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Qualitative and Quantitative Evaluation of Videoendoscopic Simulation in Surgical Residents Training

Cerrahi Asistanlarının Videoendoskopi Simülasyon Eğitiminin Kalitatif ve Kantitatif Olarak Değerlendirilmesi

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ABSTRACT

Background: In our study, we aimed to evaluate the contribution of video-endoscopy simulation for the development of gastroscopy and colonoscopy skills of residents in surgical resident training, using qualitative and quantitative methods.

Materials and Methods: Sixteen novice surgeons were trained with an endoscopic virtual reality simulator. Ten colonoscopy and 10 gastroscopy cases were overviewed in this training. Three hundred-twenty gastroscopy and colonoscopy simulation modules were evaluated. Continious variables are presented as median and interquartile range. Wilcoxon signed-rank test was used to detect changes during the training. For the qualitative data of the study, in-depth interviews were conducted with the residents who completed the modules. At the end of the interviews, the answers were documented directly in the same day. The themes and sub-themes related to the content were determined by two medical evaluators.

Results: A significant improvement was observed both in colonoscopy and gastroscopy modules. While the time to reach the cecum in the colonoscopy module decreased from 20 minutes to 3 minutes on average, and the time to reach the duodenum in gastroscopy from 4 minutes to 3.6 minutes. The percentage of mucosal surface examined increased both in gastroscopy and colonoscopy. The time spent to obtain quality images did not change in gastroscopy, but there was an obvious increase in colonoscopy. The percentage of effective usage of the screen increased both in gastroscopy and colonoscopy. Qualitative data proved that all participants were satisfied by the training and benefited from it.

Conclusion: The results of our study indicate the importance and advantage of the utilization of simulators in trainings that require interventional skills, before patient encounter. It has been shown that video-endoscopy simulation supports the dexterity of residents in gastroscopy and colonoscopy applications.

Keywords: Medical simulation, video-endoscopy, medical education

ÖZ

Amaç: Çalışmamızda cerrahi asistan eğitiminde, video-endoskopi simülasyonunun asistanların gastroskopi ve kolonoskopi becerilerinin gelişimine katkısını kalitatif ve kantitatif yöntemlerle değerlendirilmeyi amaçladık.

Gereç ve Yöntemler: Çalışmada daha önce video-endoskopi deneyimi olmayan 16 genel cerrahi asistanınına bir sanal gerçeklik simülatöründe, eğitmen gözetiminde 10 kolonoskopi ve 10 gastroskopi olgusundan oluşan simülasyon eğitimi verildi. Toplam 320 modül değerlendirildi. Eğitmenler tarafından seçilen orta zorlukta bir modül ilk modül olarak çalıştırıldı ve tüm eğitim tamamlanınca tekrar edildi. Veriler medyan, birinci çeyreklik ve üçüncü çeyreklik olarak verildi. Eğitim süresince değişikliklerin saptanması için Wilcoxon rank-sign test kullanıldı. Çalışmanın niteliksel verileri için, asistanlarla yüz yüze derinlemesine görüşmeler yapıldı. Görüşme sonunda aynı gün yazıya döküldü. İki değerlendirmeci tarafından içeriğe ilişkin temalar ve alt temalar belirlendi.

Bulgular: Hem kolonoskopi hem de gastroskopi modüllerinde anlamlı iyileşme gözlendi. Kolonoskopi modülünde çekuma ulaşma süresinin 20 dk'den ortalamada 3 dk'ye gastroskopide duedonuma ulaşma süresinin 4 dk'den 3,6 dk'ye indiği görüldü. Gastroskopi ve kolonoskopide değerlendirilen mukozal alan yüzdesi anlamlı olarak arttı. Kaliteli görüntü elde etmek için harcanan süre

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ÖZ

gastroskopide değişmezken, kolonoskopi uygulamaları sırasında anlamlı oranda arttığı izlendi. Ekranın etkin kullanım yüzdesi hem gastroskopide, hemde kolonoskopide arttı. Niteliksel veriler değerlendirildiğinde yapılan yüz yüze görüşmeler sonucunda katılımcıların tümü simülasyon eğitimini faydalı bulduklarını ifade ettiler.

Sonuç: Girişimsel beceri gerektiren eğitimlerde, hasta deneyiminden önce simülatör kullanımının faydalı olduğunu, video-endoskopi simülasyonunun asistanların gastroskopi ve kolonoskopi uygulamalarında el becerilerinin gelişmesine katkı sağladığını destekler niteliktedir.

Anahtar Kelimeler: Medikal simülasyon, video-endoskopi, tıp eğitimi

Introduction

Healthcare providers must be able to competently perform a wide range of clinical skills. These skills include taking a patient's history, performing a physical examination, and performing procedures. While some procedural skills are unique to certain fields, proficiency in the execution of skills is necessary to provide safe patient care (1). The effectiveness of skills training is controversial, and data show that novice healthcare professionals are overconfident in their ability to teach practical skills (2,3). This may cause undesirable consequences during patient intervention. The use of simulators and task trainers provides the opportunity to safely train and practice procedural skills before applying them to the patient. The simulation was derived from the Latin word simulare. Simulating means making something look like the real thing. Nowadays, simulation is widely used, especially in the medical field. Patient simulations, which provide significant benefits especially in the field of medical teamwork, and surgical simulations that are effective in developing technical skills, are some of the important medical simulations. Thanks to simulation, a technical skill develops much better and facilitates the transfer to the real clinical environment (2,4,5). High-quality simulations supported by visual elements have been identified in systematic review as the most successful technique in arranging adult learner needs and procedural skills training (6). As it is known, the most valuable motivators for adult learning are the practical use of the information to be learned and the security principles provided for the application environment. Six principles have been developed for the effective learning and application of procedural knowledge.

1. Learn: Knowledge acquisition
2. See: Observation of the procedural skill
3. Practice: To make a practice using simulation
4. Prove: To assesss the competency
5. Do: The technique is carried out on a patient under direct supervision until the student is trusted to carry it out on his or her own.
6. Maintain: To make continuing clinical practical skills, with simulation-based training as a supplement (4).

As stated in this example, simulation is a training model that is applied not only to teach a skill but also to reinforce it. Before becoming competent at a skill, learners go through a succession of phases. In the acquisition of skills, there are four levels: 1) Unconsciously incompetent, 2) Consciously incompetent, 3) Consciously competent, 4) Unconsciously competent (1). The 4 phases of skill acquisition are also shown in (Figure 1) (7).

Just like using a car, we need to reach an unconsciously competent level in applications that require medical intervention. We think that one of the most important educational elements that facilitates access to this level is medical simulation. We will try to demonstrate this in our own working practice. In line with the results we have obtained, we will discuss the inclusion of simulation in the curriculum.

Material and Methods

In this study, a "virtual reality (VR)" simulator with a special video-endoscopy software, the same fiber system as the original endoscope models, was used as the simulator (Figure 2). The simulator was a simulator given as a donation to the simulation center. Three hundred-twenty gastroscopy and colonoscopy modules were evaluated. Sixteen surgical

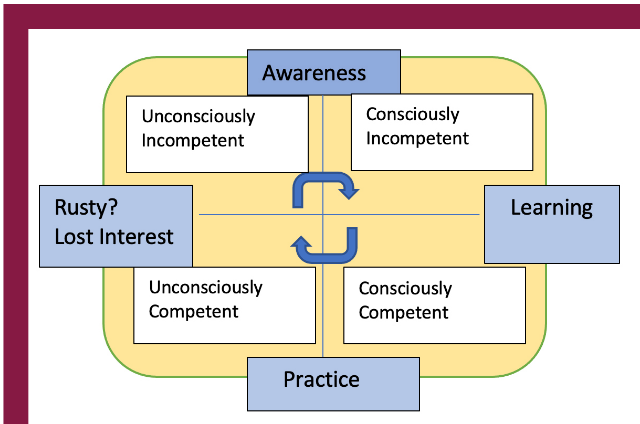

Figure 1. Development of competency (Peyton, 1998)

residents, who had not previously performed video-endoscopy on the patient, carried out 20 video-endoscopy cases, 10 of which were colonoscopy and 10 gastroscopies. Modules were structured in increasing difficulty. A medium difficulty module selected by the instructors was run as the first module and repeated when all modules were completed. Third module for gastroscopy and 5th module (Figure 3, 4) for colonoscopy were chosen as the reference. It was started with this module first and after 9 consecutive modules were studied, the first module was run again. Improvement trends were also examined in other modules other than the reference module.

For the qualitative data of the study, in-depth interviews were conducted with the residents who completed the

Figure 2. Virtual reality video-endoscopy simulator, lower endoscopy set up

modules. The answers given to the semi-structured questions prepared by the trainers with the support of the literature were recorded. The interviews lasted about 35-40 minutes. Before the interviews, verbal and written consents were obtained from the sixteen participants. It was informed that the interviews will be recorded. At the end of the in-depth interview, recordings were transcribed in the same day. The themes and sub-themes related to the content were determined by two medical evaluators. The expressions indicating the theme and sub-themes were written in the words of the participant. Ethical Permissions were obtained from Marmara University Health Sciences Institute (22.03.2021-45).

Statistical Analysis

The results of the 160 gastroscopy and 160 colonoscopy applications consisting 10 different modules with gradual difficulty, which were demonstrated by each of the 16 surgical assistants were evaluated. Continuous variables were summarized according to their distribution with mean and standard deviation or median and interquartile range (IQR). R was used as a statistical program, $p<0.05$ was considered significant. Wilcoxon rank-sign test was used to detect changes during the training.

Results

Ten tasks with different difficulty levels were run for gastroscopy training. Case 3, which has a medium difficulty level, was given as the first task, and followed by Cases 1,2,4,5,6,7,8,9,10 and Case 3 was given again as a last task. Success and improvement in technical skills between the repeated Case 3 tasks were evaluated in terms of percent

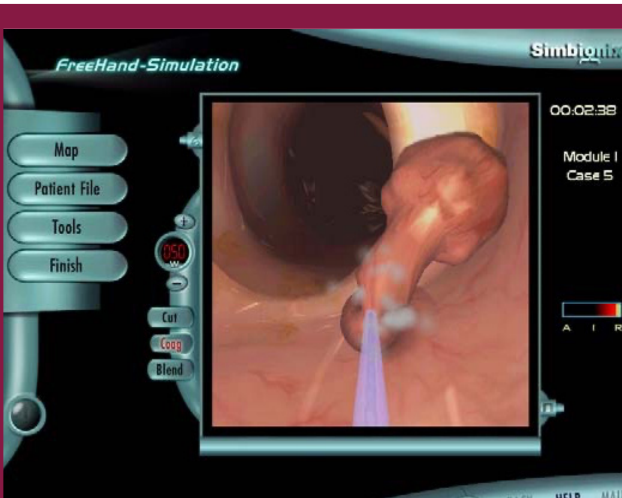

Figure 3. Polypectomy exercise module

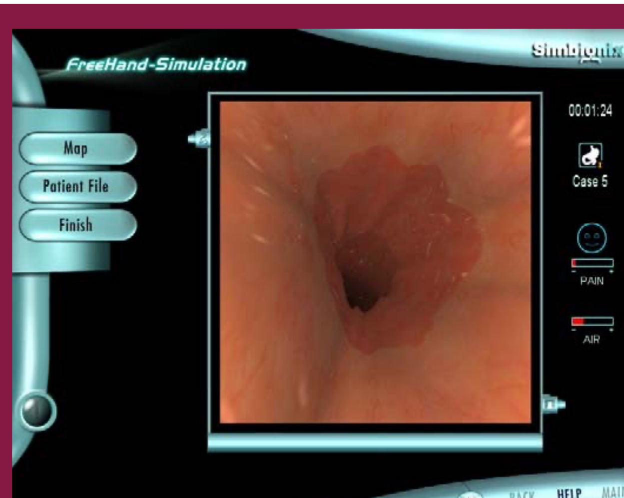

Figure 4. The view of gastroesophageal-junction

of mucosal surface examined, percent of time spent with clear view, time to reach the duodenum, the efficiency of screening.

Wilcoxon signed rank-test results showed that for gastroscopy, the percentage of mucosal area evaluated increased significantly in the repeated case [(Md=89) (IQR=8) and Md=94 (IQR=4.5) respectively, p=0.002]. Percent of time spent with clear view had not changed [Md=97 (IQR=2.2) and (Md=96.5) (IQR=3.7) respectively p=0.365]. The time to reach the duodenum had shortened [(Md=241.5 (IQR=213.5) and Md=221.5 (IQR=60.7) respectively p=0.024]. The efectiveness of screen use also had increased [Md=23 (IQR=35) and (Md=58.5) (IQR=16.7) recpectively p=0.008]. The trainer's observational notes also indicate that technical skills improve in repetitive tasks (Table 1).

For colonoscopy, the tasks were started with Case 5, which was determined to be of medium difficulty by the trainer, and Case 5,1,2,3,4,6,7,8,9,10, and Case 5 (R) were repeated, respectively. The trend towards improvement in achievement and technical skills between Case 5 and Case 5 (R) was evaluated. Success and improvement in technical skills between the repeated Case 5 tasks were evaluated in terms of percent of mucosal surface examined, percent of time spent with clear view, time to reach cecum, efficiency of screening.

For colonoscopy, the percentage of mucosal area evaluated increased significantly in the repeat case (Case 5 R) [Md=83.5 (IQR=35.8) and (Md=88.5) (IQR=14.5) respectively p=0.031]. The time to reach the cecum had significantly shortened [Md=1425 (IQR=1406.5) and (Md=180) (IQR=205) respectively p=0.001]. The percentage of time spent producing clean images [Md=76.5 (IQR=13.5) and (Md= 87.5) (IQR=10.5) respectively p=0.004] and the effectiveness of screen use have also increased [(Md=20) (IQR=33) and (Md=84) (IQR=16.7) respectively p=0.001]. The trainer's observational notes also indicate that technical skills improve in repetitive tasks (Table 2).

The themes and sub-themes obtained from the qualitative data are shown in (Table 3).

Table 1. Gastroscopy case 3 results

	First time	Second time	p-value
Percent of mucosal surface examined (%) Median (Q1-Q3) Min-max	89.0 (83.0; 91.0) (67.0; 95.0)	94.0 (91.5; 96.0) (89.0; 98.0)	0.002
Percent of time spent with clear view (%) Median (Q1-Q3) Min-max	97.0 (96.0; 98.2) (85.0; 99.0)	96.5 (93.5; 97.2) (87.0; 98.0)	0.365
Time to reach duodenum (sec) Median (Q1-Q3) Min-max	241.5 (163.0; 376.5) (11.0; 602.0)	221.5 (183.5; 244.2) (97.0; 397.0)	0.024
Effciency of screening Median (Q1-Q3) (sec) Min-max	23.0 (20.0; 55.0) (16.0; 78.0)	58.5 (50.5; 67.2) (32.0; 78.0)	0.008

Q1: First quantile, Q3: Third quantile, p-value: Wilcoxon signed-rank test p-value, sec: Second, %: Percentage

Table 2. Colonoscopy case 5 results

	First time	Second time	p-value
Percent of mucosal surface examined (%) Median (Q1-Q3) Min-max	83.5 (53.2; 89.0) (13.0; 94.0)	88.5 (78.7; 93.2) (73.0; 97.0)	0.031
Percent of time spent with clear view (%) Median (Q1-Q3) Min-max	76.5 (71.2; 84.7) (64.0; 89.0)	87.5 (84.2; 94.7) (64.0; 96.0)	0.004
Time to reach cecum (sec) Median (Q1-Q3) Min-max	1425.0 (568.5; 1975.2) (249.0; 3016.0)	180.0 (125.0; 330.0) (122.0; 456.0)	0.001
Effciency of screening (%) Median (Q1-Q3) Min-max	20.0 (19.2.0; 52.2) (18.0; 87.0)	84.0 (50.5; 67.2) (63.0; 97.0)	0.001

Q1: First quantile, Q3: Third quantile, p-value: Wilcoxon signed-rank test p-value, sec: Second, %: Percentage

Table 3. Qualitative data which were obtained from in-depth interview	
Themes	1- Factors that facilitate simulation and increase success 2- Negative aspects of simulation
Sub-themes	1a- The presence of an instructor giving feedback 1b- No repeat limit, providing a self-learning environment 1c- High fidelity, virtual reality simulator 1d- Increasing the feeling of trust in the practitioner physician 2a- The difficulty of going to another place outside the hospital environment 2b- Technical problems may reduce the training time and quality

The statements of the assistants who participated in the in-depth interviews are as follows:

Participant 1, P(1): "The most important feature of simulation for me is to be able to repeat as many times as I want in a stress-free environment"."In addition, having someone to consult with me when I need it increases the feeling of trust".

P(3): "I was very comfortable working on the patient as the fiber optic part of the simulator is the same as the real video endoscopy device".

P(7): "I think the simulator application before the patient experience is extremely necessary, but studying in a separate location was a waste of time for me. I wish this simulator was in our hospital".

P(9): "The simulator broke down very often while I was working. I had to rebuild the modules. I wasted a lot of time".

Qualitative data also show that; By making their first experience on the simulator, the residents experienced increased confidence in patient intervention. The high reality feature of the simulator was stated by most of the participants as a factor facilitating adaptation in patient practice.

While a simulation center that is isolated and outside of the working environment is considered a waste of time, very few participants stated that receiving training in a separate place is a break from their busy work schedule. Generally, because of the qualitative study, the idea that simulation increases successful patient outcomes, creates familiarity in terms of devices and interventions, reinforces the feeling of trust in physicians and patients. In addition, the answers given to the evaluation questions asked in the interviews with two trainers support our findings.

Discussion

As it is known, video-endoscopy is a very important and difficult training due to the difficulty in selecting the appropriate patient for resident training and the inadequacy of the cases. Unfortunately, it is not easy to achieve adequate technical skills for video-endoscopy in the early stages of surgical residency (8).

Competence is defined as "the minimum level of ability, knowledge, and/or expertise that is required to safely and efficiently perform a task or a procedure gained via training and experience"(8). In recent years, competence and skill development in endoscopy has been considered as an important problem (9,10,11). Different models and task trainers have been used in endoscopy training for many years. The aim of simulator-based training is to shorten the learning time in endoscopy for beginners and to eliminate the possible harm that can be given to the patient. For physicians who do not perform endoscopic interventions very often, working with a simulator before patient application, provides serious benefits (12). The performance of novice endoscopists using this simulator, improved significantly between pre- and post-training, according to this study. It is shown that surgical residents improve psychomotor and endoscopic skills with simulation-based education. Other researchs have investigated the impact of virtual endoscopic training. A study from Texas showed significant improvements in cecal intubation time, total time, and percentage of surface area scanned from pre- to post-training. In this study, the same VR simulator was used, but unlike ours, this study was conducted with senior surgical residents (13). In a study, took placed Nederlands, surgical assistants improved their performance in both the VR colonoscopy and the endobubble task. Unlike our study, there was no instructor guidance during the training (14). In another randomized controlled study, two groups were compared. One group consisted of novice residents who had less than 10 endoscopies, and the other group was senior residents. Then, these two groups are randomly seperated and simulation training is given. The total procedure time and the time to reach cecum were significantly reduced in the simulation-trained group (15). In our study, unlike this study, we evaluated the comparison of the results of the same people before and after the training as more meaningful. In a randomized study conducted in Denmark, an intermediate task was chosen, as in our study, and when all modules were completed, the same task was run again, and improvements were evaluated. Improvements in skills such as total time and clean surface area monitored by endoscopists were determined (16). In our study, based on the literature, we evaluated parameters such as the cleanly observed surface area, the percentage of the scanned mucosal area, the time to reach the cecum, and the time to reach the duedonum. We determined the shortening of the time to reach the cecum and duodenum and the percentage of mucosal area observed and the percentage of the area observed as clean as skill development criteria. Although simulators are seen as expensive devices, general maintenance costs are not very high after the initial purchase costs. The first and most comprehensive study examining the cost-effectiveness values of VR simulators was conducted by Barsuk et al. (17). On central line-associated bloodstream infections (CLABSI). Ninety-two assistants received a simulation-based training with an instructor. Surprisingly, CLABSI rates were reduced by more than sixfold after simulation training (0.50 infections per 1000 catheter days) compared to the same uninterrupted unit (3.20 per 1000 catheter days). The annual cost of the simulation-based intervention was $112,000, reducing the net savings from lower CLABSI rates to about $700,000 (18).

Although there are studies evaluating simulation-based surgical assistant training in the literature, we have not encountered both a qualitative and quantitative evaluation (19,20,21). In this sense, we find it meaningful to support our study with qualitative data. From the results of the in-depth interviews, it is understood that the surgical residents benefited from the simulation training. Accurate feedback and unlimited repeatability provided by simulation were other important issues emphasized by the residents.

Conclusion

We found that simulation shortens the application time and increases the application skills of endoscopists in colonoscopy and gastroscopy applications that require interventional skills. In our study, we got the idea that simulation video-endoscopy training can fill a very important gap in surgical assistants training and it would be beneficial to add it to the curriculum. Quantitative data support that this training provides positive contributions in dexterity, time use and treatment management. Qualitative data also show that with this training, the trust of the residents increased, and they also gained more awareness about the sensitivity and seriousness of the intervention they performed. We believe that the malpractice problems, experienced especially in recent years, will decrease with the spread of simulation application centers.

Ethics

Ethics Committee Approval: Ethical Permissions were obtained from Marmara University Health Sciences Institute (22.03.2021-45).

Informed Consent: Written consents were obtained from the sixteen participants.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: S.M.A., W.A., Concept: S.M.A., W.A., Design: S.M.A., W.A., Data Collection or Processing: S.M.A., E.A., W.A., Analysis or Interpretation: S.M.A., E.A., W.A., Literature Search: S.M.A., W.A., Writing: S.M.A.

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