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The Prevalence of Otitis Media with Effusion in Children with Tracheotomy

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Abstract

Introduction: Otitis Media with Effusion (OME) is a common pathology in children. Children with tracheotomy are at an increased risk of developing OME. Since pediatric tracheotomy has become relatively common in recent year, it is of great importance to properly assess the occurrence of OME and identify contributing factors in this population.

Materials and Methods: A prospective cohort study in pediatric patients with tracheotomy treated in a rehabilitation center. Data regarding the patient's medical history, duration and manner of ventilation, modes of feeding and the use of pacifier was gathered. Middle ear status was determined by otoscopy and tympanometry.

Results: The 22 patients participated in the study; data was gathered regarding 43 ears. In the study population, 70% of the ears had pathologic tympanograms. Patients who received full or partial respiratory supports had a higher incidence of pathologic tympanograms compared to those with spontaneous breathing (70% *vs.* 50%). The incidence of pathologic tympanogram was higher in patients who were enterally fed compared to orally fed (75.9% *vs.* 57.1%). Among those who were enterally fed, patients who were using a pacified were less inclined to have a pathologic tympanogram (62.5% *vs.* 92.3%).

Discussion: Children with tracheotomy have a greater tendency for OME than healthy. Mechanical ventilation seems to adversely affect middle ear ventilation. Oral feeding is associated with better Eustachian tube function and less middle ear pathology. Pacifier usage was also found beneficial in reducing OME in this population.

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Introduction

Pediatric tracheotomy has become a relatively common procedure in recent years. The indications for tracheotomy vary and it is being increasingly performed in younger patients [1]. Tracheotomy allows a safe and comfortable route of ventilation in patients with long-term mechanical ventilation. However, tracheal cannulation and mechanical ventilation might adversely affect middle ear ventilation.

Middle ear pathology is prevalent in children. The most common pathology is Otitis Media with Effusion (OME). The pediatric Eustachian tube anatomy and frequent upper respiratory tract infections impair middle ear ventilation and result in fluid accumulation. Persistent middle ear effusion affects sound conduction and may cause hearing impairment [2].

Children with tracheotomy are at increased risk for developing OME. Some have neurological disabilities, impaired level of consciousness or require sedation. As a result, decreased swallowing and oral feeding decrease Eustachian tube function and middle ear ventilation. Furthermore, these patients commonly rely on mechanical ventilation that alters upper airway pressure and mucociliary function and may further predispose to OME [3-5].

The occurrence of OME in children with tracheotomy has not yet been properly assessed. Since this population often suffers from communication difficulties, it is of great importance to diagnose and treat OME in these children.

Materials and Methods

Ethical considerations

The study was conducted in ALYN pediatric rehabilitation center, a comprehensive rehabilitation center for physically challenged and disabled children and adolescents, located in Jerusalem, Israel. The study was performed according to the ethical standards and under the supervision of the institutional ethical committee.

The study population included patients 18 years old and younger on mechanical ventilation *via* a tracheotomy tube or spontaneous breathing through tracheotomy. The patients' legal guardians received an explanation regarding the study and gave their informed consent.

Study design

Information regarding the patients' medical status was recorded. Socio demographic and clinical data were recorded, including: date of birth, sex, level of consciousness (intact, impaired or vegetative), date of tracheotomy, mode of respiratory support (full, partial or spontaneous breathing), and feeding route (oral or enteral *via* nasogastric tube, gastrostomy or jejunostomy). In the patients who were enterally fed, the use of a pacifier and administration of oral tastings were recorded.

During the evaluation, the patients underwent otoscopy by an otolaryngologist. Patients with external auditory canal stenosis or an acute external or middle ear infection were excluded from the study. After validating full visualization of the tympanic membrane, tympanometry was performed using a Titan IMP440 tympanometer. Tympanograms were classified as Jerger types A, B or C as follows: Type A, peak admittance between +100 daPa and -100 daPa; type B, no peak and little admittance (common in cases of middle ear effusion); and type C, negative peak at a pressure more negative than -100 daPa (common with poor middle ear aeration). For the purposes of this analysis, type A tympanograms were considered normal and types B and C were considered pathologic.

Statistical methods

Statistic analysis was performed using SPSS statistics 21.0 software. Correlation between age and tympanogram type was calculated using point briserial correlation coefficient. Correlation between tympanogram type and variables potentially associated with middle ear pathology was calculated using Pearson chi-square test. A p value of less than 0.05 was considered statistically significant.

Results

A total of 22 patients participated in the study. Data was gathered regarding 43 ears. 6 of the participants were female and 16 male. The age ranged from 5 months to 18 years. Seventy nine percent were 6 years old and younger. The average age was 4.53 years and the median was 2.9 years. An inverse correlation was found between age and middle ear pathology (point briserial correlation coefficient -0.37).

In the study population, 70% of the ears (68% of the participants) had type B or C tympanogram (Figure 1). The pathologic tympanogram represents impaired middle ear ventilation and most commonly the occurrence of middle ear effusion.

Level of respiratory support

The level of respiratory support required by the participants was divided into full mechanical ventilation (10 participants), partial respiratory support (6 participants) and spontaneous breathing (6 participants). Among those who required full mechanical ventilation, 12 ears (63%) had type B or C tympanogram. Among those who required partial respiratory support, 12 ears (100%) had type B or C tympanogram. When combining results of all the patients who required respiratory support (full and partial), a total of 24 ears (77%) had type B or C tympanogram. Among participants with tracheotomy who breathed spontaneously maybe better with spontaneous breathing, 6 ears (50%) had type B or C tympanogram. To summarize, the incidence of pathologic tympanogram was significantly higher in patients who require mechanical ventilation (full and partial support), than in those who breathe spontaneously (77% *vs.* 50%) [p<0.01] (Figure 2).

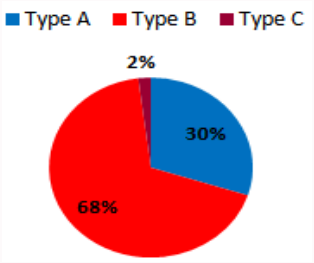

Figure 1: Tympanometry in pediatric patients with tracheotomy.

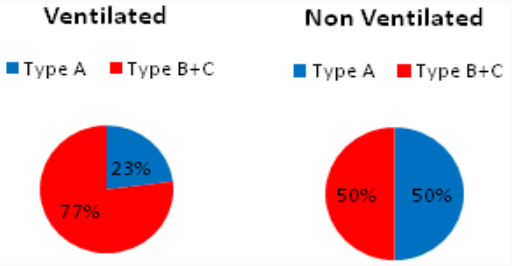

Figure 2: Tympanometry in ventilated and non-ventilated pediatric patients with tracheotomy.

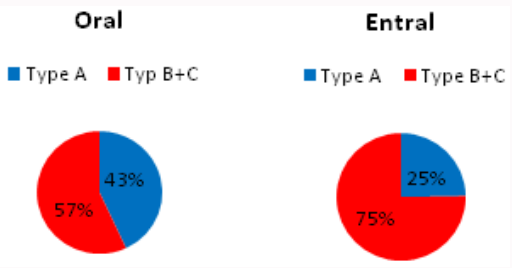

Figure 3: Tympanometry in pediatric patients with tracheotomy orally and enterally fed.

Modes of feeding

Fifteen of the participants were orally fed and 7 were enterally fed (*via* nasograstric tube, gastrostomy or jejununostomy). Among those who were orally fed, 8 ears (57%) had type B or C tympanogram. In participants who were enterally fed, 22 ears (75%) had type B or C tympanogram. The incidence of pathologic tympanogram was higher in participants who were enterally fed, compared to those who received oral feeding (75.9% *vs.* 57.1%). This difference did not reach statistical significance [p<0.01] (Figure 3).

Among participants who were enterally fed (n=15), 8 used pacifiers. In those who used pacifiers, the incidence of pathologic tympanograms was lower than in those that did not (62.5% *vs.*

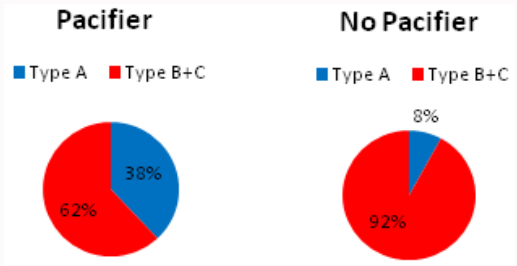

Figure 4: Tympanometry in enterally fed patients with tracheotomy with or without the use of a pacifier.

92.3%). The beneficial effect of the pacifier was statistically significant ($p<0.05$) (Figure 4).

The effect of oral tastings on middle ear ventilation in enterally fed patients was also assessed. The occurrence of tympanogram B or C in participants who received oral tastings was similar to that of those who did not receive this (75% *vs.* 76.5%). There was no statistically significant difference between the two groups.

Discussion

Middle ear effusion is common in the pediatric population. Studies from North America and Europe have estimated that about 50% to 80% of children aged 4 years have been affected by OME at some time [6,7]. Another study found that, at any given time, 5% of children aged 5 years had persistent (at least 3 months) bilateral hearing impairment associated with OME [8].

Young children are especially prone to middle ear disease. The majority of the children diagnosed with OME are under the age of 6 years [6]. Our results were consistent with that, as in our study population, in which almost 80% of the participants were under the age of 6 years, the prevalence of OME decreased as the participants got older. This may be attributed to Eustachian tube dysfunction that resolves as the child gets older and position and length of the Eustachian tube changes.

In children with tracheotomy there are further conditions that predispose to OME. These children often require frequent hospitalization, they are more inclined to respiratory infections, and they have higher incidence of gastroesophageal reflux. Some of the patients may also suffer from other related comorbidities, such as craniofacial abnormalities, neuromuscular disease and immunodeficiency [3-5]. All of the above potentially interfere with normal functioning of the Eustachian tube and equalization of middle ear pressure.

In our study population, comprised of chronically ill children with tracheotomy who are treated in a rehabilitation center, 68% of the children (70% of the ears) had impaired middle ear ventilation. The increased prevalence of middle ear disease in children with tracheotomy was similar to that reported in the literature. Palmisano et al. [5] reported in a review of a population of ventilator dependent children with tracheotomy, that 75% of the patients progressed later on to require tympanostomy tube placement for OME. In a retrospective review conducted by Beste et al. [3] the prevalence of OME was up to 60% in a pediatric population with tracheotomy treated in an outpatient constellation. McAfee et al. [4] demonstrated that in their institution, 17% of the children receiving a tracheotomy also required tympanostomy tube placement. That study apparently underestimated the prevalence of operative middle ear disease since it did not record procedures performed in medical institutions other than the one followed.

In the population of adults with tracheotomies, the occurrence of middle ear effusion was also reported increased compared to normal adults. In a study by Ilan et al. [9] pathologic tympanograms were found in up to 56% of the ears of adult patients chronically ventilated through tracheotomy. In another study, that examined the way conversion of endotracheal tube to tracheal cannulation affects middle ear ventilation, OME was found in 22% of the patients with tracheotomy. The study results indicate that the occurrence of OME decreases after performing tracheotomy. Removal of the endotracheal tube and reduced demand of sedation probably contributed to improved Eustachian tube function [10].

The impact of mechanical ventilation on the occurrence of OME was evaluated. In our study population, patients who received mechanical respiratory support (either partial or full) were found to have higher rates of OME than those with spontaneous breathing. A similar trend was demonstrated in the work of Beste et al. [3]. The patient's general medical condition determined whether artificial support was needed, and was influenced by the patients' neuromuscular and cognitive function. Clearly, all of the above influenced the function of the Eustachian tube as well. However, the magnitude of respiratory supports was not found to correlate with the occurrence of OME, unlike presented in the work of Palmisano et al. [5]. Meaning that mechanical ventilation impacts upper airway physiology, but in a manner magnitude that have not been properly evaluated yet.

Another factor affecting middle ear status is the action of the Eustachian tube during swallowing. The tensor veli palatine contracts and lateralizes the lateral cartilaginous lamina of the auditory tube, allowing pressure equalization with the tympanic cavity [11]. In our study, patients with tracheotomy who received oral feeding showed a trend towards better middle ear aeration. A similar but stronger correlation was demonstrated in adult patients with tracheotomy by Ilan et al. [9]. It is possible that in children, swallowing affects the function of the Eustachian tube to a lesser degree than in adults, as its function is inherently defective. Our results were consistent with that, as in patients who were enterally fed, oral tastings did not seem to impact significantly the occurrence of OME. Another explanation of the lesser effect seen in our study is the small number of patients.

Pacifier usage, famous for its ability to soothe babies, has further benefits in preventing Sudden Infant Death Syndrome (SIDS) and supporting development [12]. It stimulates sucking and swallowing and is presumed to affect Eustachian tube function. A clear association between pacifier usage and recurrent acute otitis media has been demonstrated in several studies [13]. The mechanism is unknown; theoretically frequent pacifier sucking may alter intranasal pressure and promote reflux of nasopharyngeal secretion into the middle ear cavity. However, whether pacifier usage affects the occurrence of OME has not yet been well studied. In this study, pacifier usage in children with tracheotomy seemed to improve middle ear aeration and decrease the occurrence of middle ear pathology. This beneficial effect could be attributed to stimulation of recurrent swallowing. The frequency of pacifier use and the number of swallows have not been documented in our study. Hypothetically the swallowing activity the pacifier promotes might exceed that required in oral feeding and thus be more significant in Eustachian tube pressure equalization.

Conclusion

Children with tracheotomy have a greater tendency for OME than do healthy children. Oral feeding is associated with better Eustachian tube function and less middle ear pathology. Pacifier usage was also found beneficial in reducing OME in this population. Middle ear effusion interferes with sound conduction and adversely affects hearing and communication capabilities. Raising awareness to the possibility of this problem in the population of children with tracheotomy is of great importance in early detection, treatment and prevention. This study is limited by the small number of patients. A larger cohort might elucidate some points as the effect of oral feeding. Another limitation is its cross-sectional nature. There is no data on middle ear status before tracheostomy was performed and on when OME appeared or on the duration of pathology.

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