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Original Article

Serious gaming technology in spinal surgery training

Sedigeh Hanani[1], Azin Arab- Khazaie[1*], Leila Sadati[2], Azar Arab-Khazaei[1]

[1] Operating Room Department, Paramedicine Faculty, Iran University of Medical Sciences, Tehran, Iran, [2] Operating Room Department, Paramedicine Faculty, Iran University of Medical Sciences, Alborz, Iran.

Correspondence: Azin Arab-Khazaie, Operating Room Department, Paramedicine Faculty, Iran University of Medical Sciences, Iran, Tehran. E-mail: azinkhazaie721@gmail.com

ABSTRACT

Background and Purpose: Concerning the sensitive tasks of surgeons and nurses, nobody could overlook the need to use virtual reality techniques and serious games in the age of information and knowledge for training surgical cognitive skills in different fields of medicine. Game-based educational software with realism and high quality is a notable strategy to limit the high risk of traditional surgical training that can reduce medical errors and improve patient safety. Materials and Method: This was a semi-experimental research, that 30 surgical technologist students were selected by census method and trained with the simulation games. A practical simulation and a theoretical assessment tests were taken before and after the training to measure the participants' amount of skills and basic knowledge. Findings: After passing the course in a simulated environment at the workshop, students' knowledge scores by 100% were at a good level, and their scores in cognitive skills of spinal fusion surgery by 100% were at the dominant level as well. Conclusion: Serious games are used mostly as education tools and supplements in learning and these pieces of software, that are designed with an educational purpose, provide opportunities to gain knowledge as well as cognitive, critical thinking, and problem solving skills in order to perform complex surgical exercises.

Keywords: Spinal Fusion Surgery, serious games, virtual reality, surgical technologist, cognitive skills.

Introduction

After about only thirty years since the commencement of neurological and spinal surgery, the surgery is one of the most commonly performed surgeries; about one or one and a half million neurosurgeries being performed annually around the world [1, 2]. Spinal surgery is a complex specialty that requires thoughtful clinical judgment, technical skill, and close attention [3]. Due to the close proximity of vascular and neurological structures and the lack of adequate anatomical vision, it poses various risks; therefore, it is necessary that the spinal surgery team to be well trained for the operation [4]. Surgical education has been in form of internship and apprenticeship since the inception of the field. In which, trainees with observation and work along with experienced practitioners acquired the necessary expertise and skills [5]. In the course of surgical progress due to the complexity and difficulty of spinal surgery, the inefficiency of traditional methods in training surgeons with adequate skill and competence and the safety risk of patients, new methods were invented for training in spinal surgery [5, 6]. One of these new methods is the learning based on serious games that are widely used in different areas of the health system [7]. In recent years, these types of games have become commonplace in the teaching of technical skills including surgery [8]. The use of game-based instructional techniques in medical education with the aim of preserving patient safety before the direct contact with patients is widely used in the education of residents and medical students. Although simulated systems are widely being used in the education of residents, it is not yet a common method for training the surgical technologists, especially the scrub that can play a role as an assistant surgeon. And they are still taught in the operating room environment in the form of internship and apprenticeship [9, 10]. The operating room is the main environment of clinical education for the surgical technologists [11]. That by preserving patient safety, the student should gain advanced psychomotor skills, the ability to make the right decisions, and teamwork skills at all critical and non-critical situations in this stressful environment. This stressful environment undoubtedly has a significant effect on the professional performance and decision-making ability of the trainees during the operation [12, 13]. On the other hand, an increase in the number of students and a limited

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period of internship, as well as a low number of clinical educators, different individual talent and abilities in acquiring skills at varying degrees, lack of procedures and clinical aspects for observation and the practice will lead to less learning opportunities for the students. The inadequacy of these clinical experiences throughout education may increase the level of anxiety, fear of the inability to do clinical work and thus reduces the amount of students' learning and increases the medical errors [12, 14]. Several studies have shown that most of the errors occur during the initial learning in the operating room; and the primary reason for the medical errors is the insufficient knowledge of the trainees [15]. Activities based on the game provide an opportunity for learning experiences that the learners actively participate in their individual skills and become self-confidant and motivated enough to have practice and feedback, and eventually learn in a safe and non-threatening environment for patient safety [16]. By increasing the complexity of the operation in surgical games, they are used as an effective tool for training and to grant certification and university degrees [17]. Training via the simulation method seeks to make learning situations come pretty close to real situations so that they can employ the acquired knowledge in the real world [18]. Practice and rehearse in simulated environment can help the staff get the right skills, and so, facing the real patients in the clinical environment have proper performances on patients' care. In fact, learners can gain experiences of situations they did not deal with in the true clinical setting in the simulated environment. This training method helps them develop communication and practical skills, critical thinking and clinical decision making ability, and their knowledge of surgery [19]. Although the training based on simulated surgical systems targets almost exclusively the role of the surgeon, since the technologist can play the role of first assistant surgeon in different surgeries as the residents do, training of the technologists using the same method could also be very valuable [20]. Undoubtedly, the training of technologists using this training method makes them act more than just a scrub or a circulator nurse and do more professional performances.

Materials and Methods

This was a semi-experimental research with pre- and post-intervention. It was conducted on 30 eighth-semester undergraduate surgical technologists that were studying at Iran University of Medical Sciences and had passed their internship and neuroscience course during the years 2017-2018. In order to collect information in the field of knowledge, a researcher-made questionnaire was used. That had two sections of demographic information and the test section. The test section contained 20 multiple choice questions based on the field's references. And some topics on spinal anatomy, introductory radiographic image analysis, spine stabilization methods, causes of spinal fusion, understanding of tools and methods of using them, and arranging the surgeon's equipment that was theoretically assessed. The way of assessment was as follows. That any correct answer was scored 1 point and any wrong answer was scored zero. The maximum score obtained was 20 and the minimum was 0. The content validity of the tool was designed according to the scores of the blueprint tables covering the educational content; the number of questions and the proportion of the question type concerning the main and essential goals of the course were examined by the experts' panel; and the essential validity was obtained. In order to standardize the designed questions, in terms of the structure of items and choices for each question, the Milmen checklist was used. To evaluate the reliability of the questionnaire, Kappa coefficient was used. The Kappa coefficient corrects and standardizes the agreement percentage occurred by chance. Total Kappa coefficient was 0.942 that represented a high agreement among the respondents before and after the educational intervention. Instrument used to determine the cognitive skills of the subjects was an observation checklist that included 7 phases: 1. pedicle preparation; 2. pin marker; 3. screw insertion; 4. rod insertion; 5 provisionally tightening; 6. final tightening; 7. crosslink; and it was recorded and scored according to practical progress made in the simulated virtual world. The evaluation of each phase is done by the professors of the spine surgery and according to the degree of item difficulty and the student level. Phase 1 was one point; phase 2 was two points; phase 3 was three points; phase 4 was four points; phase 5 was five points; phase 6 was six points; phase 7 was seven points. The scientific validity of this tool was also obtained through the content validity and the opinion of the field specialists in order to cover the surgical stages properly; and to confirm the reliability, the simultaneous testing was used by two evaluators. With Paramedicine College collaboration a one-day workshop was conducted. Before presentation the educational content, to determine knowledge level and cognitive skills of the subjects, theoretical and practical simulation test about spinal fusion surgery were taken. After completing the workshop, subjects were tested again in order to assess their knowledge levels. And to assess the cognitive skills of the subjects after simulation, they were taken a practical simulated test. The data were analyzed using descriptive and inferential statistics Wilcoxon, Man-Whitney, and Kolmogorov Smirnov Tests by SPSS-22.

Findings

According to data collected from 30 subjects participated in the research, 67% were females and 33% were males. Mean age of the subjects were 23.00±0.75 years of old.

Table 1: Comparison of mean scores of students before and after simulation

Variable	Basic knowledge (pre-intervention)	Basic knowledge (post-intervention)	Cognitive skill (pre-intervention	Cognitive skill (post-intervention)
Mean	10.93	17.47	3.6	23.7
Probability value	0.006	0.004	<0.001	<0.001

The results of this study showed that the mean scores concerning the basic knowledge, especially cognitive skills significantly increased after simulation, Table 1.

To evaluate and compare the basic knowledge and cognitive skills of surgical technologist in spinal surgery before and after the educational intervention, non-parametric Wilcoxon signed-rank test was used. The results of these studies showed that there was a significant difference between the basic knowledge and cognitive skills of the surgical technologist students regarding spine surgery before and after the educational intervention ($P<0.001$), Table 2.

Table 2: The results of Wilcoxon signed-rank test

Variable	Basic knowledge (pre-post intervention)	Practical Skill (pre-post intervention)
Wilcoxon signed-rank	−4.72	−4.79
Probability value	<0.001	<0.001

Considering the basic knowledge scores of surgical technologists at the beginning of the study as a disturbance variable, the effectiveness of the educational intervention was examined by analysis of the covariance. The results are presented in Table 3. The results showed that there was a significant difference regarding the subjects' scores in the two groups of males and females.

Table 3: Comparison of basic knowledge of surgical technologists after the educational intervention in gender group by analysis of the covariance

Variables	Sums of squares	Degree of freedom	Mean squares	Test statistic	P-value
Basic cognitive skill	1.11	1	1.11	0.415	0.525
Gender	14.18	1	14.18	5.29	0.029
Error	72.34	27	2.68		

After eliminating the impact of the basic knowledge of surgical technologist students at the beginning of the study, marginal averages, represented in Table 3, comparison between the two groups showed that the highest increase in the basic knowledge score of the subjects related to the group of females (17.84 vs. 16.74).

Similar to the above analysis, the cognitive skills variable was also analyzed. By considering the practical skill scores of the participants obtained at the beginning of the study as a disturbing variable, the effectiveness of educational intervention was examined by analysis of the covariance. Results represented in Table 4-22. The results showed that there was no significant difference between the subjects' scores in both male and female groups ($F_{(1, 27)} = 0.29$, $P = 0.595$).

Table 4: Comparison of the cognitive skill scores of the surgical technologists after the intervention in the gender group obtained by analysis of the covariance

Variables	Sums of squares	Degree of freedom	Mean squares	Test statistic	P value
Cognitive skill	149	1	149.11	2.42	0.131
Gender	17.85	1	17.85	0.29	0.595
Error	1661.84	27	61.55		

After eliminating the impact of the cognitive skill score of the surgical technologists at the beginning of the study, the comparison of the marginal averages in Table 4 in the two groups shows that the highest increase in the cognitive skills scores of the subjects related to the group of males (24.83 vs. 23.14).

Discussion

The results of this study showed that the use of the game-based training method had a significant effect on knowledge and especially the cognitive skills of the surgical technologist students. In their study, Haghghani et al. indicated the positive impact of simulation on increase in students' knowledge level, ability to diagnose patients' problems, the critical thinking and self-confidence that is consistent with the present study results [21]. Also, the findings of Madhavanprabhakaran et al. indicated that using the simulation increased knowledge level of students that is consistent with the present study results [22]. Besides, in a study by Amiralavi et al., simulation method increased assistants' knowledge regarding the anatomy of tracheobronchial tree that resulted in an increased skill in performing bronchoscopy [23]; that is consistent with results of this research. Furthermore, the results of semi-experimental study by Lis et al., conducted on medical students in the Netherlands in 2014, showed that using simulation in the intervention group was effective in increasing the self-efficacy and improving clinical skills [24].

The next variable was the effect of game-based education on cognitive skills acquired by the surgical technologist students. The results of this study showed that students' skills after spinal stabilization training increased dramatically with simulation that is consistent with results of a study by Gasco et al. The results of their study on the effect of training simulation in learning spinal fusion surgery in a group of residents showed that simulation is a valuable method for teaching professional skills such as pedicle screw insertion; that by precisely understanding how to perform, the order of using the tools and the anatomy of the body, leads trainees to lifelong learning [25]. The recent studies have shown that simulation based exercises improve the transfer of surgical skills to trainees. It contributes to a more structured way of teaching surgical techniques [26]. In the research by Khazaei Jalil et al. also working with educational software was effective in students learning, besides, their scores increased sharply in the practical test, and that is consistent with the results of the same study [27]. Likewise, the research results by Paige et al. confirmed the positive impact of using simulations on increase in learning opportunities, increased self-esteem and improved standard of clinical performance [28]. The studies confirm the results of the present study and hence the importance of using simulation-based training methods to teach cognitive and practical skills is emphasized.

The next research variable was the effect of gender on the outcome of training simulation; in the present study, gender had no direct correlation with knowledge and skill level. However, after eliminating the effect of the basic knowledge

scores of the surgical technologists obtained at the beginning of the study, as an intervening variable, the highest value of the basic knowledge scores belonged to females. Likewise, mentioned analysis was considered for the cognitive skills variable. The highest increase in practical skill scores was for male groups. The results of a research by Entezari et al. showed that male assistants had more knowledge and skill [29]. Also, the results of a research by Ahmadi et al. indicated that gender (male) has a direct correlation with performance [30].

Conclusion

Based on the findings of this study, simulation method is recommended as an effective training method to teach cognitive skills to students especially to surgical technologist students; that takes place in a safe and non-threatening environment concerning patients' safety. Moreover, this training method is a notable new strategy in case there is no suitable clinical education that could be in line with the educational aims.

Research Limitations

The limitation of student more experience during the internship period is controlled through group study and pre-post comparison.

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References

1. Bohm, P.E. and P.M. Arnold, Simulation and resident education in spinal neurosurgery. Surgical neurology international, 2015. 6.
2. Jancuska, J.M., et al., Utilization of lumbar spinal fusion in New York State: trends and disparities. Spine, 2016. 41(19): p. 1508-1514.
3. Rehder, R., et al., The role of simulation in neurosurgery. Child's Nervous System, 2016. 32(1): p. 43-54.
4. Sundar, S.J., et al., A pilot study of the utility of a laboratory-based spinal fixation training program for neurosurgical residents. Journal of Neurosurgery: Spine, 2016. 24(5): p. 850-856.
5. Gallagher, A.G., J.A. Jordan-Black, and G.C. O'sullivan, Prospective, randomized assessment of the acquisition, maintenance, and loss of laparoscopic skills. Annals of surgery, 2012. 256(2): p. 387-393.
6. Kirkman, M.A., et al., The use of simulation in neurosurgical education and training: A systematic review. Journal of neurosurgery, 2014. 121(2): p. 228-246.
7. Palter, V.N. and T.P. Grantcharov, Simulation in surgical education. Canadian Medical Association Journal, 2010. 182(11): p. 1191-1196.
8. Boker, A., Setup and Utilization of Clinical Simulation Center, Faculty of Medicine, King Abdulaziz University, Saudi Arabia. Life Science Journal, 2013. 10(1): p. 1079-85.
9. Lynn, A. and S. Brownie, The Perioperative Nurse Surgeon's Assistant: Issues and challenges associated with this emerging advanced practice nursing role in Australia. Collegian, 2015. 22(1): p. 109-115.
10. Paschold, M., et al., Laparoscopic assistance by operating room nurses: Results of a virtual-reality study. Nurse education today, 2017. 51: p. 68-72.
11. Carifa, L. and H. Janiszewski Goodin, using games to provide interactive perioperative education. AORN journal, 2011. 94(4): p. 370-376.
12. Ong, C.C., A. Dodds, and D. Nestel, Beliefs and values about intra-operative teaching and learning: a case study of surgical teachers and trainees. Advances in Health Sciences Education, 2016. 21(3): p. 587-607.
13. Jones, J.H., Developing critical thinking in the perioperative environment. AORN journal, 2010. 91(2): p. 248-256.
14. Butler, K.W., D.E. Veltre, and D. Brady, Implementation of active learning pedagogy comparing low-fidelity simulation versus high-fidelity simulation in pediatric nursing education. Clinical Simulation in Nursing, 2009. 5(4): p. e129-e136.
15. Gawande, A.A., et al., Analysis of errors reported by surgeons at three teaching hospitals. Surgery, 2003. 133(6): p. 614-621.
16. Hemingway, M.W., P. Osgood, and M. Mannion, Implementing a Cardiac Skills Orientation and Simulation Program. AORN journal, 2018. 107(2): p. 215-223.
17. Aggarwal, S., et al., Simulation in cardiac catheterization laboratory: Need of the hour to improve the clinical skills. Annals of cardiac anaesthesia, 2016. 19(3): p. 521.
18. Abelsson, A., et al., Learning by simulation in prehospital emergency care–an integrative literature review. Scandinavian journal of caring sciences, 2016. 30(2): p. 234-240.
19. Brady, S., F. Bogossian, and K. Gibbons, The effectiveness of varied levels of simulation fidelity on integrated performance of technical skills in midwifery students—a randomised intervention trial. Nurse education today, 2015. 35(3): p. 524-529.
20. Boss, S., Expanding the Perioperative Role the Surgeon's Assistant. British Journal of Perioperative Nursing (United Kingdom), 2002. 12(3): p. 105-113.
21. Haghani F, E.M., Jafari Myanayy S, Simulation. Iran J Med Edc, 2014. 11(2): p. 272-79.
22. Madhavanprabhakaran, G., E. Al-Khasawneh, and L. Wittmann, Perceived benefits of pre-clinical simulation-based training on clinical learning outcomes among

Omani undergraduate nursing students. Sultan Qaboos University Medical Journal, 2015. 15(1): p. e105.
23. Amir-Alavi, C., et al., Comparison of The Effectiveness of Web Based Bronchoscopy Simulator Versus Traditional Educationon on Knowledge of Tracheobronchial Anatomy of Anesthesia Residents. Research in Medical Education, 2017. 8(4): p. 52-60.
24. Ma, H., et al., Video feedback teaching method in teaching of abdominal physical examination, in Frontier and Future Development of Information Technology in Medicine and Education. 2014, Springer. p. 2707-2713.
25. Gasco, J., et al., Virtual reality spine surgery simulation: an empirical study of its usefulness. Neurological research, 2014. 36(11): p. 968-973.
26. Alaraj, A., et al., Role of cranial and spinal virtual and augmented reality simulation using immersive touch modules in neurosurgical training. Neurosurgery, 2013. 72(suppl_1): p. A115-A123.
27. Shahbazian, B., A. Montazeri, and A. Abbasi, The Impact of Educational Software Designed on Operating Room Students' Learning of Practical Skills. Research in Medical Education, 2016. 7(4): p. 13-19.
28. Paige, J.T., et al., Debriefing 101: training faculty to promote learning in simulation-based training. The American Journal of Surgery, 2015. 209(1): p. 126-131.
29. Entezari M, A.z.N., Eslam madad V.(dissertation), Evaluation of knowledge and skills of medical students in cardiopulmonary resuscitation in ardabil medicen faculty in 2001. 2011.
30. Mohammad Ahmadi, N.E., Emadi Seyed Abdollah, Mohammadpourt Momena Reza Ali., Evaluation of Knowledge, Attitude and Practice of Newborns Recovery Teachers in Mazandaran University of Medical Sciences. 2007.