ORIGINAL ARTICLE

Effectiveness of Simulation Training for Minimal Access Surgery (MAS) in PG Students

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Abstract

The use of simulation-based medical education and learning is one of the most crucial phases in curriculum development. A synthetic depiction of a real-world procedure used to accomplish educational objectives through hands-on learning is referred to as simulation. Any educational activity that uses simulation aids to mimic clinical circumstances is referred to as simulation-based medical education. Instead of studying like an apprentice, medical simulation enables the purposeful practice of clinical skills acquisition. Real patients can be substituted using simulation technologies. A trainee does not have to worry about hurting the patient in order to make errors and grow from them. Simulators come in a variety of forms and classifications, and their prices vary based on how closely they mimic reality, or "fidelity". The cost of simulation-based learning is high. But when used correctly, it's economical. It has been discovered that medical simulation improves clinical competency for both undergraduate and graduate students. It has also been discovered to have several benefits, including raising medical providers' competency levels, which can lower medical expenses and increase patient safety. This narrative review article's goal is to emphasize the value of simulation as a cutting-edge teaching strategy for graduate and undergraduate students.

Keywords: Clinical skills, Diagnostic laparoscopy, Laparoscopic, Medical education, Medical simulation, Surgery, Surgical Procedure, Simulators.

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Introduction

One of the medical specialties where expertise is crucial is general surgery. Laparoscopy surgery is now considered a fundamental skill. However, due to their greater complexity than open surgery, laparoscopic techniques are harder to learn. Additionally, more and more novel techniques are emerging. We are now able to train in a secure and controlled environment thanks to simulation, which is emerging as a complementary tool for the development of surgical skills. There is apprehension about practicing on actual patients, which takes time and can result in greater issues. Additionally, there is a greater demand for skill coordination, which calls for more repetition and practice. If we could begin training our Residents in our simulation lab early, it would boost their self-confidence and allow them to acquire superior abilities. Laparoscopic simulation-based training can therefore be more beneficial than training with actual patients. Today, simulators are frequently used in medical and surgical training.

Rapid modifications have been made to medical education worldwide in response to all of the present challenges.[1,2] Many factors contributed to these advances, such as changing population needs and the many scientific and technical advancements brought about by the evidence-based body of medical knowledge. Innovative approaches must be used since medical education is evolving and new educational paradigms are being established.[3] It has been demonstrated that a virtual reality simulator can enhance initial laparoscopic and minimally invasive surgery abilities as well as advanced suturing skills at the initial stage. Performance has been evaluated using pre-post training exams. These incidents are mostly related to medical education, which has to use the best teaching resources to transform inexperienced doctors. Pre- and post-training assessments have been used to assess performance. These phenomena are mostly related to medical education, which has to use the best teaching techniques to turn novice students into qualified experts. These constant disputes have made new and creative approaches to teaching, learning, and evaluation possible. Simulation facilitates risk-free learning in difficult, crucial, or uncommon circumstances and supports multidisciplinary and team-based learning strategies in the medical field. Furthermore, simulation can be useful in outcome evaluation and accreditation. Virtual reality refers to the computer simulation of various skills encountered in real life. The trainee reacts in a scenario with realistic elements that can be changed and adjusted as needed.

Simulation enables appropriate instruction and consistent evaluation of the skills needed to deal with an ever-shifting environment through supervised experiences in safe environments. We outlined the history and background of the clinical simulation in this paper, as well as described the present state of the art in this field and suggested future approaches. With patient care and public health as its ultimate goals, this study hopes to mold the next generation of health educators and professionals.

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The Past and Present of Simulation

Because imitation is ubiquitous in nature, simulation predates the existence of man. Jean Baudrillard argues that imitation has the potential to supplant reality. The first full-body simulator (called "Ms. Chase") was used at Hartford Hospital in 1911 to teach nursing skills.[4,5] In aviation instruction, the look of simulation is critical. During World War II, hundreds of pilots were trained with great success using the "Link Trainer" flying simulator.[6] These days, simulation is a key tool used by the aviation industry to train its employees and support the creation of strict safety regulations.[7] A simulator is more successful in practicing specific piloting maneuvers, and "no one could imagine using an aircraft to train today." Observing the procedures employed to decrease errors in aviation can reveal new alternatives for reducing medical errors in health.[8] Since the mid-twentieth century, various simulators for medical education have been developed, including the Resusci AnneTM, SimOneTM, NoelleTM, and SimManTM, which have enhanced the quality of simulated scenarios and also made them more realistic.

There are simulation centers across the globe, including simulated healthcare setups or virtual hospitals, that have similar equipment as real hospitals. This permits the requalification of professionals who are currently working with patients as well as the training of students. Along these lines, simulation has been considered as one of the fundamental aspects utilized in CME (Continuing Medical Education), with the goal of maintaining and improving previously learned abilities in situations comparable to those seen in real-world settings.[9] Being able to acquire "knowing," "knowing how to do," and "knowing how to be" abilities makes this methodology significantly superior to other approaches.[10]

It is possible to create safe, reproducible, standardized, regulated, and predictable simulation settings. Practise skills needed for rare scenarios, such as managing cardio-respiratory arrests, is made possible by the simulation. Moreover, the simulation situations may be run again until the desired degree of training is attained. When presented with a similar circumstance in clinical practice, this facilitates effective performance. It is feasible to train to a high degree by doing a skill repeatedly and receiving appropriate feedback. Simulations are not perfect and may not accurately represent reality. As a result, it is important to create a "fiction contract" and communicate with and guide the student so that this "lack of reality" does not affect future performance. Scenarios should be reviewed on a regular basis to ensure that they are still relevant.

The simulation creates realistic environments. Because powerful emotions are involved in psychologically safe and effective feedback situations, which together support long-term learning, this modality facilitates multimodal learning. This improves educational system efficiency in terms of costs and training time. Although the link between the two is not entirely clear, engaging emotions may help with long-term learning.[11] When compared to other methods of skill acquisition, emotional learning is more effective.[12] Modern simulation techniques come in a variety of forms, from part simulator training for specialized skills to immersive environments employing techniques like virtual reality, surgical simulation, and standardized patients to learn numerous and complicated abilities.[13] Gurusamy et al. have published an intriguing systematic review.

Hence, the study was undertaken to train first and second-year postgraduate students in laparoscopic skills so as to improve hand-eye coordination, train them for basic laparoscopic procedures like endo suturing, and give early exposure to basic/advanced laparoscopic procedures.

Methodology

It was a cross-sectional study conducted at the Simulation lab of Dr DY Patil Medical College Hospital and Research Institute, which included all 20 Medical Residents from the General Surgery Department of the college. A Simulation-based module was used to teach and assess the use of early basic laparoscopic training for the duration of 1 year (2021–2022). The focus of this module was to make them aware of all the laparoscopic instruments and take care of them and train the residents in basic laparoscopic procedures such as camera navigation, clip application, cutting, and needle driving.

Three training sessions, each one month apart was conducted for all students focusing on simulation-based laparoscopic training, their progress was assessed in each session by training Faculty, and at the end of the training, the final assessment was done by a neutral laparoscopic-trained faculty other than the trainer on set parameters. Regular feedback from faculty and students was taken.

Laparoscopic training was done on Cae Healthcare LapVR including training sessions planning, hands-on education station, simulation-based training and assessment. The mode of Data collection was through a Standard performance sheet from the lab, DOPS, Feedback from faculty and students, and data was tabulated using paired-*t* test.

Observations

Laparoscopic surgery training using virtual reality simulations gives the option of training without using actual patients. In addition to encouraging team-based and interdisciplinary learning approaches in the field of healthcare, simulation offers a way to learn without taking any risks in complex, important, or uncommon circumstances. Furthermore, accreditation and outcome evaluation are two areas where simulation can be very helpful. Virtual reality is the term used to describe the computer-based simulation of various real-world abilities. In a scenario that has elements that could be altered and adjusted to achieve the desired degree of performance, the trainee responds. As a result, virtual reality simulators offer a promising method for complicated laparoscopic surgery instruction. However, since the virtual reality simulation training involves time and money investment, its efficacy as a teaching method needs to be demonstrated. Residents, new surgeons, and surgeons with different levels of experience must learn the principles, get training in both basic and advanced laparoscopic procedures, or receive training in unusual scenarios in the context of minimally invasive surgery, a field that is still developing.

As a result, various levels of human behavior should be examined to determine the efficacy of virtual reality simulation training. Three stages of human behavior are identified by Rasmussen's model: knowledge-based, rule-based, and skills-based behavior.[14]

Skills-based behavior is concerned with actions by surgeons that happen automatically, such as moving the tools as a result of the fulcrum effect. A behavior dependent on skill is suturing. At this stage, box trainers or virtual reality simulators can be used for training. Task execution governed by rules or processes is considered rule-based behavior. The operation protocol, which specifies the procedure to be followed, is an example of a job at this level. For instance, prior to dividing the cystic duct and cystic artery during laparoscopic surgery, they must first be isolated

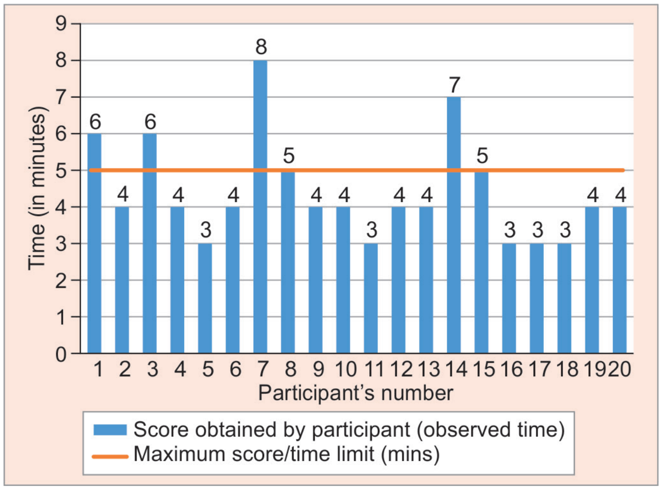

Fig. 1: Time for camera navigation

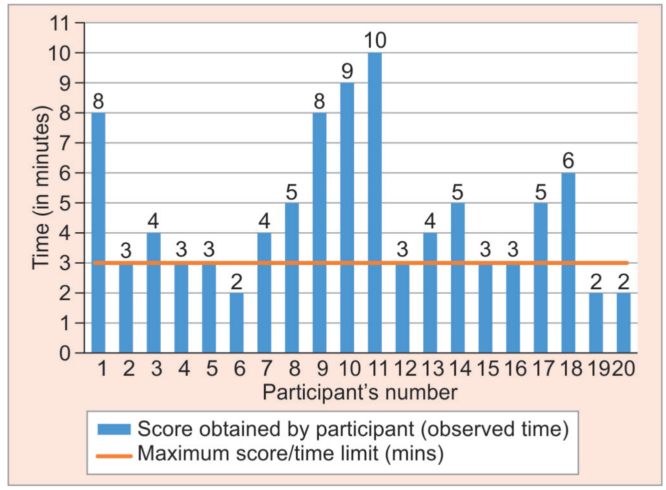

Fig. 2: Time for clip application

and recognized. Knowledge-based behavior addresses unfamiliar circumstances for which there are no established standards, such as internal bleeding and tissue damage.[14]

When it comes to surgical trainees with little to no prior experience, Gurusamy et al. interesting systematic review from three years ago looked at whether virtual reality simulator training can substitute or supplement traditional laparoscopic training. About 22 studies including 622 participants compared the use of virtual reality simulators with other training methods, including video trainers, no training, standard laparoscopic instruction, and other virtual reality training approaches. The authors came to the conclusion that video trainer training is at least as successful as virtual reality simulation training in terms of enhancing conventional surgical training.[15]

Hare calculated value of test statistic T ($T = 1.93$) is greater than the table value of T at a 5% level of significance and 19 degrees of freedom (Table $T = 1.73$) As a result, we find that there has been a considerable improvement in camera navigation skill (p-value = 0.03) and reject the null hypothesis (H_0) and accept the alternative hypothesis (H_1) (Fig. 1).

Hare calculated value of test statistic T ($T = 2.96$) is greater than the table value of T at a 5% level of significance and 19 degrees of freedom (Table $T = 1.73$) After rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_1), we can thus infer that the clip application skill has significantly improved (p-value = 0.00) (Fig. 2).

Hare calculated value of test statistic T ($T = 1.75$) is greater than the table value of T at a 5% level of significance and 19 degrees of freedom (Table $T = 1.73$) After rejecting the null hypothesis (H_0) and accepting the alternative hypothesis (H_1), we may thus infer that cutting skill has significantly improved (p-value = 0.04) (Fig. 3).

Hare calculated value of test statistic T ($T = 1.93$) is greater than the table value of T at a 5% level of significance and 19 degrees of freedom (Table $T = 1.73$) Hence we reject the null hypothesis (H_0) and accept alternative hypothesis (H_1) and conclude that there is significant enhancement in needle suturing skill (p-value = 0.04) (Fig. 4).

From the Chi-square test conducted on the analyzed data in Table 1, the maximum time limit to complete the task was 5 minutes for the camera navigation procedure with a mean being 4.4 and a standard deviation is 1.39 with a corresponding p-value of 0.03 showing the significance of the pro-cure and concluding the effectiveness of the simulation-based training to the resident

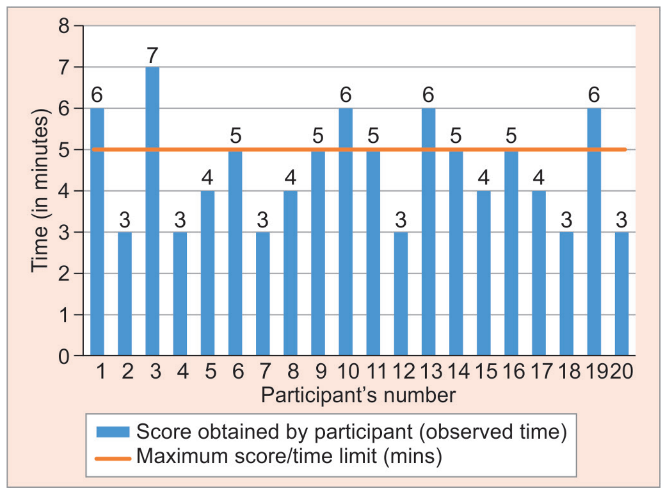

Fig. 3: Time for cutting

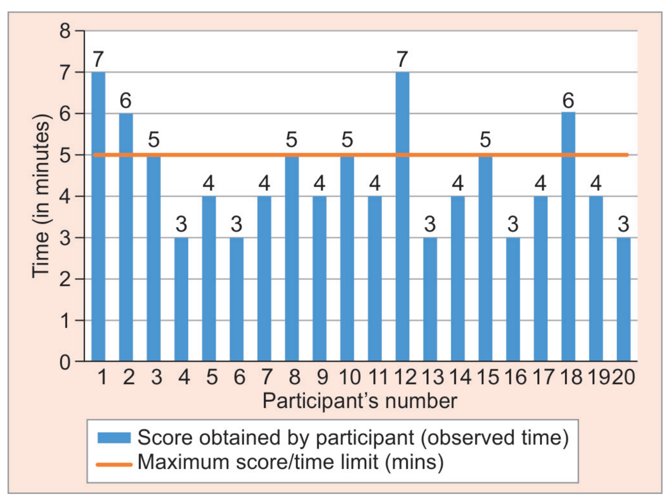

Fig. 4: Time for needle suturing

Table 1: Chi-square test

Time (in minutes) for	*Mean*	*SD*	*Calculated value of T*	*Table value of T*	*p-value*	*Decision*
Camera navigation	4.4	1.39	1.93	1.73	0.03	Significant
Clip application	4.6	2.41	2.96	1.73	0.00	Significant
Cutting	4.5	1.28	1.75	1.73	0.04	Significant
Needle suturing	4.45	1.28	1.93	1.73	0.04	Significant

doctors. The maximum time was 3 minutes for the clip application procedure; for which the mean value was found to be 4.6 with the standard deviation being 2.41 and *p*-value obtained was 0.00, which again showed the effectiveness of training the respective procedure.

The time limit given for 5 minutes for cutting procedure was 5 minutes and the mean obtained was 4.5, standard deviation calculated was 1.28, and the effectiveness of this technique was found to be significant with *p*-value being 0.04 respectively. The last procedure was needle suturing skills for which the given time was 5 minutes respectively, the calculated mean and standard value for the given procedure were 4.45–1.28 respectively and the effectiveness of this skill was also found out to be significant with the *p*-value being 0.04.

Thus, we may conclude that virtual reality models constitute a new paradigm in surgical education and that it is essential that postgraduate general surgery students learn the principles of laparoscopic surgery using these simulations. Future research should, however, concentrate on the following areas: How virtual reality simulation training affects performance during complex laparoscopic procedures; how it influences knowledge-based behavior; how it affects patient outcomes; how standardizing virtual reality simulation training is necessary; and whether using it in conjunction with other training techniques can have synergistic effects.

Conclusion

Laparoscopic surgical training using simulation has many benefits, including being a risk-free environment for the patient; providing novice training in a variety of cases with high complexity; providing instant feedback on the training tasks; being ethically acceptable because the training is not carried out on real patients; being useful in identifying the right people who will develop into technically competent surgeons; and being helpful for credentialing.

Due to the rising demand for advanced laparoscopic complicated surgery with an adaptation of innovative techniques, the clinical training curriculum for surgeons should include laparoscopic VR simulators through an integrated evidence-based, simulation-based education program.

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Data Availability

The dataset generated during the current study is available in with Dr. Rekha Khyalappa (repository). The dataset generated during the research is not publicly available. However, it can be made available from the corresponding author on reasonable request.

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