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Research Article

Case-based Learning Combined with Scenario Simulation in the Operating Room Practice Teaching for Surgical Graduate Students

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Abstract

Background: The Case-Based Learning (CBL) combined with scenario simulation represents an innovative approach to medical and surgical education aimed at bridging the gap between theoretical knowledge and practical application in real-world settings. It is increasingly recognized as an effective strategy in surgical training, designed to improve patient safety and outcomes by preparing future surgeons with the necessary skills and confidence for the operating room. *Methods:* Thirty surgical graduate students were randomly divided into a study group (group CS) and a control group (group T), with 15 students in each group. The group CS received training using CBL combined with scenario simulation, while the group T underwent traditional teaching methods. After training, the outcomes, teaching satisfaction, and learning confidence were compared. *Results:* No significant differences in baseline data were observed between the two groups ($P > 0.05$). The group CS scored higher on theoretical exams (94.5±4.9 vs. 89.3±4.3, $P < 0.05$) and practical skills assessments (94.7±4.3 vs. 86.4±4.2, $P < 0.05$) after training. Additionally, teaching satisfaction (43.6±3.5 vs. 36.1±4.4, $P < 0.001$) and learning confidence scores (42.9±2.9 vs. 34.2±4.8, $P < 0.001$) were higher in the group CS. *Conclusion:* Incorporating CBL combined with scenario simulation into the practical training of surgical graduate students results in improved training outcomes. It not only enhances clinical thinking skills and overall competence but also increases teaching satisfaction and learning confidence among students.

Keywords

Case-based Learning, Scenario Simulation, Operating Room, Practice Teaching, Surgical Graduate Students

1. Introduction

The operating room is a critical area where surgeries and emergency interventions occur. Factors such as changes in a patient's condition and the unpredictability of surgeries and anesthesia contribute to the high-risk nature of this environ-

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ment [1, 2]. Consequently, surgical residents must possess a strong foundation of theoretical knowledge and strive to enhance clinical thinking, teamwork, and crisis management skills during their operating room practice [3, 4]. Traditional operating room practice teaching is predominantly led by instructors who guide students through learning in the operating room. In this setup, students passively receive knowledge transmitted by the instructors, which limits their proactive involvement [5]. The case-based learning (CBL) approach involves the use of pre-designed classical cases to guide students in deep learning discussions, thereby stimulating their ability to solve various clinical problems and actively engage in the learning process [6-8]. Scenario simulation teaching complements CBL by providing specific clinical scenarios in which students are immersively placed into diverse medical environments, simulating the entire medical process [9, 10]. This study investigates the application effectiveness of CBL combined with scenario simulation in the operating room practice teaching of surgical professional graduate students.

2. Materials and Methods

2.1. Subjects

This prospective, randomized, single blind study was approved by the Ethics Committee of the First College of Clinical Medical Science of Three Gorges University. Written informed consent was obtained from all participants. Thirty surgical graduate students, who had not undergone systematic airway management training before this study, were selected for a rotation learning session in the operating room of the Anesthesiology Department at Yichang Central People's Hospital from January 2025 to June 2024. These students were randomly divided using a random number table into two groups: the CBL combined with scenario simulation teaching group (group CS) and the traditional teaching group (group T), with 15 surgical graduate students in each group. There were no statistically significant differences between the two groups in terms of age, gender, and educational background of the residents ($P > 0.05$).

2.2. Teaching Methods

Both groups were given lessons by one blinded teacher. The teacher designed the theoretical knowledge and practical skills training content based on the 2022 American Society of Anesthesiologists (ASA) difficult airway management guideline for handling difficult airways [11]. The teacher utilized PowerPoint presentations to introduce various aspects of airway management, including airway assessment, use of different airway tools, and the procedure and key points for handling difficult airways. Students also watched videos that demonstrated airway management techniques. After completing the theoretical knowledge sessions, the teacher led the surgical graduate students in clinical observations and practical exercises.

2.2.1. Study Group

Preparation before class: The teacher selected an anticipated difficult airway case involving "maxillary fracture with limited mouth opening" as the teaching case. Medical records were organized and distributed to the surgical graduate students one week before the class.

Setting the teaching scenario: Based on the teaching content, the teacher guided group members in role-playing exercises. Surgical graduate students played the roles of resident physicians, patients, and their families, respectively. The resident physician was responsible for preoperative airway assessment and examination, and the patient was to be aided by providing the medical history as the main complaint, and the family member's role provided additional patient information. Post-lesson, the resident physician was assigned research questions, which required them to independently investigate and create a mind map. During the next class, they presented their findings through slides for collective learning. The teacher managed the process throughout, summarizing and evaluating each student's performance.

Scenario simulation in the operating room: Scenario-based simulation involved choosing group members to act out roles of the patient and anesthetists, demonstrating their understanding of difficult airway management processes. The teacher immersed group members in a simulated anesthesia scenario using mannequins linked to a computer and a projector. The teacher operated simulation software, choosing pre-set scenarios reflecting difficult airway situations. Initially, individuals performed airway management training. Following this, team members collaborated, switching roles and making real-time decisions based on the conversion of the simulated scenario and changes in the mannequin's vital signs. This allowed them to practice both airway management techniques and teamwork.

Group discussion: After the simulation training, the teacher organized a group discussion to review each member's performance in difficult airway management processes. The group members analyzed problems and found solutions by looking up literature and textbooks.

Summary and Feedback: The teacher concluded by summarizing the group members' theoretical knowledge and clinical practice performance, highlighting areas for improvement. Encouragement was given for inter-group evaluations to identify each other's strengths and weaknesses. The teacher further critiqued the group scenario handling processes, offering guidance on the correct airway management procedures.

2.2.2. Control Group

The teaching content covers aspects such as the history

and characteristics of oral and maxillofacial fractures, pre-anesthetic airway assessment, utilization of airway management tools, and airway management procedures. The teacher delivers lectures using slides to explain the theoretical concepts, including the specifics of oral and maxillofacial fractures and airway management protocols. Students watch videos demonstrating airway management during surgeries involving these types of fractures. The teacher guides surgical graduate students in selecting appropriate patients to observe the tracheal intubation process firsthand in the operating room. Following the observation, students practice their skills using mannequins. This hands-on practice is facilitated through simulations on these mannequins, allowing students to refine their techniques in airway management.

2.2.3. Assessment and Evaluation

On the second day following the completion of training, both groups underwent a uniform theoretical knowledge and practical skills assessment. These assessments were independently conducted by three blinded teachers who were not involved in the teaching.

Theoretical Knowledge: This exam evaluated the students' understanding of airway management theory, encompassing airway assessment guidelines, airway management procedures, pre-intubation preparation, and post-intubation management. The test format included multiple-choice questions and short-answer questions. A standardized closed-book exam, administered by the first teacher, was used for both groups, with a maximum score of 100 points.

Practical Skills: Conducted by the second teacher, this assessment measured the students' proficiency in essential procedural skills. Evaluation criteria included pre-intubation preparation, positioning, general anesthesia, mask ventilation, laryngoscopy use, glottis exposure, catheter insertion, depth of catheter placement verification, artificial ventilation, and intubation complications. Each item was scored out of 10, with a potential total score of 100 points.

Training Satisfaction and Learning Confidence: After completing all assessments, the third teacher distributed questionnaires to gauge student teaching satisfaction and learning confidence [12].

3. Results

The assessment results showed that the surgical graduate students in the group CS outperformed those in the group T in both theoretical knowledge (94.5±4.9 vs 89.3±4.3, $P < 0.05$) and practical skills evaluations (94.7±4.3 vs 86.4±4.2, $P < 0.05$) (Table 1). The students in the group CS reported higher levels of teaching satisfaction (43.6±3.5 vs 36.1±4.4, $P < 0.001$) and learning confidence than those in the group T (42.9±2.9 vs 34.2±4.8, $P < 0.001$)(Table 2).

Table 1. *Comparison of Assessment Results Between the Two Groups (Scorces, n=15).*

	Group CS	Group T	*P*
Theoretical Knowledge	94.5±4.9*	89.3±4.3	0.021
Practical Skills	94.7±4.3*	86.4±4.2	0.026

NOTE. Data are presented as mean ± standard deviation.
* Statistically significant

Table 2. *Comparison of Teaching Satisfaction and Learning Confidence Between the Two Groups (Scorces, n=15).*

	Group CS	Group T	*P*
Teaching Satisfaction	43.6±3.5*	36.1±4.4	<0.001
Learning Confidence	42.9±2.9*	34.2±4.8	<0.001

* Statistically significant

4. Discussion

The study applied the CBL combined with scenario simulation teaching in the surgical graduate students' operating room practice training. Our results showed that the theoretical knowledge and operational skills scores of the observation group were higher than those of the control group ($P < 0.05$), indicating that CBL combined with scenario simulation teaching can improve training effectiveness. This is similar to the findings of several studies [13, 14]. The Department of Anesthesiology, characterized by its independence and strong practical orientation, requires surgical graduate students to have strong clinical thinking and comprehensive ability [15]. Traditional operating room practice teaching models primarily involve teacher lectures and on-site observations, allowing surgical graduate students to master basic skills but lacking exposure to real cases. This limits their ability to exercise proactive thinking and collaborative skills [16, 17]. CBL emphasizes student-centered, case-based learning and scenario simulation teaching reproduces the process of disease occurrence and treatment in a simulated environment [18-20]. By simulating real cases, it guides students to apply proper clinical thinking for diagnosis and decision-making, effectively enhancing problem-solving abilities while improving practical skills [21, 22]. CBL combined with scenario simulation teaching can stimulate learning interest and effectively mobilize students' subjective initiative. Through role swaps and cooperative drills in a single case, it enhances clinical thinking and non-technical skills in case handling, further improving training outcomes [23-25].

Several studies applied the CBL combined with scenario simulation teaching model in anesthesia teaching and found

an improvement in clinical thinking abilities among trainees, better teaching quality, and promotion of professional talent development, which is consistent with the findings of these studies [26-28]. In this study, a difficult airway management case in oral surgery was used as the basis to set scenarios for pre-anesthesia visits, airway assessment, and airway management during anesthesia. Surgical graduate students participated in this case's anesthesia treatment process in various roles, immersing themselves in simulated real scenes. This provided opportunities for difficult airway management without risk, thereby improving difficult airway management skills and enhancing clinical thinking abilities among surgical graduate students [29, 30].

In this study, the surgical graduate students in the observation group reported higher satisfaction and learning confidence compared to the control group. Moreover, the teaching effectiveness of the CBL combined with the scenario simulation teaching model was superior to that of traditional teaching methods, benefiting the surgical graduate students more significantly. This indicates that CBL combined with scenario simulation teaching, compensates for the shortcomings of traditional teaching methods by using real cases and creating realistic simulated scenarios. This approach increases the interest and engagement of surgical graduate students, exercises their comprehensive capabilities in operating room practice learning, and further stimulates their learning enthusiasm and initiative, thereby enhancing their satisfaction and confidence in learning. By analyzing the performance of surgical graduate students, teachers can identify areas where knowledge is lacking, optimize case settings, and simulate teaching processes to improve teaching efficiency and quality. The research by Li Qin et al [31]. showed that CBL combined with scenario simulation teaching addressed the deficiencies of traditional teaching methods, focusing on students' learning needs, enhancing their clinical thinking and comprehensive abilities, and gradually developing them into qualified medical professionals, thus helping to improve their satisfaction.

Several design limitations of this study should be of concern. Firstly, the study may not be completely blinded because two groups of students may communicate after training. Secondly, the pre-training evaluation method could be used to investigate the learning effect of the two groups of students before training in the future study. Furthermore, the potency and reliability of the checklist of difficult airway management had not been tested in this study and should be identified in the future.

5. Conclusions

In summary, the application of CBL combined with scenario simulation teaching in surgical graduate students' operating room practice has a significant effect. It not only effectively enhances surgical graduate students' theoretical knowledge and practical skills but also increases their satisfaction with the teaching and confidence in learning. A future study with pre-training evaluation and longer follow-up periods of more participants to estimate the effect on long-term retention of learning outcome is needed.

Abbreviations

CBL	Case-Based Learning
ASA	American Society of Anesthesiologists

Author Contributions

Yang Xiao: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization

Qibin Ke: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation

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Data Availability Statement

The data supporting the outcome of this research work have been reported in this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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