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A Simple Egg Membrane Patch Bridging Method for Repairing Tympanic Membrane Perforation

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Abstract: *Objective:* To analyze the clinical effect of a simple egg membrane patch bridging method in repairing tympanic membrane perforation. *Methods:* A total of 93 tympanic membrane perforation patients admitted to the hospital between September 2022 and October 2023 were selected and divided into two groups according to the random number table method. The control group implemented the conventional treatment (n = 46 cases), and the patch group adopted the simple egg membrane patch bridging method (n = 47 cases). The healing rate of the tympanic membrane, the air-bone gap, the air conduction hearing threshold, the dry ear rate, and the incidence of complications in both groups were compared before and after treatment. *Results:* The healing rate of the tympanic membrane in the patch group was significantly higher than that of the control group (95.75% vs. 76.09%), with $P < 0.05$; there was no difference in the air-bone gap and air conduction hearing threshold levels between the two groups before treatment ($P > 0.05$), and the hearing indexes of the patch group were significantly lower than those of the control group 3 months after treatment ($P < 0.05$); the dry ear rate in the patch group was significantly higher than that of the control group after treatment (85.11% vs. 67.39%), and the total incidence of complications was also significantly lower than that of the control group (6.38% vs. 21.74%), with $P < 0.05$. *Conclusion:* The simple egg membrane patch bridging method is effective in repairing tympanic membrane perforation, which can effectively improve patients' hearing levels and reduce the occurrence of post-treatment complications. Thus, it is worth popularizing and applying in the clinic.

Keywords: Egg membrane; Patch bridging method; Tympanic membrane perforation; Hearing level

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1. Introduction

The tympanic membrane, also known as the eardrum, is an oval translucent membrane at the junction of the middle ear tympanic chamber and the external auditory canal, which can effectively block the entry of foreign bodies and prevent bacterial infections [1]. The tympanic membrane is susceptible to tears when subjected to external force or air pressure, leading to perforation. Most tympanic membrane perforations are caused by external injuries, such as slaps, boxing, ear picking, diving, etc. The perforation can result in conductive and mixed hearing loss, accompanied by symptoms such as tinnitus, a feeling of fullness in the ear, bleeding in the

external ear canal, etc. A lack of timely treatment will lead to suppurative otitis media, further compromising health [2]. At present, the clinical approach to treating traumatic tympanic membrane perforation primarily involves traditional conservative methods, which emphasize keeping the ear canal dry and waiting for the injury to heal on its own. However, this method often requires a long healing time, and the perforation may not fully close. Finding an effective treatment method is a key challenge that needs to be addressed [3]. The membrane of a boiled egg has a certain degree of elasticity, making it resistant to displacement within the ear canal. It effectively counters negative pressure in the middle ear, and after soaking, it develops some antimicrobial properties. It also possesses anti-inflammatory effects, protects the wound, and promotes blood circulation [4]. The simple egg membrane patch bridging method uses the membrane from an egg to repair tympanic membrane perforations, aiming to reconstruct a complete and healthy tympanic membrane and restore the patient's hearing to normal levels. The materials used are readily available, easy to store, and highly effective, making this technique a high-quality and efficient treatment method for perforations [5]. Currently, there is limited clinical data on the use of the simple egg membrane patch bridging method for repairing tympanic membrane perforations. Therefore, this paper delves into the analysis of the efficacy of the egg membrane patch bridging method in treating patients with tympanic membrane perforations and its impact on hearing recovery, providing theoretical support for clinical practice.

2. General information and methods

2.1. General information

Ninety-three cases of tympanic membrane perforation patients admitted to our hospital between September 2022 and October 2023 were selected and divided into two groups according to the random number table method. The control group implemented the conventional treatment (n = 46), and the patch group adopted the treatment of the simple egg membrane patch bridging method (n = 47). In the control group, there were 22 males and 24 females, aged 8–53 years old; there were 35 cases of slap or punch injuries, 3 cases of explosion injuries, and 8 cases of ear picking or puncture injuries; the consultation time was 0.5–6 days, with an average of 3.12 ± 2.63 days. In the patch group, there were 24 males and 23 females, aged 8–55 years old; there were 33 cases of slap or punch injuries, 5 cases of explosion injuries, and 9 cases of ear picking or puncture injuries; the consultation time was 0.6–6 days, with an average of 3.32 ± 2.63 days. There was no difference in the general information of the two groups of patients ($P > 0.05$).

Inclusion criteria: (1) Meeting the diagnostic criteria in the *Clinical Diagnosis and Treatment Guidelines* [6]; (2) Endoscopic examination revealing congested tympanic membrane, with irregular perforations in the tense part of the membrane; (3) Conductive hearing loss indicated by hearing tests; (4) Tinnitus or hearing loss after the injury; and (5) Cooperating with follow-up visits.

Exclusion criteria: (1) Presence of a history of ear disease before the injury; (2) Suffering from serious mental illness; (3) Intellectually disabled; (4) Injury occurring more than 30 days; (5) Poor compliance.

2.2. Methods

In the control group, conventional therapy was applied. Alcohol was used regularly to clean patients' external ear canal and perforated parts. To keep the ear canal dry and clean, sterile cotton balls were stuffed into the ear to prevent ear infections and oral antibiotics were administered twice daily for 1 to 3 days. Tympanic membrane perforations less than 5 mm in size typically heal spontaneously within 1 month after the injury.

In the patch group, a simple egg membrane patch bridging method was adopted. (1) A piece of boiled egg

membrane, about twice the diameter of the perforation, was cut and soaked in povidone-iodine for 30 min; (2) After surface anesthesia with 1% tetracaine, a sharp edge of a 5 ml syringe was used to create a fresh wound around the perforation to stimulate the growth of tympanic membrane for healing; (3) Blood was sucked out, and the egg membrane was placed to completely cover the perforation. Epidermal growth factor was coated on the surface of the membrane, and an absorbent gelatin sponge external patch was applied. Oral antibiotics were administered for 1 to 3 days following the patching; (4) The gelatin sponge was removed after approximately 20 days. If the edges of the egg membrane have lifted or shifted, it was removed; if it was tightly adhered or the perforation was large, removal was delayed.

2.3. Observation indexes

(1) Tympanic membrane healing rate: The healing of the tympanic membrane was categorized into effective and ineffective, of which effective included cured and improved. Cured indicates the perforation was completely healed and repaired by epithelial tissue; improved indicates the perforation was partially healed and the fissure was significantly reduced; ineffective indicates the perforation was not reduced or had enlarged.

(2) Hearing indexes: Pure-tone audiometry was conducted for both groups before treatment and 3 months after treatment. The speech frequencies (0.5, 1, 2, and 4 kHz) were used as monitoring frequencies. The air-bone gap and air conduction hearing thresholds for both groups were recorded, with higher values indicating poorer hearing function.

(3) Dry ear rate and incidence of complication: After 3 months of treatment, patients were examined and assessed. A dry ear was determined if the ear canal skin was dry, the cerumen was relatively hard and light yellow in color, and there was no odor. A follow-up visit was conducted for the patients to record the occurrence and details of complications such as perforation pain, perforation infection, and hematoma. This data was then compared and analyzed.

2.4. Statistical methods

The data were processed using SPSS26.0. The measurement data were expressed as mean ± standard deviation (SD) and the *t*-test was performed for comparison between groups. The count data were expressed as %, and the difference between groups was considered statistically significant with $P < 0.05$.

3. Results

3.1. Comparison of tympanic membrane healing rate between the two groups

The tympanic membrane healing rate of the patch group was significantly higher than that of the control group (95.75% vs. 76.09%), with $P < 0.05$, as shown in **Table 1**.

Table 1. Comparison of tympanic membrane healing rate between two groups [*n* (%)]

Groups	Cured	Improved	Ineffective	Healing rate
Patch group ($n = 47$)	29	16	2	45 (95.75)
Control group ($n = 46$)	17	18	11	35 (76.09)
χ^2	-	-	-	7.471
P	-	-	-	0.006

3.2. Comparison of hearing indexes between the two groups

There was no difference in the comparison of air-bone gap and air conduction hearing thresholds between the two groups before treatment ($P > 0.05$). After treatment, these indexes in the patch group were significantly lower than those in the control group ($P < 0.05$), as presented in **Table 2**.

Table 2. Comparison of hearing indexes between the two groups (db, mean ± SD)

Groups	Air-bone gap		Air conduction hearing thresholds	
	Before treatment	After treatment	Before treatment	After treatment
Patch group ($n = 47$)	28.67 ± 3.81	16.41 ± 5.45	47.84 ± 3.59	31.97 ± 5.82
Control group ($n = 46$)	28.38 ± 3.64	20.19 ± 5.76	47.24 ± 3.61	35.37 ± 5.79
t	0.375	3.251	0.804	2.824
P	0.708	0.002	0.424	0.006

3.3. Comparison of dry ear rate and incidence of complications between two groups

After treatment, the dry ear rate of the patch group was significantly higher than that of the control group (85.11% vs. 67.39%), while the total incidence of complications of the patch group was significantly lower than that of the control group (6.38% vs. 21.74%), $P < 0.05$. The results are shown in **Table 3**.

Table 3. Comparison of dry ear rate and incidence of complications between the two groups [n (%)]

Groups	Dry ear rate	Incidence of complications			
		Perforation pain	Perforation infection	Hematoma	Total incidence
Patch group ($n = 47$)	40 (85.11)	3	0	0	3 (6.38)
Control group ($n = 46$)	31 (67.39)	5	3	2	10 (21.74)
χ^2	4.040		4.559		
P	0.044		0.033		

4. Discussion

The tympanic membrane is a thin, elastic, and resilient membrane located deep within the ear canal. It is highly susceptible to rupture and perforation when subjected to direct or indirect force [7]. Tympanic membrane perforation is a common condition in otology, with causes including ear infections, direct or indirect trauma, and acoustic injury. Most perforations result from external trauma. Patients typically experience symptoms such as ear pain, a feeling of fullness, tinnitus, and significant hearing loss. If not treated promptly, it can progress to acute otitis media [8]. In clinical practice, most traumatic tympanic membrane perforations with small diameters can heal naturally. However, studies have shown that more than 40% of perforations fail to heal naturally, indicating that tympanic membrane perforations require early therapeutic intervention to prevent the worsening of infection [9]. Implementation of the egg membrane patch bridging method can quickly restore the stability of the tympanic membrane and promote improvement in hearing levels, thus protecting the patient's inner ear canal and leading to a faster recovery.

Li *et al.* [9] have shown that efficient and high-quality treatment can promote the rapid repair of the tympanic membrane, shorten the healing time for perforation, and enhance the healing rate of the tympanic membrane. Therefore, this study includes the healing rate after treatment as part of the research scope, with the

results effectively reflecting the efficacy of the two treatment methods. Huang *et al.* [10] showed that follow-up with patients after treatment revealed a significantly higher healing rate in those treated with the egg membrane patching method compared to the conservative treatment group. In this paper, it was found that the healing rate of the patch group was 95.75%, which was significantly higher than that of the control group, consistent with the previous study. The tympanic membrane consists of three layers from the inside out: the mucosal layer, the fibrous layer, and the squamous epithelial layer. After perforation, the different growth rates of these layers and the lack of a supportive framework can affect the healing process. Applying the egg membrane to the site of the tympanic membrane perforation creates a bridge that connects the damaged membrane, serving as a support structure and providing an effective barrier against middle ear infections, thereby promoting tympanic membrane healing. The egg membrane is readily available and abundant, and the patch bridging method is simple, easy to perform, and associated with minimal patient discomfort. It is a widely applicable clinical treatment method that can help patients achieve early recovery. Research indicates [11] that if the pressure within the middle ear cannot be balanced with the pressure in the external ear canal, a significant pressure differential can develop across the tympanic membrane. When this pressure difference reaches 70 mmHg, it can cause tympanic membrane pain and potentially lead to perforation, which severely impacts the patient's hearing levels. Effective treatment methods can reduce complications such as perforation pain, perforation infection, and hematoma, thus decreasing patient discomfort. Additionally, maintaining a good ear canal condition can facilitate the transition from wet to dry ear, improving the overall dry ear rate. Therefore, in this paper, hearing levels such as air-bone gap, air conduction hearing thresholds, post-treatment dry ear rate, and complication rate were included in the research indexes to examine the therapeutic effect of the simple egg membrane patch bridging method. Jiang *et al.* [12] showed that the dry ear rate of the study group after treatment could reach 95.56%, and the complication rate was also significantly lower than that of the control group. This study found that the dry ear rate of the patch group was 85.11%, which was significantly higher than that of the control group, and the incidence of complications such as perforation pain, perforation infection, and hematoma was also lower than that of the control group. This indicates that the egg membrane patch bridging method is highly effective for tympanic membrane perforation. After treatment, the ear canal condition improved significantly, resulting in a higher dry ear rate and a decrease in complication rates, consistent with the findings of the aforementioned studies. This study also found that the air-bone gap and air conduction hearing thresholds in the patch group decreased significantly 3 months after treatment compared to pre-treatment, and their levels were lower than those in the control group. The egg membrane is easily shaped and its adhesive and elastic properties help it adhere closely to the perforation site. Rich in moisture, inorganic salts, and vitamins, the egg membrane serves as an excellent aid in promoting perforation healing. It can assist patients in restoring their hearing to normal levels and reduce the occurrence of adverse reactions after treatment. This method is simple, cost-effective, and scientifically supported, making it an efficient treatment option.

5. Conclusion

In conclusion, the application of the simple egg membrane patch bridging method in the repair of tympanic membrane perforation has high practical value, which can effectively promote the healing of tympanic membrane perforation, improve hearing levels, and reduce complications. Thus, it has significant clinical application value.

Disclosure statement

The author declares no conflict of interest.

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