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REVIEW OF SURGICAL TREATMENT OPTIONS OF CHRONIC OTITIS MEDIA WITH RESPECT TO ADENOID HYPERTROPHY IN PEDIATRIC POPULATION

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Abstract

Introduction. Optimization of management of chronic inflammatory diseases of the middle ear in children is one of the priority tasks in otiatric practice. Hearing impairment can lead to deteriorated socialization, cognitive and behavioral disorders of the child. At the same time, the pathology of the middle ear in children is often accompanied by inflammatory processes in other ENT organs. In particular, hyperproliferative changes in the adenoids and tonsillar tissue of the pharynx can serve as a reservoir of persistent microbial infection. Integration of the surgical treatment of adenoid vegetations into the management of patients with inflammatory middle ear pathology can significantly optimize the anatomical and functional outcomes of the surgical treatment of the disease.

Objective: to review the literature on the existing methods of surgical treatment of chronic otitis media (COM) and the contribution of timely treatment of adenoid hypertrophy to the management of COM.

Search strategy: The search for sources was carried out in the following databases: Pubmed, ResearchGate, Cyberleninka, eLibrary. *Inclusion criteria* were full-text publications in Russian and English; research conducted on humans and animals; primary studies (descriptive and analytical studies, clinical trials); secondary studies (systematic reviews and meta-analyses); educating manuals; clinical guidelines and protocols.

Results and conclusions. Our review showed that the most frequently used surgical interventions in the treatment of COM are I and II tympanoplasty types by Wullstein. There are studies conducted to compare endoscopic and microscopic imaging options for tympanoplasty. In addition, performing adenoidectomy before tympanoplasty in patients with COM has certain clinical advantages.

Key words: chronic otitis media, surgical treatment, tympanoplasty, adenoidectomy.

Резюме

ОБЗОР ХИРУРГИЧЕСКИХ МЕТОДОВ ЛЕЧЕНИЯ ХРОНИЧЕСКОГО СРЕДНЕГО ОТИТА С УЧЕТОМ ГИПЕРТОФИИ АДЕНОИДОВ СРЕДИ ПАЦИЕНТОВ ДЕТСКОГО ВОЗРАСТА

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Введение. Оптимизация тактики ведения и лечения хронических воспалительных заболеваний среднего уха является одной из приоритетных задач в детской отиатрической практике. Расстройства слуха могут приводить к нарушениям процесса социализации, отставанию когнитивного и поведенческого развития ребенка. В то же время патология среднего уха у детей часто сопровождается воспалительными процессами в других ЛОР-органах. В частности, гиперпролиферативные изменения в аденоидной ткани глотки могут служить резервуаром персистирующей микробной инфекции. Интеграция оперативного лечения аденоидных вегетаций в менеджмент пациентов с воспалительной патологией среднего уха может значительно оптимизировать анатомо-функциональные исходы хирургического лечения заболевания.

Цель: обзор литературных источников по существующим методам оперативного лечения хронического среднего отита (ХСО) и вкладу своевременного лечения гипертрофии аденоидов в менеджмент ХСО.

Стратегия поиска: Поиск источников проводился в следующих базах: Pubmed, ResearchGate, Cyberleninka, eLibrary. *Критериями включения* являлись: полнотекстовые публикации на русском и английском языках; исследования, проведенные на людях и животных; первичные исследования (описательные и аналитические исследования, клинические испытания); вторичные исследования (систематические обзоры и мета-анализы); учебно-методические пособия; клинические рекомендации и протоколы.

Результаты и выводы. Проведенный нами обзор показал, что наиболее часто используемыми оперативными вмешательствами при лечении ХСО являются тимпанопластика I и II типа по Вульштейну. По-прежнему остаются актуальными исследования, направленные на сравнение эндоскопической и микроскопической визуализации при

проведении тимпанопластики. Кроме того, проведение аденоидэктомии перед тимпанопластикой у пациентов с ХСО имеет определенные клинические преимущества.

Ключевые слова: хронический средний отит, хирургическое лечение, тимпанопластика, аденоидэктомия.

Түйіндеме

БАЛА ЖАСЫНДАҒЫ НАУҚАСТАРДЫҢ СОЗЫЛМАЛЫ ОРТА ОТИТТЫ ХИРУРГИЯЛЫҚ ЕМДЕУ ТӘСІЛДЕРІНІҢ АДЕНОИДТЫ ГИПЕРТОФИЯҒА БАЙЛАНЫСТЫ ӘДЕБИЕТКЕ ШОЛУ

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Кіріспе. Балалардың ортаңғы құлақтың созылмалы қабыну ауруларын жүргізу және емдеу тактикасын оңтайландыру отиатриялық тәжірибедегі маңызды мәселелердің бірі болып табылады. Есту қабілетінің бұзылуы баланың әлеуметтенуінің нашарлауына, когнитивті және мінез-құлық ауытқуларына әкелуі мүмкін. Сонымен қатар, балалардағы ортаңғы құлақтың патологиясы басқа ЛОР мүшелерінің қабыну процестерімен жиі бірге жүреді. Атап айтқанда, жұтқыншақтың аденоидтонзиллярлы тініндегі гиперпролиферативті өзгерістер тұрақты микробтық инфекцияның резервуары бола алады. Ортаңғы құлақтың қабыну патологиясы бар науқастарда аденоидты вегетацияларды алып тастау хирургиялық емдеудің анатомиялық және функционалдық нәтижелерін айтарлықтай оңтайландыруға мүмкіндік береді.

Мақсаты: Созылмалы ортаңғы отит (СОО) хирургиялық емдеудің қолданыстағы әдістері және аденоидты гипертрофияны уақтылы емдеудің ауруды ұйымдастыруға қосқан үлесі туралы әдебиеттерге шолу жасау.

Іздеу стратегиясы: Дереккөздерді іздеу келесі мәліметтер қорларында жүргізілді: Pubmed, ResearchGate, Cyberleninka, eLibrary. Шолуға енгізу критерийлері: орыс және ағылшын тілдеріндегі толық мәтінді басылымдар; адамдар мен жануарларға жүргізілген зерттеулер; бастапқы (сипаттамалық және аналитикалық зерттеулер, клиникалық зерттеулер); екіншілік зерттеулер (жүйелі шолулар және мета-талдаулар); оқу-әдістемелік құралдары; клиникалық нұсқаулар мен протоколдар.

Нәтижелер мен қорытындылар. Біздің шолуымыз СОО емдеуде ең жиі қолданылатын хирургиялық араласулар Вульштейн бойынша I және II типті тимпанопластика екенін көрсетті. Тимпанопластикада қолданылатын эндоскопиялық және микроскопиялық бейнелеуді салыстыру бойынша зерттеулер әлі де жалғасуда. Сонымен қатар, СОО бар науқастарда тимпанопластика алдында аденоидэктомияны орындау белгілі бір клиникалық артықшылықтармен байланысты.

Түйінді сөздер: созылмалы ортаңғы отит, хирургиялық емдеу, тимпанопластика, аденоидэктомия.

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Introduction

Chronic otitis media (COM) is one of the most common reasons for seeking medical help in pediatric practice. The number of visits to the clinic for otitis media may reach 30 million annually [38]. Diagnostic and classification approaches to the determination of COM and its varieties differ throughout the world. Thus, the prevalence rate of COM in the world ranges from 65 to 330 million cases annually [10]. The burden of disease in developed countries is associated with hearing loss and further delay in child development, while in developing countries the problem of COM is associated with deaths and severe complications leading to disability. The data of modern literature demonstrate that modern health care systems are faced

with an increasing rate of morbidity and prevalence of COM. Exacerbations of COM are also associated with the problem of antibiotic resistance, a deterioration in the quality of life of children and their parents. Economic burden is related to the management of the disease and temporary loss of work capacity for parents due to the opening of sick leave certificates for caring for a child [23].

In addition to such obvious aspects of the problem, we would like to note another potentially formidable complication of COM. The hearing loss affects seriously the harmonious development of the child's speech and behavior. Obviously, COM is most often resulting the conductive type of hearing impairment, since in chronic purulent inflammation, the bone elements of the auditory chain are destroyed. However, the

permanent presence of pathogenic flora in the middle ear cavity promotes the absorption of microbial toxins and macromolecules, which can affect the structures of the inner ear, leading to the development of a sensorineural type of hearing loss [7]. Intracranial complications of COS can lead to the development of deafness in 10% of patients [37]. According to Acuin J. (2002), 20% of children suffering from chronic otitis media with perforated tympanic membrane had a hearing loss of more than 40 dB [6]. Thirty percent of children with bilateral sensorineural hearing loss have a history of middle ear pathology, and each new episode of inflammation can worsen existing hearing loss [5]. In turn, hearing loss leads to developmental delay and speech impairment, deterioration in verbal communication and socialization, as well as to behavioral and cognitive disorders [49]. Correct management of CSO (timely diagnosis and treatment) can significantly reduce the number of patients with developed hearing impairment [22, 27].

Thus, chronic otitis media is a fairly common pathology in the practice of pediatricians, general practitioners, and ENT doctors. COM is associated with various acute complications (disruption of the structures of the middle and inner ear, intracranial injuries), the problem of resistance to antibiotic therapy, disability, and mortality [47]. Hearing loss and deafness, resulting from chronic inflammation of the middle ear, can lead to impaired speech development, communication, and learning skills. At the moment, a fairly wide range of conservative and surgical methods of treatment is used to organize the care for children with COM, but numerous methods of treatment do not guarantee a relapse of the disease and the development of complications.

Aim of current review is to describe the existing options of surgical treatment of COM. Another goal was to demonstrate the benefits of adenoidectomy in the management of pediatric patients with COM.

Search strategy. The comprehensive database search for English-language sources was performed in the Pubmed (<https://www.ncbi.nlm.nih.gov>) and ResearchGate (<https://researchgate.net>) databases. Two scientific electronic libraries (eLibrary (<https://elibrary.ru>); cyberleninka (<https://cyberleninka.ru>)) were used also for search and collection of publications in Russian and Kazakh.

In accordance with the goal of literature review, a search strategy was developed using the following keywords and phrases using the AND/OR/NOT logical operators (the terms were retrieved using MeSH (NLM controlled vocabulary thesaurus)): 1) otitis media; 2) chronic otitis media; 3) chronic otitis media with effusion; 4) otitis media, suppurative; 5) tympanoplasty; 6) myringoplasty; 7) adenoids, adenoiditis, adenoids hypertrophy; 8) adenotomy, adenoidectomy.

Our inclusion criteria were as follows: full-text publications in English and Russian, animal and human trials, primary (descriptive and analytical studies, randomized and non-randomized clinical trials) and secondary data (systematic reviews and meta-analyses), educational methodological manuals, clinical guidelines, protocols and recommendations. In addition to materials available in digital format, the review includes information from the available printed versions of chapters of textbooks and monographs. The publication time was not adjusted,

since the review contains information concerning some theoretical and historical aspects. The initial search and selection of articles was performed independently by two co-authors (T.Sh. and S.T.). Subsequently, we screened for titles and abstracts and excluded all articles that did not meet the inclusion criteria. Finally, we selected 51 publications (48 in English and 3 in Russian) which were analyzed for the present literature review.

Results and discussion

The review of the surgical methods of COM treatment

In the current otiatric practice, a wide spectrum of pharmacological and surgical methods of COM management are presented. All of them are aimed at relieving signs of inflammation, preventing complications, and eliminating impaired hearing function. First of all, the patient with a purulent process in the middle ear needs to take measures to eliminate the infectious agent using topical and systemic antibiotics alone or combination of them. Ideally, etiological therapy should be based on the results of bacteriological analysis of the discharge from the ear. In the presence of granulation tissue, it is recommended to use topical steroids for the early resolution of the hyperproliferative process. Thus, the primary measures in the management tactics are sparing. They can either stop the entire process or prepare the patient for subsequent surgical manipulations. Conventionally, these types of interventions can be divided into two large groups - sanitizing operations and reconstructive methods. In turn, sanitizing operations can be carried out in an "open" or "closed" way. Variants of operations performed by the "open" method have the following common feature - the creation of a single air trepanation cavity communicating with the external acoustic meatus. The presence of a large open mastoid cavity leads to the development of the so-called "disease of the operated ear", characterized by relapses of exudative and proliferative processes. In modern conditions, radical sanitizing ear surgery is performed only if there are definite vital indications [1]. "Closed" sanitizing operations allow to preserve the posterior wall of the external acoustic meatus, and the mastoid cavity communicates with the tympanic cavity through the aditus. Among the many methods of closed surgery, intact canal mastoidectomy is often mentioned as the optimal way to prepare the middle ear cavity for subsequent reconstructive interventions, since during this operation the cholesteatomic matrix is removed if present [12, 51].

Reconstructive surgery is closely related to the name of Horst Ludwig Wullstein, a German otorhinolaryngologist and university lecturer. In 1968, Wullstein published the systematized presentation on surgical methods for the restoration of the conduction system. According to the presented classification, there are five types of tympanoplasty, depending on the degree of damage to the sound-conducting structures of the middle ear. Nowadays the type I (simple myringoplasty) tympanoplasty is the most commonly used option for the reconstructive surgery. The type II (reconstruction of the bones of the auditory chain) tympanoplasty is the second one by the popularity. Historically, the emergence of functional (or reconstructive) otological surgery significantly optimized the quality of life of the COM patients. Also, the existing methods may improve

the prognosis of cognitive and speech development in pediatric patients [3].

In current publications on otological surgery, the main debate unfolds regarding the technical nuances of surgical intervention. There is the wide range of the methods of perioperative revision of the middle ear, optimal materials for tympanoplasty, as well as the effect of concomitant ENT pathology on the effectiveness of hearing-improving operations [39, 45].

The analysis of the effectiveness of surgical methods in COM patients

The outcome of surgery for COM depends on many factors. The complexity of the clinical case and the presence of complications, the state of local and systemic immunity, the adequacy, timeliness, and volume of surgical care affect the effectiveness of surgical intervention. In addition to the technical equipment of the hospital and the experience of the operating doctor, the success of the treatment is influenced by many technical nuances, in particular, the use of additional instrumental equipment for visualizing the operative field [2]. Since the 50s of the previous century, the technique of tympanoplasty using a microscope (MMP) has been widely used to restore a perforated tympanic membrane. The behind-the-ear approach with microscopy is the most popular among adherents of classical approaches to surgical interventions on the middle ear because this type of surgery allows to achieve the greatest visibility of operative field [44]. In addition to traditional microscopy, the otosurgeon's arsenal includes endoscopes to optimize the visualization of hard-to-reach areas. For the first time, the technique of preoperative assessment of the middle ear cavity using endoscopes of various diameters (0.4-1.9 mm) was presented by a group of American researchers led by Poe D. in 1992. The authors proposed to insert the endoscope through the opening after myringotomy or through the existing perforation in the tympanic membrane. Initially, the method was considered as an additional diagnostic option [36]. In the late 1990s, the Arabian otosurgeon M. Tarabichi substantiated the use of an endoscope as a mono-visualization method when performing interventions on the middle ear [41, 42]. Thirty years of experience in the use of otoendoscopy clearly defines the advantages of this technique. The use of an endoscope allows for more effective diagnosis of cholesteatoma in COM, increases the chances of perioperative detection of destruction of the auditory chain, improves access and visualization of the "blind" areas of the middle ear cavity, and is also an integral part of transcanal tympanoplasty with lateral flap placement according to Sheehy [21, 43]. In modern otosurgical practice, both types of tympanoplasty (in combination with microscopy or endoscopy) are used, the comparative characteristics of which are given in the results of clinical trials and secondary studies.

A recent comparative study by Hsu et al. (2018) evaluated the outcomes of both tympanoplasty techniques in 139 Taiwanese patients who received treatment for COM without cholesteatoma. The researchers found that patients who underwent tympanoplasty with endoscopy (ETP) (53 operated ears) had the same satisfactory surgical outcomes as patients who underwent microscopic surgery (100 operated organs). Successful healing of the tympanic

membrane in the first group was noted in 96.2% of cases, whereas the success rate reached 92% in the second one ($p = 0.28$ using the chi-square test). The difference in hearing improvement in both groups also was comparable. In patients after ETP and MTP the indicators of the audiogram increased by an average of 10.3 dB and 12.4 dB respectively. However, the duration of hospitalization, the duration of surgery and anesthesia were statistically significantly shorter in ETP patients than in the MTP group [17].

Another study with the assessment of similar clinical and instrumental parameters was performed in the pediatric population. Cohen et al. (2015) carried out a retrospective analysis of the outcomes of 51 cases of ETP and 70 cases of operations without the use of endoscopy. The type of imaging during TP did not affect the duration of surgery. ETP showed the best results in increasing audiometry indicators ($\Delta 7.8$ dB versus $\Delta 1.3$ dB in the group of patients after TP without endoscopy; $p = 0.03$ using Student's t test) [11]. The effectiveness of ETP in improving the hearing function was shown in a case-control study conducted at a Japanese university hospital in 2019. Forty-seven patients underwent ETP, whereas the comparison group consisted of 75 patients who underwent MTP with behind-the-ear access. When comparing postoperative indicators of audiometry among patients with mild COM (MERI (Middle Ear Risk index) = 1-3 points), no statistically significant differences were found. The comparison of the air-bone interval gap (ABG) was determined by the method of tone threshold audiometry. After 12 months from the moment of intervention, in the groups of participants with moderately expressed signs of the disease (MERI = 4-6 points) the ABG meanings were 12.9 dB and 26.6 dB in ETP and MTP groups, respectively; $p = 0.07$ using Student's test) [32].

Conclusions on the comparability of short-term and long-term outcomes of ETP and MTP are confirmed by data from secondary studies. In a meta-analysis by Tseng et al. (2017) presented the results of systematization of four studies (with a total number of patients = 226). The frequencies of successful tympanic membrane repair in the ETP and MTP groups were practically equal (85.1% versus 86.4%, respectively). The frequency of canaloplasty in the MTP group was 18.8%; while in the ETP group such intervention was not required. In addition, up to 20% of patients who underwent MTP noted dissatisfaction with the cosmetic effect of the operation after 6 months from the date of the operation [44]. The study by Pap et al. (2019) included 16 primary comparative studies with a total number of interventions $n = 1179$. The authors came to conclusions similar to the previous meta-analysis: surgery with the use of endoscopy is characterized by satisfactory engraftment in the tympanic membrane, improved auditory function, lower frequency of canaloplasty and the occurrence of undesirable cosmetic defects [33]. Han et al. (2019) also published data from a meta-analysis comparing ETP and MTP performed in pediatric otiatric practice. Researchers included 19 controlled studies for qualitative analyzes and 10 articles for meta-analyzes. As in the adult population, the outcomes associated with the clinical results of defect closure in TM and hearing improvement did not differ statistically significantly. However, ETP was more successful in preventing residual or recurrent cholesteatoma (OR 0.56; 95% CI 0.38-0.84; $p = 0.005$) [16].

A similar comparative analysis is carried out for the results of studies on tympanoplastics using different materials (cartilaginous tissue, fascia of the temporal bone) as a graft to close the perforation of the TM. Based on systematic reviews by Mohamad et al. (2012) (14 studies, 1475 participants), Iacovou et al. (2013) (12 studies, 1286 participants), Yang et al. (2016) (8 studies, 915 participants), Jalali et al. (2017) (27 studies, 3606 participants) tympanoplasty using cartilage showed the best results in graft engraftment, but the outcomes related to the restoration of auditory function were similar in the comparison groups [29, 18, 50, 20]. In a systematic review, Lyons et al. (2016), including 10 studies, found no statistically significant differences in outcomes such as anatomic repairment and improvement in audiometry between the compared groups [26]. However, almost all authors noted the similar limitations among of their publications. The most important one was a rather high heterogeneity of the samples included in the meta-analysis, as well as a predominantly retrospective study design. In addition, further longitudinal studies are needed specifically in the pediatric population. An example of this approach is a recent study involving 40 children aged 6 to 13 years, all patients underwent type I tympanoplasty with endoscopy. The authors did not find statistically significant differences in the success of perforation healing after reconstruction with cartilaginous tissue ($n = 19$) or temporalis muscle fascia ($n = 21$). However, postoperative audiometric parameters ($ABG < 20$ dB) were statistically significantly better in the group of children after TP using fascia than TP using cartilage (95.24% versus 78.95%; $p = 0.044$ using Fisher's test) [40].

The significance of adenoidectomy in the management of pediatric COM

Adenoids and tonsillar tissue perform important biological functions. However, chronic inflammation of the Waldeyer's ring components can lead to its hyperplasia and, as a consequence, to obstruction of the nasopharynx, mouth breathing, and malformation of the facial skeleton. It has been proven that adenotomy can be a decisive intervention in the management of some ENT pathologies, for example, in obstructive apnea syndrome [14]. In some children, adenoiditis can lead to the development of a pathology of the middle ear since a persistent infection in the pharynx can act as a constant "supplier" of microbial agents through the auditory tube [13, 31, 48]. As early as 30 years ago, it was found that such a pathogenetic relationship explains the success of adenotomy in children over the age of 4 years, especially in the group of patients who underwent the installation of a tympanic ventilation tube [34]. In addition, the removal of hyperplastic adenotonsillar tissue has some advantages in children suffering from chronic otorrhea [30]. It may seem that preventive adenotomy can avert further development of inflammation in the middle ear, but this intervention has been ineffective in preventing acute otitis media in children under 4 years of age [15]. Thus, over the past thirty years, the established indications for adenotomy have become such diseases of the middle ear as acute otitis media and exacerbations of COM [8, 35].

A systematic review by van den Aardweg et al. (2010), revealed some advantages of using adenotomy in 2712 children suffering from otitis media, based on the results of 14 randomized clinical trials. The authors concluded that

the study intervention was successful in preventing recurrence of otitis media with effusion. However, the high heterogeneity of the RCT results did not allow to determine the effectiveness of adenotomy for improving hearing and changing the properties of the tympanic membrane [4]. Nevertheless, the generally accepted approach for the combination of chronic otitis media with adenoiditis is surgical treatment of both nosologies according to the principle "first the nose, then the ear" [25].

Regarding to a systematic review by Wallace et al. (2014) performing adenotomy increased the likelihood of resolution of COM with effusion (COME) in 27% of cases within six months according to otoscopy data and in 22% of cases during the same period according to tympanometry data [46]. Meta-analyses by Boonacker et al. (2014) and Mikals and Brigger (2014), demonstrated the success of adenotomy in reducing the number of tympanic ventilation tubes in patients with COM older than four years [9, 28]. These data allowed to substantiate and formulate the recommendations of the American Association of Otorhinolaryngology, Head and Neck Surgery (2016), according to which children aged four years and older, suffering from COM and adenoiditis, are supposed to either install a tympanic ventilation tube, or adenotomy, or both surgical interventions [24]. Japanese otosurgeons agree with the opinion of their American colleagues, who recommend treatment of any concomitant pathology of ENT organs in pediatric patients with COM [19].

Conclusion

Concomitant persistent infection of the adenoid tissue plays an important role in the occurrence and maintenance of chronic inflammation of the middle ear. This aspect of COM etiopathogenesis justifies the need to improve the tactics of management and treatment of children with COM. The existing range of operational methods for the treatment of COM used in modern otosurgery indicates the absence of a generally recognized universal technique. In addition, there is a lack of evidence in the current publications about the potential advantages of combinatory treatment of chronic otitis media and adenoiditis.

Limitations of the study: Since our study is cross-sectional and not cohort, the results of the study cannot indicate a causal relationship. However, the results of the study indicate the relationship of variables among themselves.

Conflict of interest. The authors declare that there is no conflict of interest.

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