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ORIGINAL ARTICLE

Effect of Local Vitamin A Versus Local Dexamethasone in Prevention of Myringosclerosis

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Abstract
Comparing the effects of local vitamin A and local dexamethasone on preventing myringosclerosis in human tympanic membranes caused by ventilation tubes was the aim of the study. Three groups were created from 90 kids having myringotomies and ventilation tube insertions: In group I, thirty children are undergoing myringotomy and the insertion of a ventilation tube alone; in group II, thirty children are undergoing myringotomy and the insertion of a ventilation tube along with the use of local vitamin A; and in group III, thirty children are undergoing myringotomy and the insertion of a ventilation tube along with the use of local dexamethasone. According to otoscopic and microscopic examination, group 2 (6 ears) that received local vitamin A had a lower incidence of myringosclerosis than group 3 (11 ears) that received local dexamethasone and group 1 (21 ears) that did not receive any local medication. According to the study's findings, local vitamin A is more effective than local dexamethasone at reducing the severity and incidence of myringosclerosis in children having myringotomy and ventilation tube insertion.

Keywords Vitamin A · Ventilation tube · Dexamethasone · Myringosclerosis

Introduction

The most widely used treatment for otitis media with effusion is myringotomy combined with the insertion of a ventilation tube. It is also used as a preventative measure for recurrent otitis media [1]. The most frequent side effect of myringotomy with ventilation tube treatment is tympanosclerosis [2].

Tympanosclerosis is caused by the deposition of large amounts of collagenic fibrosis tissue in the lamina propria, which covers the ossicles, the walls of the tympanic cavity, and the medial layer of the tympanic membrane [3]. A homogenous, hyaline substance may form due to the thickness caused by collagen deposition, which may then result in the deposition of calcium and phosphate crystals.. [4] There is myringosclerosis when Only the most frequent location, the tympanic membrane, is where crystals are deposited [5, 6].This condition is clinically significant if it can disrupt the transmission of sound waves via the middle ear structures [7].

Due to hyaline alterations at the submucosal level, tympanosclerosis is the development of ossification in the tympanic membrane, middle ear cavity, ossicles, and infrequently in the mastoid bone. Myringosclerosis is the term used when tympanosclerosis exclusively affects the tympanic membrane [8–10]. Myringosclerosis is found in 28%–61% of patients who had VT implantation. [10]. It is currently uncertain what exactly causes tympanosclerosis pathogenesis. It could be the result of a unique scar tissue or healed inflammation following recurrent bouts of otitis media, or it could be the direct result of hydrolytic enzymes in the serous fluid caused by the lamina propria [1, 9].

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Trauma is another factor. Myringosclerosis can develop as a result of any trauma, from extreme tension to the eardrum fibers (the most basic type) to tympanic membrane perforation (the most severe type) [12]. Intraepithelial hemorrhage and fibrosis-induced healing are possible outcomes of myringotomy with VT insertions [13]. Reducing the bleeding during myringotomy helps reduce the long-term development of myringosclerosis because studies have shown that ear canal bleeding may contribute to the development of myringosclerosis [14]. According to the literature, the incidence of tympanosclerosis following VT insertion varied between 25 and 35%. [15]. Recent research indicates a possible link between reactive oxygen species and myringosclerosis development following tympanic membrane damage and/or VT insertion [16].

Topical Vitamin A, mainly as retinol and retinoids, offers multiple skin benefits. It reduces signs of aging by boosting collagen production, improving skin elasticity, and smoothing wrinkles. It effectively treats acne by exfoliating pores, reducing inflammation, and minimizing scars. Vitamin A also lightens hyperpigmentation and sun damage, leading to a more even skin tone. Additionally, it strengthens the skin barrier, enhances immune response, and normalizes oil production. In wound healing, it promotes cell growth, collagen synthesis, and speeds tissue regeneration, supporting overall skin health [17].

Comparing the effects of local dexamethasone as a steroid and local vitamin A, a strong chain-breaking antioxidant, on the development of tympanosclerosis following VT insertion was the goal of this study.

Methods

Ethical approval

This study was done after the approval from the Benha University Hospitals Committee. Subjects enrolled in this study were fully informed about the nature and the procedures of the study and approved for publication.

The subjects included in this study had given an informed consent.

In our study, we target subjects previously diagnosed to have OME based on 1. History: most cases are asymptomatic and discovered accidentally during otoscopic examination, some suffer from mild degree of hearing loss, decrease scholature achievement, sense of popping noises or ear fullness, less commonly vertigo and tinnitus. 2. Examination: otoscopic examination shows dull opaque retracted tympanic membrane with air fluid levels or bubbles behind it with disturbed cone of light. Pneumatic otoscopy shows reduced mobility of tympanic membrane. Tunning fork tests show conductive hearing loss. 3. Investigations: tympanometry shows flat curve or type B. audiometry may show mild degree of conductive hearing loss.

Our sudy is performed on subjects exposed to conservative treatment including decongestants, antihistamincs, mucolytics and systemic corticosteroids with persistant flat curve for 2,3 months indicating failure of conservative treatment. Here myringotomy and tympanostomy tube insertion is a must with treatment of the predisposing factor after good preoperative preparation.

This study comprised 90 children between the ages of 3 and 11 who underwent myringotomy and VT insertion at Benha University Hospital's Faculty of Medicine, ENT department, between June 2023 and June 2024. Prior to the start of the trial, parental agreement and clearance from the local ethical committee were obtained. Group I was 7.27 years old, Group II was 7.73 years old, and Group III was 7.93 years old. There were forty-two males and forty-eight girls among the children. Myringotomy and VT insertion are being performed on children who have persistent otitis media-related hearing loss and effusion that is not responding to medical treatment after three months.

Patients who underwent previous ventilation tube insertion and also patients who had previous myringosclerosis and patients who had excessive bleeding during operation were excluded.

All patients gave their written agreement after receiving ethical committee approval from the Benha University Hospitals Committee. Every youngster underwent surgery while under general anesthesia. Three groups of thirty patients each were formed from the 90 patients:

Group I: 30 Patients are having a myringotomy and only having a ventilation tube inserted.

Group II: 30 Patients are undergoing a myringotomy and the placement of a breathing tube while receiving local vitamin A.

Group III: 30 Patients are receiving local dexamethasone while undergoing myringotomy and breathing tube placement.

In the antero-inferior quadrant, the myringotomy incision was made. Fluid was aspirated from the middle ear. In every instance, bilateral grommet tubes were utilized. In group II, vitamin A drops were used in both ears following the myringotomy incision as in Fig. 1. The middle ear cavity was filled, and it was ensured that the vitamin A drops would contact all surfaces. In group I, no medical treatment was administered during or after the insertion of a ventilation tube in either ear. After five minutes, the vitamin A drops were suctioned out, and a grommet tube was placed before applying another course of vitamin A drops as in Fig. 2.

In group III, the middle ear cavity was filled and the topical dexamethasone was applied to all surfaces following the myringotomy incision and the instillation of 0.3 ml of 8 mg/2 ml dexamethasone drops (dexamethasone

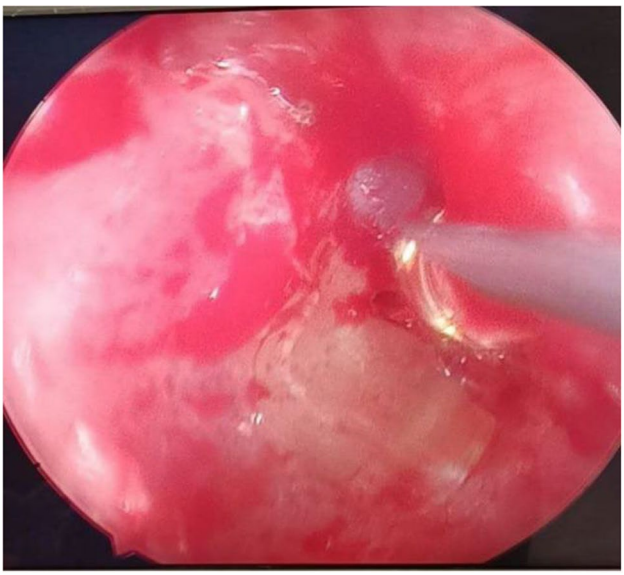

Fig. 1 Local application of vit A after myringotomy incision

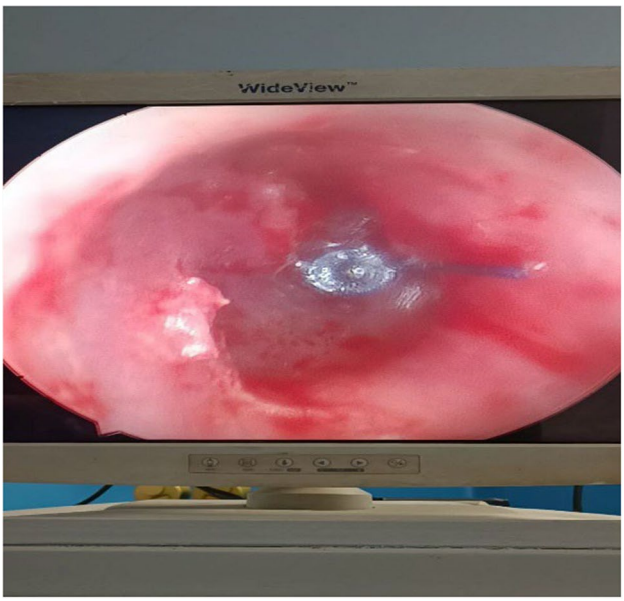

Fig. 2 Local application of vit A after grommet

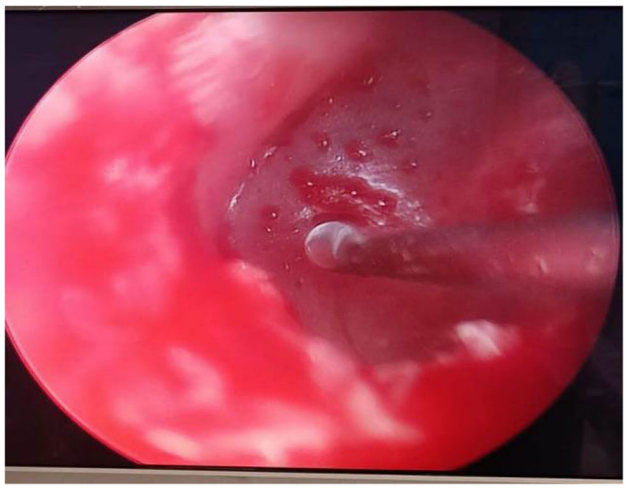

Fig. 3 Local application of dexamethasone after myringotomy incision

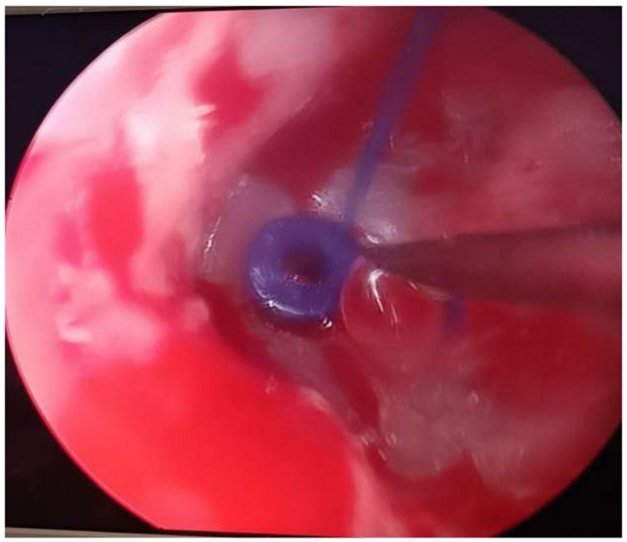

Fig. 4 Local application of dexamethasone after grommet tube insertion

sodium-phosphate injection) as in Fig. 3. Following a 5-min topical dexamethasone suction, a grommet tube was placed, and a second round of local dexamethasone was administered as in Fig. 4. A week of postoperative prophylactic ampicillin-clavulinic acid was administered.

As part of the follow-up, routine otoscopic and microscopic examinations were planned two, four, and six months after the procedure, and no additional issues were found. The observer who conducted the microscopic and otoscopic postoperative examinations was blind to which research group the case under evaluation belonged to. Otomicroscopy revealed the presence of any apparent white plaque in the tympanic membrane, which is known as myringosclerosis formation. The findings were presented as whether myringosclerosis was present or not.

10 children were excluded in this study as these children were lost during follow up (3 children in group I, 4 in group II, 3 in group III) from the study. A total 90 of children were finally evaluated. The appearance of tympanic membranes and development of myringo- sclerosis were evaluated according to the distribution on four quadrants.

Results

Throughout the study period, 180 ears were inspected. Table 1 indicates that 38 ears had myringosclerosis, with 21 ears in group I having myringoscerosis and 5 individuals having bilateral myringosclerosis (10 ears).

Six myringosclerotic patches (10%) were discovered in the right ear, 16.7% of the patients had myringosclerotic patches, and none were discovered in the left ear.

In group I as well, five myringosclerotic patches (8.3%) were discovered in the left ear, but none were discovered in the right ear of the same patients. group II, there

Six individuals had six myringosclerotic patches, two in the left ear (3.3%) and four in the right side (6.7%). Eleven patients in group III had myringosclerotic patches, three on the right side (5%) and eight in the left ear (13.3%).

Myringosclerosis was less established in group 2's tympanic membranes than in groups 3 and 1, according to an otomicroscopy analysis of the disease's distribution.

Table 2 demonstrates that in group I, eight myringosclerotic patches affected only the anterior inferior quadrant (13.3%), six affected only the posterior inferior quadrant (10%), five affected both the anterior and posterior inferior quadrants (8.3%), one affected only the anterior superior quadrants (1.7%), and one affected only the posterior superior quadrants (1.7%). In group II, there were four myringosclerotic patches that only affected the anterior inferior quadrant (6.7%), two that only affected the posterior inferior quadrant (3.3%), and no myringosclerotic patches that affected both the anterior and posterior inferior quadrants or the anterior and posterior superior quadrants. Six myringosclerotic patches that only affected the anterior inferior quadrant (10%) were present in group III., Five myringosclerotic patches exclusively affected the posterior inferior quadrant (8.3%); none affected the anterior or posterior superior quadrants, and none affected either of the above two quadrants (Fig. 5).

Discussion

According to this study, myringotomy with tube insertion reduced the development of myringosclerosis when local vitamin A and local dexamethasone were applied; nevertheless, local vitamin A was more effective than local dexamethasone.

Myringosclerosis is the term used when tympanosclerosis just affects the ear drum. A common side effect of OME, ROM, chronic otitis media, and VT insertion is myringosclerosis [17]. There is no precise information on its source or pathology, despite the fact that a number of theories have been put up. Research indicates that various variables, including intratympanic bleeding, hyperoxygenation foreign body reaction to VT, and autoimmune etiology, may be held responsible for tissue trauma [18].

Table 1 The distribution of research groups by myringosclerosis site, sex, and age

	Group I (30 pt) (60 ears)	Group II (30 pt) (60 ears)	Group III (30 pt) (60 ears)	Statistical test	*P* value
Age mean ± SD (range)	7.24 ± 1.36 (5–10)	7.71 ± 1.05 (5–9)	7.91 ± 1.42 (6–10)	F = 2.066	0.12
Sex n (%)					
Male	14 (45.6)	15 (50.0)	13 (43.2)	$X^2 = 0.25$	0.88
Female	16 (55.4)	15 (50.0)	17 (56.8)		
Myringosclerosis					
Rt	6 (10.0)	4 (6.7)	3 (5.0)	FET = 24.05	< 0.001**
Lt	5 (8.3)	2 (3.3)	8 (13.3)		
Bilat	10 (16.7)	0 (0.0)	0 (0.0)		
None	39 (65.0)	54 (90.0)	49 (81.7)		

Table 2 Myringosclerosis findings are distributed based on the quadrants under otomicroscopic evaluation

Myringosclerosis	Group I (60 ears)	Group II (60 ears)	Group III (60 ears)	Statistical test	*P* value
Antro-inferior Q	8 (13.4)	4 (6.6)	6 (10.0)	FET = 16.91	0.024*
Post-inf Q	6 (10.0)	2 (3.3)	5 (8.3)		
Both	5 (8.3)	0 (0.0)	0 (0.0)		
Antro-superior Q	1 (1.7)	0 (0.0)	0 (0.0)		
Postro-superior Q	1 (1.7)	0 (0.0)	0 (0.0)		
NO	39 (65.0)	54 (90.0)	49 (81.7)		

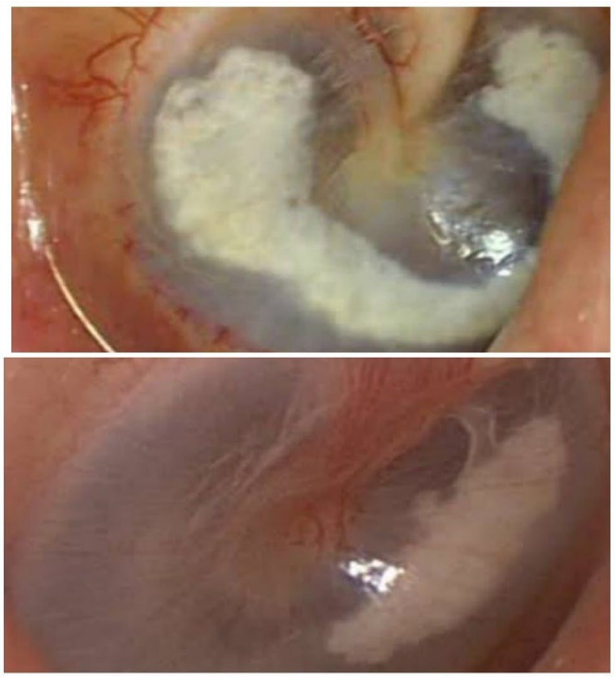

Fig. 5 Myringosclerotic ear

Histological tympanosclerosis, which may be observed in 80% of myringotomy cases, can only be seen in 40% of cases with otomicroscopy. Mattsson et al. reported that tympanic membrane sclerotic changes will develop within 9 hours of myringotomy and demonstrated that a severe histological inflammatory response will occur in pars flaccida within 12 to 24 hours after myringotomy [11]. This indicates that when tympanosclerosis is identified by otomicroscopy, there is actually twice as much tympanosclerosis (at the tissue level).

Ninety youngsters undergoing myringotomy and breathing tube insertion were split up into three groups for this study: Thirty children in group I had myringotomy and ventilator tube insertion just, while thirty children in group II had myringotomy and ventilation tube insertion plus local vitamin A group III: 30 children receiving local dexamethasone while undergoing myringotomy and breathing tube placement. Research indicates that myringosclerosis progresses in three stages, despite the fact that its etiology and pathophysiology are still unclear: There are three distinct phases: the repair phase, which is marked by fibroblastic invasion; the irreversible phase, which is where calcifications occur; and the first phase, which may be reversible and involves collagen fiber damage brought on by inflammatory processes [18].

Studies on myringosclerosis and tympanosclerosis were generally carried out to determine the etiology of the condition, evaluate myringosclerosis of the tympanic membrane based on histological and otomicroscopic results, and examine the efficacy of treatment options. Since a myringosclerotic patch develops in 21 ears in group I but only affects 6 ears in group II and 11 ears in group III, the goal of this study was to examine the otomicroscopic preventative impact of topical vitamin A and topical dexamethasone on the development of myringosclerosis.

Preventive measures, particularly those involving antioxidants, are frequently discovered in experimental myringosclerosis model studies in the literature. Less sclerotic lesions appeared in the myringotomized rats in the experiments with varying oxygen concentrations. in room-dwelling animals as opposed to rats that had myringotomy in a hyperoxic setting.

According to Mattsson et al., antioxidants that are applied locally, such as desferoxamine, copper, zinc, superoxide dismutase, and catalase, can stop or slow the formation of sclerotic lesions [19]. Under otomicroscopy, Spratley et al. demonstrated in an experimental investigation that topical application of ascorbic acid, an antioxidant agent, inhibits myringosclerosis in rats' perforated tympanic membranes. [20]

After conducting research on the antioxidant effects of N-acetyl cysteine in tympanosclerosis, Özcan et al. concluded that additional local N-acetyl cysteine application to the ear with VT insertion may help prevent the development of myringo-sclerosis [18]. According to Ovesen et al., N-acetyl cystein inhibits fibroblast growth and collagen release in fibroblast cultures [21]. Therefore, they suggested using local N-acetyl cysteine to reduce the middle ear's connective tissue layer thickness. In their work, Kazıkdaş et al. discovered that rats given alpha-tocopherol to prevent experimentally generated myringosclerosis had a lower incidence of myringosclerotic plaques [22]. Examining our study's otomicroscopic results, we found that group 1 had a substantially larger development of myringosclerosis than group III, which was followed by group II. Furthermore, group I included eight myringosclerotic patches that only affected the anterior inferior quadrant, six that only affected the posterior inferior quadrant, five that affected both the anterior and posterior inferior quadrants, one that only affected the anterior superior quadrants, and one that only affected the posterior superior quadrants.

Group II had four myringosclerotic patches that affected only the anterior inferior quadrant, two that affected only the posterior inferior quadrant, no myringosclerotic patches that affected both the anterior and posterior inferior quadrants, and no myringosclerotic patches that affected both the anterior and posterior superior quadrants. Group III had six myringosclerotic patches that affected only the anterior inferior quadrant, five that affected the posterior inferior quadrant, no myringosclerotic patches that affected both the anterior and posterior inferior quadrants, and no myringosclerotic patches that affected both the anterior and posterior superior quadrants.

According to Polat et al., immunological activation from the development of tympanosclerosis following myringotomy caused an increase in inflammatory reactive oxygen species, and vitamin A was utilized to lessen this impact [23]. In guinea pigs with experimental myringosclerosis, Selçuk et al. proposed that local calcium channel blocker treatment was helpful in preventing tympanosclerosis after the animals had myringotomy and Streptococcus pneumoniae type 3 inoculation [24]. In an animal investigation, Mattsson et al. discovered that an increase in oxygen content in the ear's atmosphere may hasten the development of myringosclerosis in ears with damaged tympanic membranes., an increase in oxygen concentration in the ear's atmosphere may accelerate the development of myringosclerosis [25].

Dawes et al. postulated that traumatic ventilation tube insertion, bleeding, or severe middle ear fluid aspiration all raise the likelihood of developing myringosclerosis [26]. Recent research has employed some antioxidant enzymes and components to reduce oxidative damage in tympanic membranes that have undergone myringotomy. In rats that underwent myringotomy, Polat et al. assessed the ROS levels in the middle ear mucosa and tympanic membrane. They also demonstrated that vitamin A has a strong effect on lowering ROS levels [23].

The amount of reactive oxygen species in the tympanic membrane following myringotomy with breathing tube insertion is decreased both experimentally and clinically, according to Üneri et al. [27].

According to all of these studies, the development of myringosclerosis was triggered by myringotomy and the installation of a breathing tube [28].

When compared to the ears of control groups in rats, topical application of oxygen free radical or topical steroid reduced the likelihood of myringosclerosis development [29, 30]. This study, however, is the only one to compare the effects of local vitamin A and local dexamethasone on preventing myringosclerosis in human tympanic membranes caused by ventilation tubes. It also found notable otomicroscopical differences between myringotomized ears treated with vitamin A, myringotomized ears treated with local dexamethasone, and non-locally treated myringotomized ears.

Conclusion

Myringotomized human tympanic membranes respond better to vitamin A treatment than to local dexamethasone treatment. Regular use of antioxidant treatment in myringotomy and tube insertion may result from bigger patient populations participating in therapeutic trials utilizing vitamin A and other antioxidants.

Declaration

Conflict of interest The authors had no conflict of interest to declare.

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