10] Jooma U, Numanoglu A, Cox S. Paediatric surgery training in South Africa: trainees' perspectives. Pediatr Surg Int 2020;36(12):1489–94. Dec.

[11] Celentano V, Smart N, Cahill RA, McGrath JS, Gupta S, Griffith JP, et al. Use of laparoscopic videos amongst surgical trainees in the United Kingdom. Surgeon 2019;17(6):334–9. Dec 1.

[12] Shaker D. Cognitivism and psychomotor skills in surgical training: from theory to practice. Int J Med Educ 2018;9:253–4. Sep 28.

[13] Rosser JC, Rosser LE, Savalgi RS. Skill acquisition and assessment for laparoscopic surgery. Arch Surg Chic Ill 1960;132(2):200–4. 1997 Feb.

[14] Mereu L, Carri G, Albis Florez ED, Cofelice V, Pontis A, Romeo A, et al. Three-step model course to teach intracorporeal laparoscopic suturing. J Laparoendosc Adv Surg Tech 2013;23(1):26–32. Jan.