Research of Ear Endoscopic Type I Tympanoplasty ——Single-institution Experiences in China

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Research Article

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Abstract

Purpose: To assess outcomes of one-handed ear endoscopic Type I Tympanoplasty and summarize the experience.

Methods: This study retrospectively analyzed 34 cases (23 females and 11 males) of one-handed ear Endoscopic Type I Tympanoplasty.

Result: The mean values of air conduction threshold before and after surgery were 48.22±18.36dB HL and 34.34±19.83dB HL, respectively. The mean values of the air-bone gap before and after surgery were 23.60±12.18 dB HL and 11.05±6.62 dB HL, respectively. The results showed statistically significant differences in hearing improvement (P<0.05). Among 34 ears, 30 ears had effective hearing improvement. No vertigo, intracranial infection, suppuration, and any other postoperative complications occurred. Although 1 ear occurred tympanic membrane perforation again, all ears achieved dry.

Conclusion: Ear endoscopic Type I Tympanoplasty with fewer complications and shorter surgery time were suitable for the chronic suppurative otitis media. Healing of the tympanic membrane and recovery of hearing level was ensured. However, the experience is still insufficient in China, so a large number of clinical workers need to exchange experience to promote the development of ear minimally invasive surgery.

Introduction

Chronic suppurative otitis media is a common Otology disease. The Tympanoplasty is performed under the operative microscope traditionally. The traditional operative microscope is safe and effective. It has the advantages of enough vision, less thermal, and being able to operate with both hands. However, it has some disadvantages, such as postoperative pain, large incision, scar, and so on. Endoscopic ear surgery is a hot topic recently in China. Its features, such as the high-resolution, less invasiveness, mild pain, less bleeding, small hidden incision, and ability to “look around corners”, have been noticed by more and more Chinese aurists [1]. However, it is seldomly performed in China at present. Therefore, further research on the safety and effectiveness of endoscopic ear surgery in China is a growing trend. This article presents the outcomes of 34 endoscopic ear surgeries in treating chronic suppurative otitis media, and shares some unique single-institution experiences.

Methods

Clinical Data.

The sample consisted of 34 patients with chronic suppurative otitis media in the stationary phase who underwent ear endoscopic Type 1 Tympanoplasty at the Second Affiliated Hospital of the Army Military Medical University from October 2019 to July 2021. 34 patients (34 ears) consisted of 11 males (11 ears) and 23 females (23 ears) with an average age of 41.12±12.19 years. All the patients had perforation of
tympanic membrane and had not discharged pus for at least one month. Besides, their auditory bone, inner ear, and mastoid process were confirmed unbroken before the surgery. They had surgical indications for Type I Tympanoplasty, and they had no contraindications to surgery. In this study, the data extraction had obtained the informed consent from all subjects and/or their legal guardian(s). In addition, this study adhered to the tenets of the Declaration of Helsinki and was approved by the Medical Ethics Committee of Second Affiliated Hospital of Army Medical University (2021-Research No. 106-01).

Surgical Methods.

According to the Wullstein classification, all the patients should perform the Type I Tympanoplasty. All surgeries are performed by the same surgeon and follow the otologic surgery principles in the literature [2]. Ear surgeries were performed through the transcanal approach using a rigid endoscope with an outer diameter of 2.7 mm, a length of 11 cm (1230AA Storz, Germany), and an angle of 0 or 30 degrees. Besides, the endoscope has a high-definition video system. Ear microsurgery instruments were used during the surgery. The procedure was as follows: (1) Making a 270-degree circular incision about 10mm near the tympanic ring through the external auditory canal. (2) Determining whether to supplement the second or third incision according to the surgical field. (3) Lifting the tympanic ring, separating the chorda tympani nerve, and deciding whether to remove the lateral wall of the superior tympanic chamber to better expose the superior tympanic chamber according to the patient's intraoperative situation. (4) Paying attention to the integrity of the ossicular chain during the surgery. (5) Making a graft called the CPC complex which is composed of one side cartilage and one side perichondrium. (6) Healing the perforation of tympani by using the interlay method of myringoplasty. (7) Placing absorbable gelfoam and iodoformum into the meatus and keeping them in place for one week without compression.

Follow-up.

In the second week after the surgery, the first time follow-up was performed and the endoscope was completed. At the same time, skin sutures, blood scabs, iodoform gauze and unabsorbed gelatin sponge were removed. The second time follow-up was performed in the first month after the surgery, and the endoscope and pure tone audiometry were completed. The time of subsequent follow-up was determined based on the patient's recovery. The criteria for successful surgery are intact tympanic membrane, no indentation of tympanic membrane, no bulging of tympanic membrane, no displacement of tympanic membrane, and reduction of air-bone gap (ABG) by more than 10 dB.

Statistical analysis.

The outcomes marked with $\bar{X} \pm s$ were analyzed using SPSS 20.0 software, and Paired Sample T-tests were conducted for count data. If the p-value was less than 0.05, the difference was statistically
significant. The air conduction threshold, air-bone gap, and tympanic membrane state of patients before and after the surgery were tested by Paired Sample T-tests.

Results

The status of the tympanic membrane.

All 34 ears are no longer pus. Besides, all patients have no postoperative complications such as vertigo, tinnitus, intracranial infection, postoperative bleeding, graft necrosis, decreased hearing, and facioplegia.

Among the 34 ears, one ear had a small perforation of the tympanic membrane, which healed after the endoscopic ear treatment. For the remaining 33 ears, they have intact tympanic membranes without invagination, as shown in Fig. 1.

Recovery of hearing level.

21 patients felt significant improvement in hearing, 9 patients felt moderate improvement, and 4 patients felt no improvement. The mean value of the pre-operative air conduction threshold was $48.22 \pm 18.36$ dB HL. The mean value of the postoperative air conduction threshold was $34.34 \pm 19.83$ dB HL. The results showed a statistically significant difference in the air conduction threshold ($t > 2.58, P < 0.05$). The mean value of the pre-operative air-bone gap was $23.60 \pm 12.18$ dB HL. The mean value of the postoperative air-bone gap was $11.05 \pm 6.62$ dB HL. The results showed a statistically significant difference in the air-bone gap ($t > 2.58, P < 0.05$)(see Table 1 and Fig. 2).

| Variate             | Pre-operative(dB HL) | Postoperative(dB HL) | Number | t     | p       |
|---------------------|----------------------|----------------------|--------|-------|---------|
| Air conduction      | $48.22 \pm 18.36$    | $34.34 \pm 19.83$    | 34     | 5.581 | 0.000   |
| threshold           |                      |                      |        |       |         |
| Air-bone gaps       | $23.60 \pm 12.18$    | $11.05 \pm 6.62$     | 34     | 6.412 | 0.000   |

Discussion

Aurists noticed the ability of the endoscope to look around corners. It has high resolution and can reduce the trauma and pain of the patient. It can also keep the mastoid process and osseous external auditory meatus behind intact. The ear endoscope can be used by aurists to identify hidden parts that the
microscope cannot recognize, such as the epitympanum, facial recess, and sinus meningioma angle. Besides, it can share the endoscope system with the nasal endoscope.

However, there are some disadvantages. The ear endoscope can only be operated with one hand and will cause thermal damage. Its lens can be easily blurred by heat gas or blood. Besides, it is not suitable for patients with external auditory canal stenosis, and cannot be used simultaneously with an electric drill.

We have summarized some experiences that can make the surgery more smoothly. 1) Making a 270-degree circular incision about 10mm near the tympanic ring through the external auditory canal. Sometimes the second incision (intertragic notch) or the third incision (cavity of auricular concha) is supplemented according to the intraoperative situation. 2) Gelatin sponge can be used to avoid skin flap injury. 3) In order to reduce bleeding during the surgery, tungsten needles can be used to get incisions, 1:10 adrenaline cotton wool balls can be used for pressure hemostasis, and the extremely thin BIPOLAR COAG can be used to get local hemostasis. 4) Bone needs to be drilled under saline to reduce thermal injury. 5) The use of suction or irrigation will help to reduce the impact on the visual field. 6) In order to explore the operative cavity completely, we recommend the following sequence of exploration: mesotympanum, hypotympanum, anterior tympanum, tympanic antrum, mastoid process, epitympanum, and rear tympanum. The key parts are epitympanum, facial recess, sinus meningioma angle, and tensor tympanic fold. 7) Ear endoscope is usually operated with one hand, and it can be operated with two hands when the endoscope holder or assistant is able to hold the endoscope. However, the surgeon needs to communicate with the assistant continuously, so that the field of vision can be suitable for him. 8) The most important thing is that when vision is limited, a microscope should be used to assist endoscopic ear surgery in time. When the lesions involve the upper tympanum or mastoid, microscope-assisted endoscopic ear surgery can provide a lot of help. 9) Postoperative attention should be paid to facial paralysis, cerebrospinal fluid otorrhea, hemorrhoea, and thrombus.

Recently, Professor Hou of the General Hospital of the People's Liberation Army put forward the core concept of minimally invasive ear surgery, which is called functional middle ear surgery. It means that based on clearing the lesions of the middle ear cavity, the mucosa and air chamber system of the mastoid process should be preserved as much as possible. Professor Hou recommended checking the ventilation channel from the Eustachian tube to the middle ear cavity to establish a stable air cavity and achieve satisfactory postoperative results [3].

Endoscopic ear surgery first appeared in the 1960s [4]. In the 1980s, endoscopes were widely used for nasal examinations and surgery. In the 1990s, endoscopes began to be gradually used in ear examinations and surgery [5]. In recent years, endoscopes have received widespread attention and have begun to be increasingly used in minimally invasive ear surgeries.

In the literature [6], one group of patients used an endoscope for tympanoplasty, and another group of patients used a microscope. The results showed that there was no significant difference between the two surgical methods in terms of surgical outcome, hearing restoration, recurrence rate, and complications. However, endoscopic ear surgery shortens the surgery time and anesthesia time, and reduces the patient's
pain. In the literature [7, 8], 146 cases of endoscopic cholesteatoma resection and tympanoplasty were successfully completed, and the cholesteatoma was completely removed. Although 11 cases relapsed, none of them had obvious complications, and all the grafts survived. In the literature [9], it was found that through endoscopic ear surgery, the probability of disease eradication was significantly increased, resulting in a decrease in the incidence of residual cholesteatoma from 47–6%. Literature [10] systematically reviewed 38 literatures related to endoscopic ear surgery, and found no major complications. In the literature [11], the cochlear implantation using an ear endoscope was successfully completed in 2014. In the literature [12], the Second Affiliated Hospital of Nanjing University performed 113 cases of tympanoplasty using the ear endoscope in 2012, of which 92 cases reached dry ears within half a month to one month. Tympanic pressure gradually improved after 3 to 6 months. Besides, it was found that there was no statistical difference between the endoscopic ear surgery and the microscopic ear surgery in terms of hearing restoration, recurrence rate, and the state of the tympanic membrane. As can be seen from the existing literature that, in general, endoscopic ear surgery is seldomly used in China at present.

In this study, it was confirmed that type I tympanoplasty with one-handed ear endoscope is feasible and effective. All patients reached the state of dry ears, the tympanic membrane of them healed well, the hearing was significantly improved, and no serious complications occurred.

Type I tympanoplasty is an entry-level surgery. Because the anatomy is more intuitive, doctors with less experience are more willing to use an endoscope for type I tympanoplasty. Therefore, endoscopic ear surgeries were more performed in basic hospitals than in high-level hospitals.

In recent years, ear endoscopes have gradually been used in surgeries on the mastoid, temporal bone, inner ear and other parts in China. Further clinical practice is needed to study which other parts of the ear can be operated with the ear endoscope.

**Declarations**

**Author contributions statement**

Conception and design of the work (A.C.D.); the acquisition of data (D.J., J.J.Y. and X.J.L.); analysis and interpretation of data (D.J., X.B.Z. and X.Q.Z.); draft of the manuscript (D.J.); All authors reviewed the manuscript.

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Competing interests

The authors declare no competing interests.

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Figures

Figure 1

The status of the intact tympanic membranes without invagination

Figure 2

Comparison of the results of pure tone audiometry before and 1 month after surgery (left: pre-operative; right: postoperative)