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Original Article

Study on the role of otological endoscopic technique in otology teaching

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Abstract: Background: The intricate anatomy, narrow confines of each otolaryngological organ, and complex structures that are often concealed make it challenging to comprehend the fundamental theoretical knowledge required for early clinical practice teaching. Despite an increase in literature research on otological endoscopic surgery both domestically and internationally, there is a lack of reports regarding its application value, advantages, and disadvantages from a pedagogical perspective. This study aimed to investigate the impact of incorporating otological endoscopic into otoscopy clinical practice teaching. Methods: In July 2020, 10 doctors of standardized training for residents who were rotated in the department of Otorhinolaryngology-Head and Neck Surgery (OHNS) of the First Affiliated Hospital of Anhui Medical University in 2019 were selected as the research objects. A randomized controlled trial (RCT) was used randomly divided into control (n=5) and experimental (n=5) groups by drawing lots. The control group received traditional teaching methods through video instruction, while the experimental group received traditional teaching combined with otological endoscopic examination, operation, and instruction. After completing both theoretical exams and skill operation assessments, a questionnaire survey was conducted to evaluate the effectiveness of each method. Results: No significant differences existed between groups in age, gender composition, or test scores before teaching. However, after completion of the course material, students in the experimental group scored significantly higher on both theoretical tests (42.90) and operational tests (49.60) compared to those in the control group (28.1, 32.70), respectively; this difference was statistically significant (P=0.001). Additionally, feedback from questionnaire surveys indicated that students who participated in otological endoscopic-based learning reported greater confidence in consolidating clinical practice ability as well as applying relevant knowledge under different scenarios than those who did not receive such instruction; these differences were also statistically significant (P=0.04, P=0.02, P=0.01). Conclusion: Incorporating otological endoscopic technology into otolaryngology education can enhance student engagement levels while improving overall learning efficiency by establishing standardized educational practices for future medical professionals.

Keywords: Otological endoscopy, otology teaching, standardized training for residents, questionnaire survey

Introduction

Otology deals with the anatomy of the sensory organs of hearing and balance [1], located mainly in the temporal bone. The ear canal takes on a curved narrow shape, making it challenging to observe lesions with the naked eye. Consequently, learning and memorizing become objectively difficult, resulting in a longer growth cycle for otologists [2]. Temporal bone dissection is an effective method for enhancing learning efficiency and shortening the learning curve [3]. However, conventional microscope approaches often require partial removal of the bone or joint opening of the ear canal to visualize the entire structure of the tympanic chamber, which can be challenging for beginners to comprehend [4]. Furthermore, limited access to necropsy resources restricts opportunities for practical experience. To address this issue, various models have been explored and developed for teaching purposes at the present stage [3, 5]. Nevertheless, these models offer limited simulation accuracy

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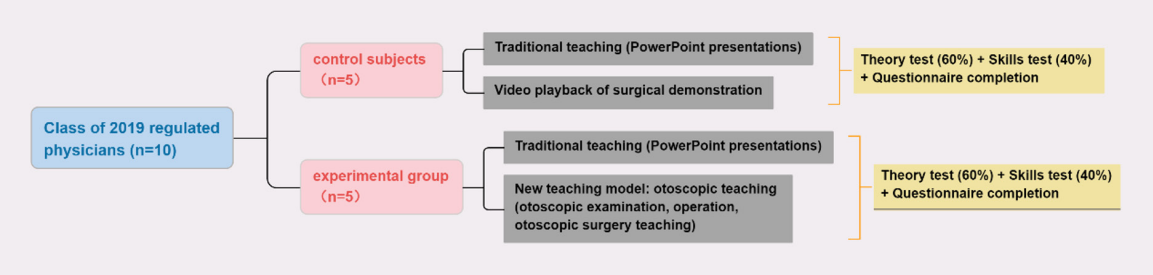

Figure 1. Design idea chart.

and provide only modest assistance in teaching. Establishing a more comprehensive and suitable teaching mode specifically designed for beginners remains a significant challenge in clinical practice education.

Endoscopic technology possesses the distinct advantage of providing clear and intuitive observation of anatomical structures and lesions [6]. Over the past decade, otological endoscopic technique has experienced significant advancements, resulting in more precise and controllable surgical procedures. The synchronization and visualization capabilities offered by otological endoscopic technique also present novel opportunities for reforming ear teaching methods [7, 8]. However, due to the absence of a standardized operating system and training process for otological endoscopy, its practical application in teaching remains underdeveloped. This study aims to enhance the training approach for doctors through otological endoscopy instruction while exploring its instructional value when combined with surgical observation, thereby further enhancing and innovating the teaching system.

Materials and methods

Research object

This study commenced in July 2020 and concluded in December 2021. Ten residents, who had received training in the OHNS rotation at the First Affiliated Hospital of Anhui Medical University and possessed clinical practicing physician qualification certificates, were selected (**Figure 1**). The average age of the participants was (23.5±0.5) years. They were randomly drawn in the order of 1 to 10. The control group consisted of singular numbers while the experimental group comprised even numbers. There were no significant differences observed between the two groups in terms of age, gender composition, or test scores, indicating their comparability. All physicians receive six months of basic teaching in otolaryngology, head and neck surgery, and pre-service training as well as one year of standardized residency training prior to training.

Teaching methods

Basic theoretical learning: The students in both groups were provided with theoretical instruction on the anatomy and endoscopy of the ear, as well as the pathology, diagnosis, and differential diagnosis of common ear diseases. Additionally, they received theoretical training on commonly used surgical techniques for middle ear diseases.

Traditional teaching model: The control group received conventional instruction. The instructor provided a comprehensive explanation of ear anatomy, otological endoscopy, and key operative techniques using visual aids. Additionally, the students observed a video demonstration of an otological endoscopic surgery to understand the structure of the middle ear. Under the guidance of the instructor, they utilized a simulation teaching device to practice various procedures such as foreign body removal in the external ear canal under endoscopic visualization.

New teaching model: Students in the experimental group received a novel form of instruction, which encompassed otological endoscopic examination teaching, otological endoscopic surgery teaching, and skill operation training. Otological endoscopic teaching involved: ① Utilizing slides to elucidate fundamental knowledge. ② Observing the tympanic membrane

and middle ear landmarks through otoscopy. ③ Independently operating on a simulation teaching device. ④ Independently performing simple otological endoscopy and disease diagnosis in the outpatient department.

Endoscopic ear surgery entailed observing the procedure from different angles to comprehend the anatomical relationship and relative position of the middle ear cavity and adjacent structures more deeply. This enhanced understanding of middle ear anatomy and spatial positioning at the surgical site facilitated clearer comprehension of surgical procedures as well as handling various emergencies during operations. The process of endoscopic ear surgery was briefly recounted while employing a simulation teaching device for learning purposes.

Skill operation training involves providing individualized and stratified instruction based on students' diverse learning abilities and needs [6]. Teachers emphasized different aspects for each student to enhance their proficiency with otological endoscopic operations.

Evaluation of teaching effect

Assessment methods: The assessment method was a combination of theory 60% and skill operation 40%, with a total score of 100. The theoretical assessment encompassed the study of anatomy and physiology of the depicted structures, as well as the diagnosis and treatment of common diseases, along with operational techniques and steps involved in otological endoscopic surgery. Skill-based examinations included otological endoscopy for diagnostic purposes, as well as foreign body removal from the external auditory canal. Evaluation of these skills was conducted by an impartial teacher who had no involvement in the teaching process.

Evaluation of teaching effect: The two groups of students were surveyed using questionnaires that encompassed stimulating interest in learning, enhancing innovative thinking abilities, strengthening clinical practice skills, expanding and applying relevant knowledge in diverse scenarios, as well as fostering confidence in future career development. Two specific questions were asked: 1. Suggestions for teaching methods; 2. What is the ideal teaching method? The evaluation of teaching effectiveness was categorized into five levels: 4 points for significant assistance, 3 points for moderate assistance, 2 points for general assistance, 1 point for minimal assistance, and 0 point for no assistance.

Statistical methods

R 4.3.0 statistical software was used to analyze the data. Measurement data were presented as sample mean ± sample standard deviation ($\bar{x}\pm s$), and an independent sample t-test was employed to compare the two groups. Count data were reported as percentages and numbers of cases, with the Fisher's exact test used for between-group comparisons.

Results

Assessment results

The assessment participation rate reached 100%. The assessment results revealed that the experimental group of trained physicians exhibited significantly higher scores in terms of relevant knowledge mastery and practical operation ability compared to the control group (**Table 1**).

Teaching effect evaluation

The questionnaire recovery rate was 100%. The scores from the questionnaires indicated that the teaching satisfaction of the experimental group surpassed that of the control group. Furthermore, feedback regarding the consolidation of clinical practice ability, application of relevant knowledge in diverse scenarios, and confidence in future career development was significantly better in the experimental group compared to the control group (P=0.04; P=0.02; P=0.01) (**Table 2**). Two participants expressed a need for improvement in theoretical knowledge delivery methods; one participant suggested making theoretical learning more engaging; three participants desired an increase in practical training time allocation. Additionally, two participants embraced the new teaching model involving otological endoscopy, while two others expressed interest in exploring problem-based learning (PBL) combined with case-based learning (CBL). Lastly, three participants wished to include temporal bone anatomy as part of their curriculum.

Table 1. The examination results table

Item	Control group (n=5)	Experimental group (n=5)	*T*-value	*P*-value
Theoretical examination	42.9±0.6	49.6±1.7	7.696	0.001
Operational assessment	28.1±1.2	32.7±2.6	6.557	0.001
Total score	70.2±2.0	82.3±4.3	7.447	0.001

Table 2. Teaching effect evaluation table

Item	Control group (n=5)	Experimental group (n=5)	*T*-value	*P*-value
Stimulate interest in learning	2.0±2.0	2.0±2.0	-0.45883	0.66
Enhance creative thinking skills	1.0±1.0	2.5±1.5	-1.8974	0.10
Consolidate clinical practice ability	1.5±1.5	2.5±1.5	-2.4495	0.04
Expanding knowledge in different scenarios	1.5±0.5	3.0±1.0	-3.1305	0.02
Confidence in future career development	1.0±1.0	3.0±1.0	-3.6742	0.01

Discussion

The foundation of otological surgery lies in a comprehensive and profound understanding of anatomical knowledge, which undoubtedly poses a challenging obstacle for the growth of otologists. The drawback of traditional teaching methods is the monotonous approach that relies on rote learning, failing to provide flexible observation from multiple perspectives and angles combined with plane anatomical images [9]. Due to the intricate nature and complexity of ear anatomy, theoretical descriptions and pictures alone are insufficient for beginners to grasp and construct their cognitive understanding of three-dimensional anatomical structures. Finding innovative teaching models, enhancing teaching efficiency, fostering interest in learning, promoting self-confidence among students, and providing support for the development of otologists are long-term challenges that need to be addressed [10].

Otological endoscopy has been utilized for observing middle ear structures since 1967 [11]. Due to its high operability, deep penetration into cavity structure, comprehensive display of anatomical landscape, and simultaneous observation of the surgical field by surgeons and students, it provides a beneficial opportunity for students to intuitively observe the anatomy of the middle ear and comprehend the principles of disease pathology and surgical procedures through simultaneous explanations provided by surgeons [12-17]. Building upon theoretical learning, the experimental group received training in otological endoscopy in an outpatient clinic which included both theoretical instruction and hands-on practice. They became proficient in one-handed operation techniques, and instrument usage, as well as familiar with anatomical landmarks and operative skills specific to otological endoscopy. Simple otological endoscopic surgeries were performed on teaching models to enhance familiarity with common surgical procedures. During student operations, teachers provided real-time feedback and corrections through a screen interface. These interactive and participatory teaching methods introduced novelty for young doctors by transforming passive learning into active engagement while maximizing learning efficiency [18]. In addition to operational teachings where instructors explained surgical skills and precautions based on past lessons learned from avoiding similar mistakes. Following this training program, students in the experimental group demonstrated profound familiarity with anatomical knowledge along with skilled operative abilities resulting in significantly better performance than that observed among control group counterparts during both theoretical examinations.

Endoscopic ear surgery is a minimally invasive and efficient procedure, aligning with the contemporary mainstream concept of precise and minimally invasive surgical techniques. Utilizing the natural space of the external auditory canal to address middle ear diseases, significantly expands the surgical field and offers notable advantages in common emergency treatments such as exploration and removal of foreign bodies from the ear canal, nasal cavity, and throat.

Consequently, this technique has gained popularity among young doctors [19, 20]. The convenience of otological endoscopy allows students not only to receive hands-on teaching during operations but also in outpatient clinics. The anatomical structures of both the outer ear and middle ear can be observed through the natural canal. Combined with intraoperative exploration and postoperative reviews of patients, students gain a comprehensive understanding of disease occurrence and outcomes while grasping continuous diagnostic processes [21]. In this study, based on examination score feedback, compared to the control group, students in the experimental group demonstrated enhanced comprehension levels along with improved disease diagnosis accuracy. This indicates that one crucial advantage offered by otological endoscopic technique in educational settings lies in cultivating clinical thinking skills as well as enhancing disease identification abilities among young doctors.

There is no significant difference in the learning curve between otological endoscopic and ontological microscopic surgery [22]. Otological endoscopy typically involves holding the scope with the left hand while operating with the right hand. However, compared to the two-handed operation under a microscope, it presents certain limitations and requires extensive learning and practice [23]. Additionally, otological endoscopy occupies space within the ear canal and provides a relatively small operational area for instruments. Therefore, operators must exercise caution during procedures, possess solid anatomical knowledge, and be highly familiar with surgical processes [24]. This is particularly important when dealing with narrow external auditory canals or intraoperative bleeding. The use of an otological endoscopy restricts observation and operation to a two-dimensional plane, lacking depth perception, three-dimensionality, and distance estimation. Furthermore, visualizing the surgical cavity is limited by its narrow structure. Insufficient proficiency in temporal bone anatomy may lead to inadvertent damage to facial nerves or tympani nerves resulting in postoperative complications [4].

Although the experimental group outperformed the control group in terms of anatomical knowledge, both groups exhibited poorer performance in the practical examination. The limited operating space and surgeon-dependent nature of otological endoscopic surgery hinder real-time teaching, leading to a one-sided learning experience for students. Despite the clear observation of endoscopic surgical steps, students often struggle with retaining complex surgical details and interpreting unclear surgical cavities. Consequently, they fail to develop their perspectives and construct a comprehensive knowledge system for endoscopic ear surgery. It is an undeniable fact that without opportunities to perform actual surgeries, improvement in surgical skills remains unattainable. During clinical practice, students should commence with basic operations. In addition to practicing teaching models with dexterity, it is crucial to possess solid anatomical knowledge and sufficient clinical reasoning abilities when selecting appropriate patients based on individual capabilities for performing simple endoscopic ear surgeries such as myringotomy, intubation, or repair of small tympanic membrane perforations in wide ear canals. By familiarizing themselves with commonly used instruments and honing their ability to hold glasses steadily while coordinating both hands proficiently during these procedures, students can gradually enhance their surgical proficiency before advancing toward more complex operations.

In the results of the questionnaire survey, no significant difference was observed in terms of stimulating learning interest and promoting innovative thinking between the two teaching models, possibly attributed to the limited sample size included in this study. The possible limitations and potential risks of bias associated with small sample sizes, and the impact of these limitations on the findings, allow for future studies to expand sample sizes to improve study reliability and generalizability. Previous research has demonstrated that otological endoscopic technique not only enhances theoretical teaching effectiveness but also fosters students' clinical reasoning and practical skills through teacher guidance, student-centered approaches, and individualized instruction. Consequently, under such positive feedback effects, students exhibit a strong inclination towards learning with increased confidence in conducting in-depth research [21].

In conclusion, the anatomical structure serves as the foundation for diagnosing and treating

diseases in OHAS. However, it should be noted that this field involves a unique and intricate anatomical location, which poses challenges to learning. Otological endoscopic technique facilitates learners in comprehending anatomical features from various perspectives during practical application, thereby significantly stimulating their interest and confidence while enhancing the accuracy of disease diagnosis. Consequently, it improves learning efficiency and enthusiasm. Therefore, promoting the application of otological endoscopic technique in teaching becomes imperative to identify and address issues through practice while establishing a standardized teaching and training system.

Conclusion

The application of otological endoscopic technique in the clinical practice teaching of otology offers distinct advantages, facilitating students' engagement, enhancing learning efficiency, and serving as a valuable adjunct for comprehending the intricate anatomical structure of the ear.

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Disclosure of conflict of interest

None.

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