

Use of simulator for EUS training in the diagnosis of pancreatobiliary diseases

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ABSTRACT

Background and Objectives: EUS has been widely used in the diagnosis of pancreatobiliary diseases. However, improvements in the conventional training pattern of EUS are needed urgently. In this study, we compared the results achieved after use of clinical practice training patterns combined with or without simulator training and evaluated the effectiveness of simulator use in EUS training. **Subjects and Methods:** The trainees were randomly divided into two groups: the experimental group was trained with both clinical practice and simulator training system and the control group was only trained through clinical practice. After 1 month of training, trainees of both groups were tested with an established technical evaluation procedure that aimed to assess trainees' ability to examine the normal anatomical structure. Then, trainees in the experimental group completed a questionnaire. **Results:** The mean test score of the experimental group (64.53 ± 4.91) was significantly greater than that of the control group (60.09 ± 5.49 ; $P = 0.028$). Moreover, the individual test score of trainees in the experimental group was positively correlated with the frequency of simulator use ($P = 0.242$). **Conclusion:** Simulator training can promote trainees' ability to evaluate the normal anatomical structure, and thus, can improve the efficiency of the EUS training program.

Key words: Diagnosis, EUS, pancreatobiliary system, simulator, training

INTRODUCTION

EUS is a relatively new diagnostic technique, for which enormous improvements have been made. Recently, EUS was developed into a minimally invasive technique and applied in the diagnosis of pancreatobiliary diseases. In the diagnosis of small pancreatic tumors (<2 cm), EUS has an unparalleled advantage over other diagnostic techniques.^[1-4] EUS can be effectively used in the clinical diagnosis and treatment of pancreatobiliary diseases. Because EUS is one of the most difficult endoscopic

techniques, the operative skills of doctors determine the accuracy of clinical diagnosis.^[5,6] Moreover, the use of EUS has been limited due to a shortage of adequately trained doctors. Although many training systems are available worldwide, the training results are often irregular and contradictory.^[5,7,8] Therefore, to promote the clinical expansion of EUS and to majorly improve the skills of operators, it is necessary to devise

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a standardized training course for doctors performing EUS.

At present, the main training courses for doctors performing EUS are as follows: the traditional clinical pattern, model training pattern,^[9-12] and simulator training pattern.^[13] Among these training courses, the traditional clinical pattern is the most widely used training program. Clinical training pattern means clinical observation and practice under the guiding of trainers. Simulator training is often used to “pretrain” novices on endoscopic skills that can be used in clinical practice; however, the optimal method of training still needs to be deciphered. In addition, some training centers provide doctors with clinical practice while training them through model training or simulator training patterns. However, the outcomes of these training sessions have not been consistent.

While physicians are being trained to perform EUS, clinical practice is permitted in most institutions. However, the resources for clinical practice are limited, and thus, they cannot completely meet the training demands of novices. As a result, such a training program is completed after a considerable duration of time. In contrast, training done through simulators allows sufficient practice under different clinical scenarios. Thus, these trainees can improve their operative skills within a short duration of time. Furthermore, the simulator equipped with an instrument for reproducing anatomical images can exactly replicate the images observed through EUS in real world clinic practice. Moreover, the ultrasonic probe of a simulator is the same as the EUS.^[14] In summary, the simulator can almost replicate the functions of EUS. Moreover, if three-dimensional images can be obtained from a simulator using optical aids, then the trainees would be benefit immensely as they would gain a deeper understanding of the anatomical marks commonly encountered in an ultrasonoscopy.

In this study, our aim was to evaluate the effectiveness of simulator training for EUS. For this purpose, we designed a research project based on the findings of our previous work to prove that simulator use is effective in EUS training and thus, may help us to provide more encouraging references for the standardized training program for EUS in China.

SUBJECTS AND METHODS

Our objective was to prove that simulator is helpful in the initial study of pancreatobiliary system anatomical structure, which may promote efficiency of EUS training. We compared the results of the clinical training pattern combined with or without simulator training to evaluate the effect of simulator in the training program of EUS.

Participants

We recruited 26 trainees who had previously learned the theoretical aspects of a radial-scanning pattern in an EUS training program. All trainees are clinical doctors who are capable of performing gastric endoscopy and colonoscopy. All pictures used in this study were from our clinic imaging system.

Training procedures

The trainees were randomly divided into two groups by a single-blinded method. Since the baseline endoscopic skills of trainees can vary the results of analyses, we categorized all the trainees on the basis of their seniority scores (number of gastroscopy cases \times 1 + number of colonoscopy cases \times 1.5). Based on the median of their seniority scores, trainees were divided into two groups: experienced group and inexperienced group. The experienced group included trainees with scores above the median while the inexperienced group included trainees with scores below the median. Then, trainees were randomized into either the experimental group or the control group. Trainees in the experimental group completed a structured EUS training program combining the clinical pattern with simulator training. The trainees of the control group were trained only with the clinical pattern. Our traditional training pattern includes two parts. The first stage consisted of clinical observation only, and the second stage included both clinical observation and clinical practice. According to the purpose of this study and in consideration of patients' safety, we only assessed whether the simulator training was helpful for examination of the anatomical structure in the pancreatobiliary system, and thus, “clinical training” mentioned in this article is equivalent to clinical observation. After undergoing the training program for 1 month, all trainees had to appear for a written test, which determined their skills using an established assessment procedure. Due to the limited availability of training resources, it was not realistic to administer the test through our simulator,

and thus, we employed the written test to assess the value of simulator use in EUS training. This written test had 100 items, and the trainees had to correctly identify the anatomical structures in the presented ultrasound images. Finally, we conducted a questionnaire survey regarding simulator use among the trainees. The survey consisted of two parts; the first part covered basic information including trainees' endoscopic experience and ultrasonic experience. The second part included questions pertaining to the reasonability of the simulator, the complexity of operative skills, the operative similarity between the simulator and EUS, the effectiveness of simulator use in EUS training, and the confidence of trainees after undergoing EUS training. Trainees were asked to provide a score ranging from 0 to 10 for every question. All trainees participated in this survey and completed the questionnaire.

Facilities

We used the GI Mentor II virtual reality endoscopy simulator manufactured by Symbionix Co. (Cleveland, OH, USA)^[14] for the training program. Under the guidance of experienced physicians, we designed our training program in a radial-scanning pattern. We divided trainees' operations over two sessions, and they were asked to work under the supervision of faculty members. Part I of the program lasted for 1 week, and in this training session, trainees only used the simulator in the EUS training mode to study the anatomical structure in the pancreatobiliary system. In Part II of the program, the practice mode was included in the training curriculum; this course was taught over the subsequent 3 weeks. Both parts were performed under the supervision of faculty members. After trainees completed the two parts of the training program, administrators checked the trainees' work to determine whether the trainees passed the training curriculum successfully.

Statistical analysis

A Chi-square test was used to compare categorical variables regarding the basic information of the trainees; and a student's *t*-test was used to compare continuous variables regarding the scores of trainees in the two groups. Since the endoscopic skills of trainees can impact the training results, we performed Pearson correlation analysis to analyze whether there were interactive effects between trainees' endoscopic skills and the operation of the simulator. A two-sided $P \leq 0.05$ was considered statistically significant. Our statistical software is SPSS 19.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Basic information of trainees

In our research study, we first divided the 26 trainees into two groups: experienced group and inexperienced group based on their endoscopic skills. Then, trainees from each group were randomly assigned to the experimental group and the control group. There were no statistically significant differences between the experimental and control groups in terms of gender, age, or endoscopic skills of trainees [$P > 0.05$, Table 1].

Posttraining test scores

After completing the training program, the trainees were tested with an established assessment procedure, which included a written test. The mean test score of trainees in the experimental group (64.53 ± 4.91) was significantly greater than that of the control group (60.09 ± 5.49 ; $P = 0.028$).

Simulator use enhances endoscopic ultrasonography training

We performed variance analysis to determine that simulator use had significant effects on the endoscopic skills of trainees undergoing EUS training ($P = 0.035$ for simulator use and $P = 0.268$ for trainees' endoscopic skills, [Table 2]). The results indicated that the simulator enhanced the training results achieved with this EUS training program while trainees' initial endoscopic skills had no impact on the effectiveness of EUS training. Furthermore, we determined the interactive effects of these two factors on the effectiveness of the training program, and we found no such interaction [$P = 0.284$, Table 2].

Individual test score in the experimental group correlated positively with the frequency of simulator use

We performed Pearson correlation analysis to determine the correlation between the test score of individuals in the experimental group and the frequency of

Table 1. Basic information of trainees

	Experimental group (n=15)	Control group (n=11)	P
Age, mean±SD	34±4.52	37±4.63	0.216
Gender, n (%)			
Male	2 (13)	4 (37)	0.348
Female	13 (87)	7 (64)	
Seniority, n (%)			
Experienced	8 (53)	6 (55)	1.000
Inexperienced	7 (47)	5 (45)	

SD: Standard deviation

Table 2. Effects of the stimulator use and trainees' endoscopic skills in the endoscopic ultrasonography training program and the interactive effects between these two factors

	Test scores		P1	P2	P3
	Experimental group	Control group			
Experienced	64.50 (4.24)	58.17 (5.91)	0.035	0.268	0.284
Inexperienced	64.57 (4.47)	62.40 (4.39)			

P1: Reflects the effects of the stimulator in EUS training, P2: Reflects the effects of the trainees' endoscopic skills in EUS training, P3: Reflects the interactive effects between these two factors, EUS: Endoscopic ultrasonography

simulator use. The Pearson's correlation coefficient was calculated to be 0.097 [Figure 1], which indicates that the individual test score may be positively correlated with the frequency of simulator use in the experimental group. In Figure 1, horizontal axis means using frequency simulator and vertical axis means scores of trainees. This result also confirmed that the simulator training program could effectively enhance the EUS training.

Questionnaire findings

Finally, all the trainees of the experimental group were asked to finish a questionnaire survey about the simulator training program. All trainees gave positive feedback to questions pertaining to the reasonability of the simulator, the complexity of operative skills, and the operative similarity between the simulator and EUS. Moreover, the self-confidence of trainees was enhanced for EUS operation. Compared to the pretraining scores in the experimental group, the trainees' self-confidence had improved significantly in the overall mean score after completing the training (6.93–7.67, $P = 0.405$)

DISCUSSION

The main purpose of our research study was to evaluate the effectiveness of simulator use in the EUS training program. Our results demonstrated that after being trained with the simulator, the trainees showed a significant improvement in their test scores and self-confidence levels. This indicates that simulator use can help trainees to improve their ability to evaluate the normal pancreatobiliary structure, which is a very important part of EUS training. Trainees were better equipped to perform EUS after completion of the training program with the simulator. Moreover, trainees could correctly identify the anatomical marks while performing ultrasonography. We next analyzed the correlation between the individual test scores and the frequency of simulator use in the experimental group. The Pearson correlation coefficient indicated that the individual test score was positively correlated with the frequency of simulator use in the experimental group.

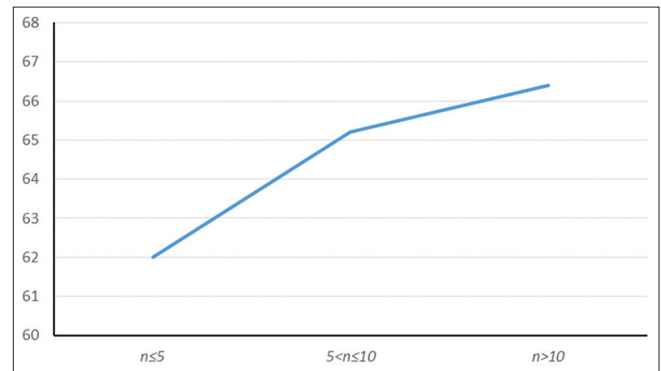


Figure 1. The individual test score was positively correlated with the frequency of simulator use

Thus, our results indicate that the simulator of EUS can greatly enhance the clinical and operative skills of trainees undergoing the EUS training program.

Other training patterns for EUS have been reported in literature, including the model training pattern and the traditional clinical pattern. There are two models. One is computer based and the other is animal model.^[15] Computer-based models include simulator and phantoms. Phantoms are easy to use and need minimal preparation although it lacks fidelity. Simulator is superior to phantoms in that it provides a more realistic environment than phantoms. On the other hand, animal models contained *ex vivo* animal model and live animal model. Live animal model is the most realistic, but this requires special facilities and equipment, making preparation complicated. In the model training pattern, trainees are mainly taught using animal models^[11,12] and self-designed ultrasonic models.^[9,10] Barring few exceptions, the animal model training pattern is being gradually eliminated because of its poor feasibility. Moreover, it also significantly increases the costs of EUS training programs. In our previous study, we designed an ultrasonic model for EUS training in our training center. This ultrasonic model could help trainees to identify the anatomical structures of the pancreatobiliary system, which is useful for training novices to perform EUS. Nevertheless, this designed model has some defects, such as poor reusability and a defective imaging system, limiting its usage

in EUS training.^[9,10] Therefore, compared with the animal models and self-designed ultrasonic models, the simulator for EUS has great advantages and better feasibility.

After completing the training, all trainees of the experimental group completed the questionnaire survey and gave positive replies when inquired about the following aspects of the simulator training program: the reasonability of the simulator, the complexity of operative skills, and the operative similarity between the simulator and the EUS. Moreover, the simulator training program also helps trainees by improving their self-confidence while performing EUS. However, some trainees pointed out that the simulator has some inadequacies because there are differences between the simulator operation and EUS. After undergoing training with the simulator, the trainees did not show a significant improvement in operative skills. However, they showed a significant improvement in their ability to identify the anatomical marks detected by ultrasonoscopy. Therefore, we deduce that the conventional clinical practice should be combined with simulator training in our future training programs. Moreover, the simulator training should be conducted at an earlier stage of the training program.

At present, the conventional training procedure for EUS involves theoretical teaching and clinical practice.^[6,16] Wang *et al.* designed a series of curriculums for conventional EUS training, including some academic forums for EUS. Then, some written tests and skill tests were conducted to evaluate the effectiveness of these curriculums and to show that they enhanced the EUS training programs.^[17] Nevertheless, their curriculums do not provide many opportunities for trainees to directly practice their clinical skills. In our training procedure, we combined the simulator training program with clinical practice. Thus, we provided the trainees with many opportunities to participate in the clinical operation of EUS. By comparing the operation of the simulator with that of EUS, trainees can gain cognitive knowledge of EUS. Thus, with this novel approach, we have maximized the promotional effect of the simulator in EUS training program. Thus, after completion of our training procedure, trainees showed a remarkable improvement while performing EUS.

There are some limitations in this research study. To ensure better training with limited research resources, we included only a limited number of trainees in

our training program. As a result, we have only determined the tendencies of the data associated with a small sample; we could not establish statistically significant differences. In addition, we only evaluated the effects of the simulator in the study of the normal anatomical structure in EUS training program. A more comprehensive research project is needed based on these results.

CONCLUSION

Our research confirmed that use of a simulator can promote the effectiveness of a EUS training program. Trainees who were taught to operate on a simulator showed better operative skills while performing EUS in clinical practice. Moreover, after use of a simulator, their self-confidence also increased. Trainees were able to successfully identify the anatomical structures of the pancreatobiliary system, which were revealed by ultrasonoscopy. Moreover, our research study provides some valuable experience and constructive instructions that need to be included in the standardized EUS training program. In our future work, we hope to design a more comprehensive training procedure to improve the effectiveness of our EUS training program.

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Conflicts of interest

There are no conflicts of interest.

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