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MULTIFACTORIAL ANALYSIS OF THE CAUSES OF INEFFECTIVENESS OF CLOSED-TYPE TYMPANOPLASTY

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Closed-type tympanoplasty is one of the leading methods of reconstructive surgery of the middle ear, aimed at restoring the anatomical integrity of the tympanic membrane and improving sound-conducting function in chronic middle ear diseases [1, 2]. Despite significant progress in the development of otologic methods and the improvement of surgical techniques, the proportion of unsatisfactory outcomes remains relatively high, which makes the study of factors affecting surgical efficacy particularly relevant [3, 4].

The effectiveness of tympanoplasty is determined by multiple components, including:

- the condition of the mucous membrane of the tympanic cavity;
- the severity of inflammatory changes;
- the integrity of the ossicular chain;
- features of tissue scarring and regeneration;
- the function of the Eustachian tube and ventilation of the middle ear [5].

Systemic factors such as rhinosinus pathology, allergic reactions, and impaired mucociliary clearance can significantly worsen surgical outcomes [6, 7].

Understanding the causes of ineffectiveness is based on data obtained from revision surgeries, which make it possible to identify hidden morphological and functional disorders that are not accessible for assessment during the preoperative period [8]. The present study is aimed at identifying a complex of factors determining unfavorable outcomes of closed-type tympanoplasty, taking into ac-

count their interaction and prognostic significance [9-11].

Objective

To determine the complex of factors leading to the ineffectiveness of closed-type tympanoplasty in patients with chronic middle ear diseases.

Materials and Methods

The study included 41 patients who underwent closed-type tympanoplasty during the period 2020-2024. In 67% of patients, the primary surgery was performed in various clinics of the Republic of Uzbekistan. Revision surgeries and comprehensive examinations were carried out at the multidisciplinary clinic "Bakhtli Hayot" and included clinical-morphological, functional, and systemic analyses of factors influencing the outcomes of surgical treatment.

Patient Characteristics

The study included 41 patients (20 women and 21 men) aged 10-62 years (mean age 34.8 ± 12.6 years) (Fig. 1). All patients underwent primary type I tympanoplasty followed by revision surgery.

In 67% of patients, the primary surgery was performed in various clinics of the Republic of Uzbekistan, which made it possible to assess the diversity of surgical techniques and the influence of external factors on surgical outcomes. Revision surgeries were carried out at the multidisciplinary clinic "Happy life,"

where a comprehensive clinical-morphological and functional analysis was performed.

Examination Methods

The examination included:

- otoscopy and endoscopy,
- computed tomography of the temporal bones,
- audiometry and tympanometry,
- functional tests of the Eustachian tube (Toynbee and Valsalva maneuvers),
- endoscopy of the nasal cavity and nasopharynx,
- intraoperative morphological assessment.

Particular attention was paid to the condition of the tympanic membrane, the ossicular chain, the presence of scar tissue, granulations, signs of cholesteatoma, and the state of the ventilation system of the middle ear.

Results

Intraoperative Findings

Revision surgeries revealed a complex of morphological changes reflecting a combination of chronic inflammation, impaired ventilation of the middle ear, and secondary tissue remodeling processes (Tab. 1). The most frequent pathological finding was cicatricial-adhesive disease, observed in 25 patients (61%), which fixed the tympanic membrane to the walls of the tympanic cavity and restricted the mobility of the ossicular chain.

Cholesteatoma was detected in 15 patients (37%), predominantly in the retrotympanum, sinus tympani, and attic, accompanied by destruction of the long process of the incus and the

suprastructure of the stapes. Recurrent perforation of the graft was noted in 12 patients (29%), most often associated with impaired middle ear ventilation and negative pressure. Displacement or instability of the prosthesis was recorded in 10 patients (24%), caused by secondary scarring and residual inflammation. Granulation tissue was identified in 9 patients (22%), mainly in the area of the promontory and the orifice of the Eustachian tube. Destruction of the auditory ossicles was registered in 8 patients (20%), predominantly involving the long process of the incus. Ossification of the tympanic cavity was observed in 6 patients (15%).

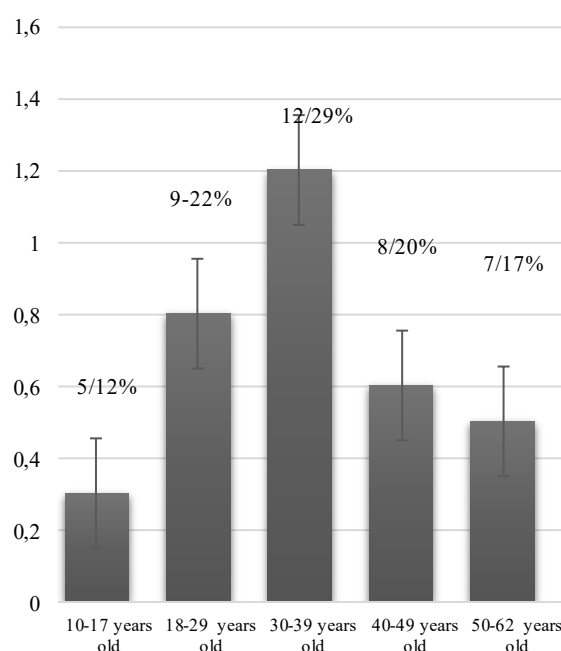


Fig. 1. Distribution of Patients by Age Groups.

Table 1

Main Pathological Changes Identified During Revision Surgery

Pathological change	Total number of patients	(%)
Cicatricial adhesive process	25	61
Cholesteatoma	15	37
Recurrent graft perforation	12	29
Prosthesis instability	10	24
Granulation tissue	9	22
Ossicular chain destruction	8	20
Ossification of the tympanic cavity	6	15

Concomitant ENT Pathology

In 61% of patients, diseases of the nasal cavity and paranasal sinuses were identified, including chronic rhinitis and rhinosinusitis, nasal septum deviation, hypertrophy of adenoid tissue, and allergic conditions. These disorders impaired middle ear ventilation and contributed to graft retraction.

Discussion

The obtained data confirm that the leading factor in the ineffectiveness of closed-type tympanoplasty is a pronounced cicatricial process (61%), resulting in fixation of the tympanic membrane and restriction of ossicular chain mobility.

Cholesteatoma (37%) remains a significant cause of recurrent inflammation and destruction of middle ear structures. Even minimal residual cholesteatoma can adversely affect surgical outcomes.

Rhinosinus pathology (61%) worsens middle ear ventilation, creates negative pressure, and contributes to recurrent graft perforations (29%) and prosthesis instability (24%).

Conflict of interest

The authors declare no conflict of interest.

Use of Generative Artificial Intelligence

The authors of the manuscript hereby certify that in the process of conducting the study and preparing this manuscript, no generative artificial intelligence tools or services were used for any of the tasks listed in the Generative AI Delegation Taxonomy (GAIDeT, 2025). All stages of the work from conceptualization to final editing were performed solely by the authors without the involvement of generative artificial intelligence.

Thus, surgical failure is formed by a combination of local morphological abnormalities, systemic factors, and technical aspects of reconstruction.

The implementation of a комплекс of preoperative measures, including correction of rhinosinus pathology and assessment of Eustachian tube ventilation, can significantly improve the effectiveness of tympanoplasty.

Conclusion

1. Ineffectiveness of closed-type tympanoplasty is due to a combination of morphological changes, impaired Eustachian tube function, and technical aspects of the surgery.

2. The main factors of unfavorable outcomes are: scarring – 61%, rhinosinus pathology – 61%, cholesteatoma – 37%, recurrent perforation – 29%, and prosthesis instability – 24%.

3. Comprehensive preoperative diagnostics and timely correction of diseases of the nasal cavity and paranasal sinuses improve the effectiveness of reconstructive surgery.

Data availability statement

The authors of the manuscript hereby confirm that the study is based on their own clinical research, the results of which were systematized and analyzed by the authors. The primary data include aggregated patient indicators, laboratory results, protocols, and examination findings. All materials are stored in the archive of the research group and may be provided upon a justified request to the corresponding author, in accordance with confidentiality requirements and ethical standards.

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Abstract

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Results: Revision surgeries revealed a complex of morphological changes reflecting a combination of chronic inflammation, impaired ventilation of the middle ear, and secondary tissue remodeling processes. The most frequent pathological finding was cicatricial-adhesive disease, observed in 25 patients (61%). In 61% of patients, diseases of the nasal cavity and paranasal sinuses were identified, including chronic rhinitis and rhinosinusitis, nasal septum deviation, hypertrophy of adenoid tissue, and allergic conditions. These disorders impaired middle ear ventilation and contributed to graft retraction.

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3. Comprehensive preoperative diagnostics and timely correction of diseases of the nasal cavity and paranasal sinuses improve the effectiveness of reconstructive surgery.

Key words: middle ear, chronic diseases, reconstructive surgery, closed-type tympanoplasty, Eustachian tube function, cholesteatoma, scarring, recurrent perforation.

БАГАТОФАКТОРНИЙ АНАЛІЗ ПРИЧИН НЕЕФЕКТИВНОСТІ ЗАКРИТОЇ ТИМПАНОПЛАСТИКИ

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А н о т а ц і я

Актуальність: Закрита тимпаноластика є одним із провідних методів реконструктивної хірургії середнього вуха, спрямованим на відновлення анатомічної цілісності барабанної перетинки та покращення звукопровідної функції при хронічних захворюваннях середнього вуха. Незважаючи на значний прогрес у розвитку отологічних методів та вдосконалення хірургічної техніки, частка незадовільних результатів залишається відносно високою, що робить вивчення факторів, що впливають на ефективність хірургічного втручання, особливо актуальним.

Мета: Визначити комплекс факторів, що призводять до неефективності закритої тимпаноластики у пацієнтів із хронічними захворюваннями середнього вуха.

Матеріали та методи: До дослідження включено 41 пацієнта, які перенесли закрити тимпаноластику в період 2020-2024 рр. У 67% пацієнтів первинне втручання було виконано у різних клініках Республіки Узбекистан. У багатопрофільній клініці «Бахті Хайот» проводилися повторні операції та комплексні обстеження, що включали клініко-морфологічний, функціональний та системний аналіз факторів, що впливають на результати хірургічного лікування.

Результати: Повторні операції виявили комплекс морфологічних змін, що відбивають поєднання хронічного запалення, порушення вентиляції середнього вуха та вторинних процесів ремоделювання тканин. Найбільш частою патологічною ознакою було рубцево-адгезивне захворювання, що спостерігалось у 25 пацієнтів (61%). У 61% пацієнтів були виявлені захворювання носової порожнини та придаткових пазух носа, включаючи хронічний риніт та риносинусит, викривлення носової перегородки, гіпертрофію аденоїдної тканини та алергічні стани. Ці порушення порушували вентиляцію середнього вуха та сприяли ретракції трансплантату.

Висновки:

1. Неефективність закритої тимпаноластики обумовлена поєднанням морфологічних змін, порушенням функції євстахієвої труби та технічними аспектами операції.

2. Основними факторами несприятливих наслідків є: рубцювання – 61%, патологія риносинусів – 61%, холестеатому – 37%, рецидивна перфорація – 29%, нестабільність протеза – 24%.

3. Комплексна передопераційна діагностика та своєчасна корекція захворювань носової порожнини та придаткових пазух носа підвищують ефективність реконструктивної хірургії.

Ключові слова: середнє вухо, хронічні захворювання, реконструктивна хірургія, тимпаноластика закритого типу, функція євстахієвої труби, холестеатому, рубцювання, перфорація, що рецидивує.