ORIGINAL PAPER

DOI: https://doi.org/10.20883/jms.2018.302

Monitoring of conductive hearing loss due to eustachian tube dysfunction preservative treated with the Otovent pneumotherapy method

Małgorzata Nowak[1, a], Beata Wolnowska[1, b], Alicja Sekula[1, 2, c]

[1] Department of Phoniatrics and Audiology, Poznan University of Medical Sciences, Poland
[2] CTS Audiology and Foniatric Clinic KIND, Poznań, Poland
[a] https://orcid.org/0000-0002-0446-254X
[b] https://orcid.org/0000-0001-7807-3267
[c] https://orcid.org/0000-0001-6975-6672

ABSTRACT

Introduction. A conductive hearing loss is a very common problem in childhood. It is possible to indicate many reasons for the problem, but most of the times it is caused by the infectious process, as well as the typical adenoid hypertrophy in children. Very often this disease is associated with obstruction of the eustachian tube.
Aim. In this study, the authors present the results of the hearing tests of patients who underwent the treatment of the eustachian tube obstruction by pneumotherapy with otovent. The aim of the work was to monitor the effectiveness of this method of OME treatment.
Material and Methods. The research group consisted of 54 children aged 4 to 15 years, including 23 girls and 31 boys. The control group consisted of 16 children. Pure tone audiometry and impedance audiometry were performed before and after the therapy, for all of the participants.
Results. Obtained results of the study showed improvement in hearing in children correctly using the Otovent set. Hearing improvement was recorded both in the results of pure tone audiometry and impedance audiometry.
Conclusions. The obtained results showed the effectiveness of the pneumotherapy method. In the case of the research group, 81.4% of children achieved the auditory norm (44 people). In the case of the control group, after a fixed period of application of the Otovent set, this value was 0%. The intergroup comparative analysis clearly shows that the research group obtained significantly better results within all of the parameters assessed, than the control group.

Keywords: conductive loss, exudative otitis media, OME, pneumotherapy, obstruction of the eustachian tube.

Introduction

A conductive hearing loss is a very common problem in childhood. It is possible to indicate many reasons for its formation, but most often it is caused by the infectious process, as well as the typical adenoid hypertrophy in children. Very often this problem is associated with obstruction of the eustachian tube.

Dysfunction of the eustachian tube is one of the causes of otitis media with effusion (OME). During this disease, exudation accumulates in the middle ear spaces – mainly in the tympanic cavity – but without the features of acute inflammation [1, 2]. It is considered that the frequency of fluctuating conductive hearing problems depends on latitude. In Poland, it is associated with humidity

and periodically cold climate [3]. It is estimated that in the first years of life, up to 90% of children are affected at least once. Studies show that the natural course of otitis media is mild, self-limiting and transient, with a tendency to recovery (in 30–40% of patients). However, in 10–20% of cases, the symptOME may last even over a year [4].

The cause of exudate has been studied for over 150 years. Initially, it was perceived by Adam Politzer as a consequence of a blocked eustachian tube. Today, however, it is recognized that etiopathogenesis is more complex – infectious, with ciliary transport disorder and metaplastic changes in the mucous membrane [5, 6, 7].

The history of the first recorded cases of OME is very long. In the 70s of the last century, a human skull of 40,000 years was found. After the analysis, temporal bone defects characteristic of otitis media were found [7]. Other studies show a significant increase in cases from the second half of the last century. This is probably due to the limitation of acute infections through the use of antibiotics and the tendency to form bacterial biofilms. It seems that changing the bacterial environment caused by the use of antibiotics may be conducive to the spread of OME [9].

An additional risk factor for OME is gastro-oesophageal reflux (GERD). This phenomenon consists of throwing gastric acid into the oesophagus. Secondarily, it may cause inflammation within the larynx, throat, paranasal sinuses and the Eustachian tube. The consequence is swelling of the mucous membrane, overproduction of exudation, impaired mobility of the cilia. It is also believed that an additional manifestation of GERD is the infection of helicobacter pylori, whose presence has been detected in the middle ear aspirants [10].

Both conservative and invasive methods are used in the treatment of OME. Conservative methods include the administration of antihistamines, antibiotic therapy [11], steroid therapy [12], and self-inflation via the Eustachian tube [13]. Myringotomy and drainage is the invasive treatment [14].

Regardless of the choice of procedure, the treatment should lead to a removal of residual fluid from the tympanic cavity and restoration of proper air pressure in the middle ear and, consequently, improvement of hearing.

Conservative methods aim to remove the exudate from the tympanic cavity the natural way, i.e. through the eustachian tube. This is to be done, for example, by reducing oedema or inflammation through the use of pharmacotherapy or mechanical opening of the tube, which is what we deal with in case of pneumotherapy.

It has been noted that conductive hearing loss in a child, even a small degree, negatively affects the development of speech and communication [15]. These types of auditory fluctuation problems may affect the central auditory processing. Early intervention can eliminate auditory deprivation [16]. For this reason, most children with conductive hearing loss attend speech therapists.

Method of pneumotherapy

Pneumotherapy is one of the conservative methods of removal of exudate from the tympanic cavity. The method used is based on a repetitive, regular and self-performed exercise with the use of an inflatable balloon. This exercise consists of two stages: inflation and deflation [17].

The first stage consists of blowing air — through the nostrils — into the closed space of the balloon (Valsalva maneuver). This leads to an increase in pressure in the nasal part of the throat by about 400–600 dPa [18].

In the second stage, the air from the inflated balloon is forced back into the nasopharynx (similar to the Politzer method), and the patient's task is to swallow, during which the eustachian tube opens and air enters the middle ear. By that means, the natural passage of evacuating the exudate from the tympanic cavity is cleared, which allows the reduction of inflammation and consequent treatment of conductive hearing loss.

The combination of two ways of producing hypertension in the nasopharynx multiplies the desired effect. Research and experience on the use of only the Valsalva in children test shows its ineffectiveness. The introduction of an additional source of air by the Politzer method (retracting from the balloon space) forces a higher value of overpressure [19, 20].

Aim

In this work, we analyze the effectiveness of pneumomassage (performed using the Otovent baloon) in the treatment of conductive hearing loss caused by hearing tube dysfunction.

Material and Methods

Diagnosis and treatment of patients took place in 2016 and 2017 at the Department of Phoniatrics and Audiology in Poznań and at the Audiological and Phoniatric Clinic of NZOZ CTS KIND.

54 children were examined, with conductive hearing loss of various severity and otoscopic features of OME, aged 4 to 15 years (median 8 years), including 23 girls and 31 boys. The control group consisted of 16 people. All patients underwent pure tone audiometry and impedance audiometry tests in the beginning of treatment (as part of the initial diagnosis) and after the recommended period of treatment with Otovent.

These patients were advised to use the pneumomassage method. Parents or family have been instructed in carrying out the exercise, i.e.: several times inflating the balloon two to four times a day.

On the follow up appointment, the parents or legal guardians from the research group reported, that the treatment was carried out as recommended. In contrast, the control group consisted of children who did not receive the recommended therapy. Some children with accompanying disorders of speech development and problems of articulation underwent speech therapy and hearing training.

Outpatient treatment lasted 5.4 months on average (median 5.5).

Results

In pure tone audiometry, the average of four frequencies was determined: 500 Hz, 1 kHz, 2 kHz and 4 kHz. Air and bone conduction tresholds were analyzed. The test results, both in the research and control group, confirmed a conductive hearing loss before the treatment. There were no mixed hearing losses.

1. Presentation of test results before treatment

1.1. Pure tone audiometry

The tonal audiometry showed an average degree of hearing loss (out of all 70 subjects) at the level of 33.16 dB. The minimum loss (average calculated for the four above-mentioned frequencies) was 26.59 dB, while the maximum loss was 40.14 dB. The average value of the cochlear reserve was 33.05 dB.

1.2. Impedance audiometry

The analysis of impedance audiometry results included the measurement of pressure changes in the middle ear, the tympanogram shape and the registration of stapedius reflex.

1.2.1. Tympanogram

Tympanometry shows us the condition of the middle ear. The results obtained are classified due to the shape of the tympanogram, the tympanogram type A means the correct result (from 0 to -50 dPa), the tympanograms B and C show the pathology of the functioning of the middle ear.

Before treatment in the research group, 7 cases of type A tympanogram, 85 type B tympanograms and 48 cases of type C tympanogram were recorded. The average susceptibility value was -328.06 dPa.

1.2.2. Stapedius reflex

The reflex of the stapedial muscle in the study group was noted in 7.86% of subjects.

2. Presentation of the test results after the treatment

2.1. Pure tone audiometry

In pure tone audiometry, the average loss recorded in the research group was 15.64 dB (minimum loss 9.9 dB, maximum loss 22.08 dB).

In the control group, the average loss was 29.60 dB (minimal loss 22.03 dB, maximal loss 37.97 dB).

2.2. Impedance audiometry

2.2.1 Tympanogram

After treatment, 64 cases of type A tympanogram, 12 cases of type B tympanogram and 32 cases of type C tympanogram were recorded in the study group. In the control group, the results were as follows: 2 cases of type A tympanogram, 20 cases of type B tympanogram and 10 cases of the tympanogram type C. The mean value of the tympanic membrane susceptibility for the research group was 159 dPa, and for the control group 318 dPa.

2.2.2. Acoustic reflex

A reflex of stapes muscle was recorded in 67.59% of subjects in the research group and 6.25% in the control group.

Intergroup comparative analysis

The research results presented above indicate an improvement in hearing in the group of people

using the pneumotherapy of the auditory tube. Mean hearing loss decreased by 13.64 dB (in the control group, the improvement was 7.43 dB).

Analyzing subsequent data, it can be noticed that impedan ce audiometry showed an improvement in the type of tympanograms and air pressure compensation in the tympanic cavity. Type A tympanogram was recovered in 68.52% of children. A wider analysis showed that in 21 cases the type B tympanogram improved to the tympanogram type A. Improvement from the tympanogram type C to type A was obtained in 37 cases, while from type B to type C — in 27 cases.

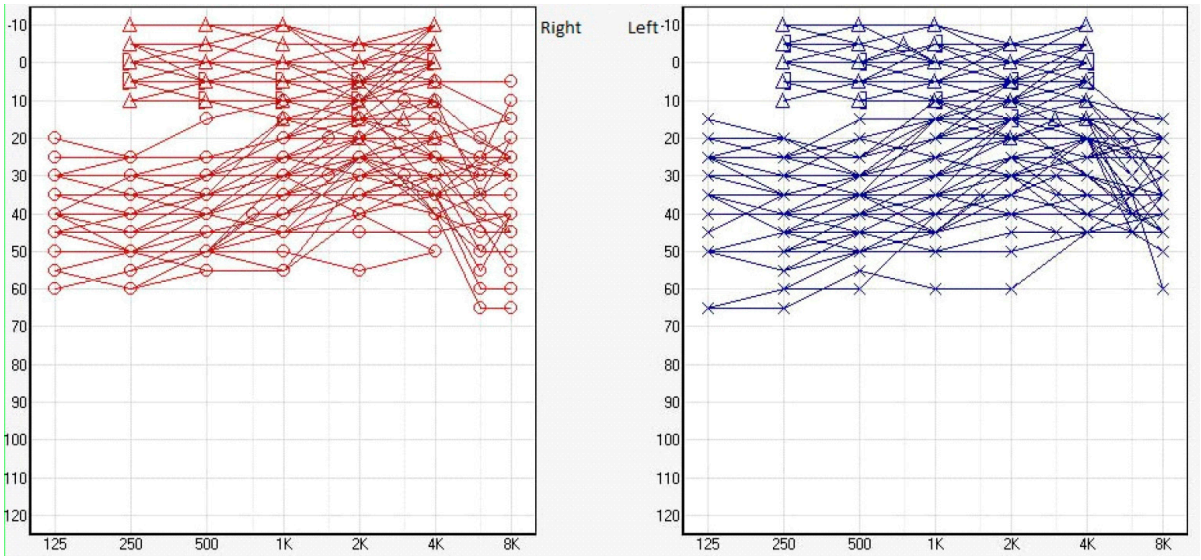

Figure 1. The results of pure tone audiometry before treatment

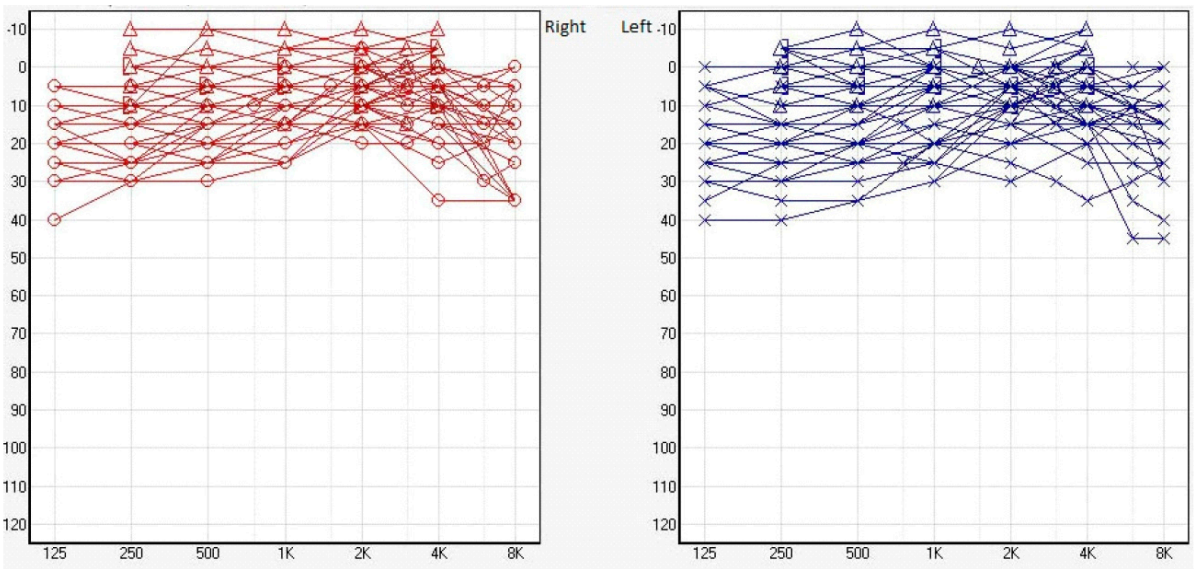

Figure 2. The results of pure tone audiometry after the end of the treatment

Table 1. Comparative analysis of the research group and the control group

	Research group (number of patients = 54)	Control group (number of patients = 16)
The number of people who improved their hearing	44	0
The value of improvement in the average hearing threshold in dB	13,63 dB	7,43 dB
Sound pressure improvement value in the middle ear	139 dPa	40 dPa
Change of the tympanogram	21	0

On the other hand, in the group of children not using the recommended method, the tympanogram type A was recovered in 6.25% of children. Type B tympanogram was not improved in any case. Type A to type C tympanogram changes were obtained in 2 cases, while type B to type C changes — in 6 cases. The rest of the patients did not get any improvement.

The pressure at the top of the maximum susceptibility of the eardrum improved in the research group by 139 dPa, while in the control group only by 40 dPa (**Table 1**).

Acknowledgements

Conflict of interest statement
The authors declare no conflict of interest.

Funding sources
There are no sources of funding to declare.

References

1. Zulkiflee S, Siti Sabzah MH, Philip R, Mohd Aminuddin MY, on behalf of the Development Group of management of otitis media with effusion in children. Management of otitis media with effusion in children. Malaysian Family Physician. 2013;8(2):32–5.
2. Zakrzewski L, Lee DT. An algorithmic approach to otitis media with effusion. Journal Of Family Practice. 2013;62(12):700–706.
3. Erdoglija M, Sotirović J, Baletić N. Early postoperative complications in children with secretory otitis media after tympanostomy tube insertion in the Military Medical Academy during 2000–2009. Vojnosanitetski Pregled. 2012;69(5):409–413. doi:10.2298/VSP1205409E.
4. Prauzińska M. Efektywność leczenia wysiękowego zapalenia ucha środkowego u dzieci. Rozprawa doktorska. 2013.
5. Rovers MM, Schilder AGM, Zielhuis GA, Rosenfeld RM. Seminar: Otitis media. Lancet. 2004;363:465–473. doi: 10.1016/S0140–6736(04)15495–0.
6. Kubba H, Pearson J, Birchall J. The aetiology of otitis media with effusion: a review. Clinical Otolaryngology & Allied Sciences. 2000;25(3):181–194. doi: 10.1046/j.1365-2273.2000.00350.x.
7. Tsuboi Y, Kim Y, Giebink GS, Le C, Paparella MM, Chen N, Lin J. Induction of Mucous Cell Metaplasia in the Middle Ear of Rats Using a Three-step Method: An Improved Model for Otitis Media with Mucoid Effusion. Acta Oto-Laryngologica. 2002;122(2):153–160. doi: 10.1080/00016480252814153.
8. Bhutta MF. Evolution and Otitis Media: A Review, and a Model to Explain High Prevalence in Indigenous Populations. Human Biology. 2015;(2):92. doi: 10.13110/humanbiology.87.2.0092.
9. Ruben RJ. Serous otitis media in the 20th and 21st centuries: evolving views and treatments. Acta Oto-Laryngologica. 2009;129(4):343–347. doi: 10.1080/00016480802454724.
10. Jastrzębska I, Górecka-Tuteja A, Sładek M, Składzień J, Fijorek K, Fyderek K. Charakterystyka refluksu krtaniowo-gardłowegoorazżołądkowo-przełykowego u dzieci z wysiękowym zapaleniem ucha środkowego. Contemporary Pediatrics, Gastroenterology, Hepatology & Child Feeding. 2012;14(2):69–73.
11. Ozmen OA, Genc A, Ozmen S, Kayikci EK, Sarac S, Sennaroglu L, Turan E. Successive Medical Treatment Versus Watchful Waiting in Chronic Otitis Media with Effusion. Journal Of International Advanced Otology. 2010;6(1):11–17.
12. Waldron C, Thomas-Jones E, Cannings-John R, Hood K, Powell C, Roberts A, Francis N. Oral steroids for the resolution of otitis media with effusion (OME) in children (OSTRICH): study protocol for a randomised controlled trial. Trials. 2016;171. doi: 10.1186/s13063-016-1236-1.
13. Stangerup S. Autoinflation: Historical Highlights and Clinical Implications. ENT: Ear, Nose & Throat Journal. 1998;77(9):737.
14. Mandel EM, ML. Recent developments in the treatment of otitis media with effusion. Drugs. 2006;(12):1565.
15. Obrębowski A, Obrębowska Z. Wpływ przewlekłego wysiękowego zapalenia ucha środkowego na rozwój mowy u dzieci. Otorynolaryngologia. 2009;8(4):159–162.
16. Khavarghazalani B, Farahani F, Emadi M, Hosseni Dastgerdi Z. Auditory processing abilities in children with chronic otitis media with effusion. Acta Oto-Laryngologica. 2016;136(5), 456–459. doi: 10.3109/00016489.2015.1129552.
17. Ozgursoy OB, Tataragasi AI, Mermerkaya M, Gercekeer M. Non-Surgical Treatment of Otitis Media with Effusion in Children: Efficacy of Middle Ear Inflation with a Politzerization Device. Journal Of International Advanced Otology. 2009;5(2):145–150.
18. Stangerup S, Klokker M, Vesterhauge S, Jayaraj S, Rea P, Harcourt J. Point prevalence of barotitis and its prevention and treatment with nasal balloon inflation: A prospective, controlled study. Otology And Neurotology. 2004;25(2):89–94. doi: 10.1097/00129492-200403000-00001.
19. Arick DS, Silman S. Nonsurgical home treatment of middle ear effusion and associated hearing loss in children. Part I: Clinical trial. ENT: Ear, Nose & Throat Journal. 2005;84(9):567–578.
20. Bunne M, Magnuson B, Falk B, Hellström S. Eustachian Tube Function Varies over Time in Children with Secretory Otitis Media. Acta Oto-Laryngologica. 2000;120(6):716–723. doi: 10.1080/000164800750000234.

Acceptance for editing: 2018-06-30
Acceptance for publication: 2018-07-02

Correspondence address:
Małgorzata Nowak
Department of Phoniatrics and Audiology
Poznan University of Medical Sciences, Poland
nowakm@ump.edu.pl