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Teaching experience of standardized training for interventional ultrasound resident

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Abstract: *To explore the effective teaching methods of interventional ultrasound resident standardized training, and to improve the quality of training and the clinical skills of residents. From January 2018 to January 2023, 60 students who received standardized training of interventional ultrasound residents in our hospital were selected as the research objects, and they were randomly divided into the control group and the observation group, with 30 students in each group. The traditional teaching mode was used in the control group, while the problem-based learning (PBL) combined with simulation training was used in the observation group. The learning effect of the two groups of students was evaluated through theoretical examination, practical operation examination and case analysis report, and the relevant data were recorded. The scores of the observation group were better than those of the control group in the theoretical examination, practical operation examination and case analysis report, and the difference was statistically significant ($P < 0.05$). The teaching method of PBL combined with simulation training has a significant effect in the standardized training of interventional ultrasound residents, which can improve the theoretical level, practical ability and clinical thinking of the trainees, and is worthy of promotion.*

Keywords: *Interventional ultrasound; Resident physician; Standardized training; PBL teaching method; Simulation training*

1. Introduction

In today's era of rapid development of medical science and technology, interventional ultrasound, as an important technology with far-reaching significance and wide application prospects in the field of modern medicine, is playing an increasingly important role in the diagnosis and treatment of various diseases with its unique advantages and irreplaceable role [1] . Interventional ultrasound technology combines the precise imaging characteristics of ultrasound imaging with the minimally invasive treatment concept of interventional medicine, which is like a silent "scout" and "scalpel", providing clinicians with more accurate and detailed lesion information, and also opening up a safer and more effective way of treatment for patients. However, the operational complexity and high risk of interventional ultrasound techniques place high demands on the professional skills of physicians [2] . Therefore, it is particularly important to carry out standardized training for interventional ultrasound residents to improve their clinical skills and diagnostic accuracy. The purpose of this study is to explore the effective teaching methods of interventional ultrasound resident standardized training, and to provide a useful reference for interventional ultrasound resident standardized training by comparing the traditional teaching mode with PBL combined with simulation training.

2. Data and methods

2.1 General information

Sixty trainees who received standardized training of interventional ultrasound residents in our hospital from January 2018 to January 2023 were selected as the research objects. In the control group, there were 14 males and 16 females, aged 23-25 years, with an average of 24.28 years. There were 17 males and 13 females in the observation group, aged 23-26 years, with an average of 25.48 years. There was no significant difference in gender and age between the two groups ($P > 0.05$), which was comparable.

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2.2 Method

The traditional teaching mode was used in the control group, including classroom teaching, observation and demonstration, and practical operation. The teaching method of PBL combined with simulation training was used in the observation group, and the specific steps were as follows:

PBL teaching: (1) Case selection and problem design: Teachers carefully select typical cases with representative and educational significance according to the training objectives and the learning progress of residents. For each case, a series of step-by-step questions were designed, which should cover the basic principles, indications, contraindications, operation skills and complications of interventional ultrasound. Question design should focus on inspiration and guidance, encourage residents to think deeply, and cultivate their clinical thinking and problem-solving ability. (2) Group discussion and autonomous learning: Residents were divided into several groups, and each group was assigned a case and corresponding questions. Residents discuss in small groups to analyze problems and propose solutions. Residents are encouraged to learn relevant knowledge independently by consulting materials and literature retrieval, so as to provide strong support for group discussion. (3) Teacher's guidance and summary: In the process of group discussion, teachers, as guides, provide clues in time to guide the direction of discussion and ensure the accuracy and depth of learning content. After the discussion, the teacher summarizes, refines the key knowledge points and strengthens the learning results. Teachers can also give feedback and suggestions according to the discussion and performance of residents to help them improve their learning methods and improve their learning effect.

Simulation training: (1) Selection and setting of simulation training system: select an advanced interventional ultrasound simulation training system, which should be able to simulate a variety of clinical scenarios and cases. According to the training objectives and the learning progress of residents, the appropriate training difficulty and scenarios are set. (2) Simulated operation training: resident doctors perform operations such as puncture positioning, guiding needle insertion, aspiration or injection in the simulated training system. The system can feed back the operation results in real time, including puncture location, depth, angle and other information, to help residents correct operational errors and improve operational skills. Residents are encouraged to try many times in the simulation training to accumulate experience and improve their operational proficiency. (3) Team cooperation and communication training: Simulation training can also simulate different roles in the surgical team, such as sonographer, surgeon, nurse, etc. Residents play different roles in the simulation training and experience the tacit understanding and coordination of teamwork. Through simulation training, residents can learn how to communicate effectively in teams, solve problems together, and lay the foundation for future practical work. (4) Feedback and evaluation: After the simulation training, the system provides detailed operation feedback and evaluation report. Based on the feedback report, residents can understand their operational strengths and weaknesses and make improvement plans. Teachers can also make a comprehensive evaluation of the training effect of residents according to the evaluation report, and provide guidance for their follow-up study.

2.3 Evaluation index

The learning effects of the two groups were evaluated through theoretical examination, practical operation examination and case analysis report.

Theory test: Closed-book test is used to test the students' mastery of knowledge related to interventional ultrasound. The content of the examination includes the basic principles, indications, contraindications, operation skills and complications of interventional ultrasound [3] .

Practical operation assessment: the form of simulated operation assessment was used to assess the interventional ultrasound operation skills of the trainees. The assessment includes the accuracy and proficiency of puncture positioning, guiding needle insertion, aspiration or injection [4] .

Case analysis report: The trainees are required to analyze the typical cases and write the case analysis report. The contents of the report include case overview, ultrasound findings, diagnostic basis, treatment options and prognosis assessment.

2.4 Statistical methods

SPSS 22.0 software was used for data analysis. Measurement data were expressed as mean ± standard deviation ($X \pm s$), and t test was used; enumeration data were expressed as rate (%), and χ^2

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test was used. The difference was statistically significant when $P < 0.05$.

3. Results

3.1 Comparison of theoretical and practical examination results

The test scores of theory and practical operation in the observation group were better than those in the control group ($P < 0.05$). See Table 1.

Table 1 Comparison of theoretical test scores of two groups of students ($X \pm s$, points)

Group	Number of people	Average score of theory test	Average score of practical operation examination
Control group	30	75.6±8.2	72.3±9.1
Observation group	30	89.4±6.8	87.6±7.5
T-value		12.45	14.32
P value		<0.01	<0.01

3.2 Quality comparison of case analysis report

The quality of case analysis report in the observation group was better than that in the control group ($t = 7.231$, $P < 0.05$). See Table 3 for specific data.

Table 2 Quality comparison of case analysis reports of two groups of trainees ($X \pm s$, points)

Group	Number of people	Mean score of case analysis report
Control group	30	70.5±8.5
Observation group	30	85.2±7.2
T-value		10.94
P value		<0.01

3.3 Trainee satisfaction comparison

The satisfaction of the students in the observation group was better than that in the control group ($\chi^2 = 4.320$, $P < 0.05$). See Table 3.

Table 3 Comparison of two groups of trainees' satisfaction (n,%)

Group	Number of people	Satisfied	Not satisfied	Satisfaction
Control group	30	22	8	73.3
Observation group	30	28	2	93.3
T-value		-	-	10.293
P value		-	-	<0.01

4. Conclusion

PBL teaching method is a problem-based teaching mode, which emphasizes that students are the main body to solve problems through autonomous learning and group discussion, and to cultivate students'clinical thinking and problem-solving ability [5]. In this study, PBL teaching method was applied to the standardized training of interventional ultrasound residents, and remarkable results were achieved. The scores of the observation group were better than those of the control group in the theoretical examination, practical operation examination and case analysis report, and the difference was statistically significant. This shows that PBL teaching method can improve the students' learning enthusiasm and autonomous learning ability, and promote the students to master and apply the relevant knowledge of interventional ultrasound.

The application value of PBL teaching method is mainly reflected in the following aspects: First, to stimulate students' interest in learning and improve their learning initiative. PBL teaching method is based on typical cases, raises questions, and guides students to learn independently by consulting materials and group discussions, so that students can get a sense of achievement in the process of

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solving problems, thus stimulating their interest in learning. The second is to cultivate students'clinical thinking and problem-solving ability. PBL teaching method emphasizes that students are the main body to solve problems through autonomous learning and group discussion, so that students can develop clinical thinking and problem-solving ability in the process of solving problems. The third is to promote communication and cooperation among students [6,7] . PBL teaching method adopts the form of group discussion to encourage communication and cooperation among students, so that students can learn from each other and promote each other in interaction [8] .

Simulation training is a method of using simulation equipment or simulation system to train students'skills. In this study, the interventional ultrasound simulation training system was used to simulate the operation training of the students in the observation group, and remarkable results were achieved. The scores of the observation group were better than those of the control group in the practical operation examination, and the difference was statistically significant. This indicates that the simulation training can improve the interventional ultrasound operation skills of the trainees, reduce the operation errors and improve the operation safety. The role of simulation training is mainly reflected in the following aspects: First, to improve the operational skills of students. The simulation training system can simulate the real interventional ultrasound operation environment, so that students can practice repeatedly in a highly simulated situation, so as to deepen their understanding and mastery of the operation steps and skills. Through continuous simulation operation, trainees can gradually become familiar with the use of various interventional ultrasound surgical instruments, improve hand-eye coordination ability and operation accuracy, and lay a solid foundation for practical operation. The second is to reduce operational errors. In the process of simulation training, students can face all kinds of complex situations and emergencies that may be encountered. Through the immediate feedback of the simulation system, students can find and correct their own operational errors in time. This immediate feedback mechanism helps trainees to form correct operation habits and avoid errors and complications caused by improper operation in actual operation [13] . Third, improve the safety of operation. Interventional ultrasound operation has certain risks, and improper operation may cause injury to patients. Through simulation training, trainees can be familiar with and master various interventional ultrasound techniques without endangering the safety of patients. In this way, in the actual operation, the trainees can be more confident and calm in dealing with various situations to ensure the safety of the operation. Fourth, enhance the psychological quality of students. Simulation training is not only the exercise of students'operational skills, but also the test of their psychological quality. In a highly simulated environment, students need to face various pressures and challenges, such as time constraints, complex operations and so on. Through continuous simulation training, students can gradually adapt to this tense atmosphere, improve their psychological endurance, and lay a solid foundation for the actual operation of coping ability. Fifth, to promote students'autonomous learning. The simulation training system usually has the functions of recording and analysis, which can record the operation process and data of the trainees for self-evaluation and reflection. Students can find their own shortcomings by analyzing their own operation records, so as to make targeted improvements and improvements. This way of autonomous learning helps to stimulate students'learning enthusiasm and initiative, and improve their learning effect.

The results of this study showed that the scores of the observation group were significantly better than those of the control group in theoretical examination, practical operation examination and case analysis report, and the difference was statistically significant ($P < 0.05$). This result fully illustrates the remarkable effect of interventional ultrasound simulation training system in improving the comprehensive ability of trainees. Simulation training not only improves the operational skills of trainees, but also promotes the mastery and application of theoretical knowledge, as well as the improvement of case analysis ability. Analyzing the reasons, the ultrasound simulation training system can highly restore the real operating environment and steps, so that students can deeply experience the feeling of actual operation in the simulation operation. This highly simulated training environment is helpful for students to familiarize themselves with and master interventional ultrasound operation skills more quickly, and to improve the accuracy and safety of operation. The simulation training system has the function of immediate feedback, which can immediately point out the mistakes and shortcomings of the trainees in the operation process. This immediate feedback helps students to find and correct mistakes in time and form correct operation habits. At the same time, students can also understand their progress and shortcomings by analyzing their own operation records, so as to make targeted improvements. Simulation training not only pays attention to practical operation, but also combines the study of theoretical knowledge. Through simulation training, the trainees can have a deeper understanding of the theoretical basis of interventional ultrasound operation, combine theoretical knowledge with practical operation, and improve their comprehensive application ability. The

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simulation training system usually contains a rich case database, and the trainees can improve their case analysis ability through simulation operation and case analysis. This analytical ability is of great significance for trainees to deal with complex and unexpected situations in practical operation. The simulation training system is interesting and challenging, which can stimulate students' learning enthusiasm and initiative. In the simulation training, the trainees constantly challenge themselves and improve their operational skills and comprehensive quality.

To sum up, simulation training has significant advantages and functions in the training of interventional ultrasound operation skills.

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