UPDATE

Eustachian tube rehabilitation therapy: Indications, techniques, and results

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ABSTRACT

Eustachian tube rehabilitation therapy (ETRT) is an underrecognized and rarely used tool for improving middle ear ventilation. Enhancing the efficiency of all the muscles that contribute to opening the Eustachian tubes is a key component of ETRT. Other components include education about nasal hygiene and nasal breathing (with children being taught proper nose-blowing technique and how to stop sniffing) and instruction about how to perform autoinsufflation.

Otitis media with effusion (glue ear) and early retraction pockets seem to be the best indications for ETRT. However, all disorders that require improved middle-ear ventilation may respond to ETRT.

Studies of ETRT are few and methodologically flawed. The results consistently indicate key roles for the qualities of the therapist, perseverance of the patients, and involvement of the parents.

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INTRODUCTION

Eustachian tube rehabilitation therapy (ETRT) is an underrecognized and rarely used treatment tool. The rehabilitation exercises and their underlying principles have been described in detail [1-6]. However, few well-designed studies have evaluated the efficacy of ETRT.

ETRT seeks primarily to restore effective patency to the Eustachian tubes in patients who have middle ear disorders thought to be related, at least in part, to Eustachian tube obstruction. The first study of ETRT in its current form is a doctoral thesis written by Jacobs in Nancy, France, in 1981, based on previous work by Wayoff [3]. Although Riu et al. [7] discussed "functional tubal therapy" in detail in their 1966 report on Eustachian tube physiology, only divers in the French Navy used this method at the time, although the authors suggested extending it to recreational divers. Jacobs [3] carried this work further and suggested adapting the exercises for children with otitis media with effusion (OME). During the same period, Cazanave [8- 9] used this technique in patients who were receiving follow-up during spa therapy. Then, in Belgium, Gersdorff [10] developed and extended ETRT techniques in 1986, suggesting the term "tubal logotherapy"; and Deggouj [4] reported a 1991 study in 81 patients. Nevertheless, ETRT is underrecognized. The few published studies are methodologically flawed. These facts, together with a number of human factors that will be discussed later on, have largely extinguished the interest shown initially by a few groups. In an attempt to fill the gap in data on ETRT, Kouwen et al. [11] recently performed a prospective randomized pilot study comparing ETRT to watchful waiting.

"Rehabilitation" is probably a better term than "physical therapy" or "functional therapy" [3], because it reflects the broad scope of the treatment program, which includes not only muscle exercises but also other techniques such as autoinsufflation. The term "logotherapy" [10] in the setting of tubal dysfunction stems from the Belgian word for speech therapist (logopedist). Thus, "logotherapy" emphasizes the role for the therapist but suggests that the focus is speech rehabilitation, which is not the case. ETRT includes patient education aimed at correcting harmful habits.

PRINCIPLES AND METHODS OF EUSTACHIAN TUBE REHABILITATION THERAPY

1. Eustachian tube function and dysfunction

The Eustachian tubes serve three functions: to protect the middle ear at several levels, to drain the middle ear, and to equalize pressures across the tympanic membrane. Multiple physiological mechanisms contribute to each of these functions. However, patency of the tube contributes to the pressure-equalizing function, although other factors are probably involved also. In addition, tube patency undoubtedly plays a role in most of the inflammatory processes that can affect the middle ear. A primary or secondary deficit in tube opening is found in most cases of tube dysfunction [12-13]. The tube is normally closed at rest. It can be opened by the synergistic contraction of several muscles, most of which arise about the uvula. Enhancing the efficiency of these muscles via specific exercises would therefore be expected to lessen the symptoms of Eustachian tube dysfunction. Although poor muscle function is not the only cause of Eustachian tube dysfunction, its role is pivotal, as indicated by the frequency and severity of middle ear inflammatory disorders in children with cleft palate.[14]

Nasal breathing contributes to good Eustachian tube function [15-16]. Sniffing, which is a common behavior in infants and children, may cause serous middle ear effusions [17]. Transient Eustachian tube dysfunction is often noted during common colds, and purulent otitis media may occur as a complication of sinonasal infections. Although the respective contributions of inflammatory processes and poor ventilation are difficult to determine, good nasal hygiene improves both factors.

ETRT aims to improve nasal breathing and to exercise the muscles that help to open the Eustachian tube. In addition, patients are taught to perform autoinsufflation, which seems helpful even when used alone.

2. Nasal hygiene and nasal breathing

In young children, the first step toward proper nasal breathing is substitution of nose-blowing for sniffing. Sniffing causes negative pressure in the middle ear, which leads to retraction of the tympanic membrane [17-18]. Children sniff naturally. Sniffing is simpler and faster than nose-blowing and does not interfere with playing. Although many authors consider that sniffing

should not be allowed [17-20], patience and persuasion are needed to bring about this change in behavior.
Young children (and sometimes older children) need to be taught proper nose-blowing technique. It is important to close one nostril at a time rather than to pinch the nose. When teaching this technique, patience is needed, and the child should be made aware of the beneficial effects on nasal breathing. In children, it is often necessary to wash the nasal cavity with isotonic seawater or saline.
Jacobs [3] reported that most children exhibited paradoxical nasal breathing, with narrowing of the nostrils during inspiration, thoracoabdominal asynchrony, and poor diaphragmatic breathing. These small abnormalities can be corrected by nasodiaphragmatic breathing exercises. Nasal valve exercises include acquiring an awareness of nostril dilation and working against resistance (the therapist's thumb and forefinger). Diaphragmatic function can be improved by exercises against pressure from the therapist's hand placed on the epigastric region. The next step consists in achieving synchrony between nasal breathing and diaphragmatic breathing.

3. Exercises for the velopharyngeal sphincter

At rest, the Eustachian tube is normally closed. The tube opens chiefly during swallowing and yawning. Cineradiography, endoscopy, and electromyography coupled with
sonomanometry and sonotubometry [6] have been used successfully to identify the main movements responsible for Eustachian tube opening.
During swallowing, the soft palate moves downward, the tongue backward, and the hyoid bone upward. Velopharyngeal contraction is greatest at the isthmic phase, when the food is ready to travel through the isthmus. The tenor and levator veli palatini muscles, as well as the uvulopharyngeal muscles, contract synchronously for about 0.60 seconds.
Protraction of the jaw increases the anteroposterior diameter of the pharynx, and when the isthmus contracts at the same time the Eustachian tubes open.
Yawning causes the soft palate to move upward, the tongue to flatten, the pharynx to dilate, and the hyoid bone to move downward. The Eustachian tubes open at the acme of the yawn.
Synergy among muscles during these movements is important [1]. Familiarity with concomitant movements, most notably of the hyoid bone, allows the therapist to check that the exercises are performed properly. Awareness of the movements by the patient is also important. Poor awareness, particularly regarding tongue position, may be noted.
The ultimate goal of these exercises is to allow work on the velopharyngeal sphincter:
- tongue movements, such as sweeping the palate and moving the tongue backward;
- soft palate movements, such as contraction of the soft palate, first stage of swallowing, induced yawning...
- protraction and side-to-side movements of the jaw;
- combined movements of the tongue and soft palate, to which jaw movements are then added. In children, these complex movements may require play activities, with which speech therapists are familiar. [4]
These movements often trigger yawning reflexes, which are effective in opening the Eustachian tubes and therefore constitute an integral part of the rehabilitation program.

4. Autoinsufflation

Autoinsufflation is a passive maneuver whose effects are transient when it is used alone [1, 4]. Nevertheless, the improvements in subjective symptoms (autophony and ear fullness) constitute an incentive to repeat the autoinsufflations, which may improve middle-ear ventilation.
- The Valsalva maneuver is the simplest and best known autoinsufflation method. The pads of the thumb and forefinger should be placed under the nostrils instead of being used to pinch the nose [3]. The Valsalva maneuver is not consistently effective in patients with Eustachian tube dysfunction. Another technique should be tried if the opening pressure is too high.
- The Misurya maneuver [2] is more difficult to perform but can be taught to children aged 5 years or older. There are three phases: first, the patient takes a gulp of air then holds his or her breath while closing the lips and puffing the cheeks out; the palm of the hand is then placed over the mouth, the nostrils are occluded, and the fingers are placed on the cheeks, still without breathing; and finally the hand is used to compress the cheeks during a swallow, which transmits the pressure of the oral cavity (160 mm Hg) to the middle ear.
- Party noise makers or balloons can be helpful. They provide useful entertainment. However, we believe that these methods are of limited value when used alone [5].

Although autoinsufflation exerts positive effects, we do not believe that it is a component of ETRT. Autoinsufflation requires specific equipment and the presence of a professional. In our opinion, ETRT can

be taught then continued by the patient alone (or with the help of a parent for young children).

5. Rehabilitation therapy in practice

In our opinion, ETRT should be carried out by a speech therapist. Speech therapists are familiar with the anatomy and physiology of the Eustachian tube and they have experience with soft-palate exercises. In some centers, however, physical therapists are trained in ETRT. The exercises are fairly tedious. They must be performed daily. To improve compliance, the sessions should not exceed 15 minutes.

For children, involvement of the parents is crucial. We recommend that the parents attend the rehabilitation sessions, which occur several times a week, so that they can learn the technique thoroughly. When the speech therapist feels the exercises are properly performed, the sessions can be brought down to one per week then spaced further apart. The exercises must be continued long enough. A brief period of exercise will not provide satisfactory results in a patient whose muscles are immature or ineffective. Three to four months is a minimum. In sum, perseverance is essential, as well as active involvement of the therapist, patient, and parents if the patient is a young child.

INDICATIONS FOR EUSTACHIAN TUBE REHABILITATION THERAPY

ETRT aims to improve Eustachian tube patency. Therefore, it may be beneficial whenever symptoms occur as a result of impaired Eustachian tube patency. Improving the efficiency of the peritubal muscles exerts beneficial effects on the middle ear in all forms of obstructive Eustachian tube dysfunction.

- Soft palate defects constitute the best indication for ETRT. We believe that ETRT is indispensable in patients with cleft palate. The exercises can be easily combined with those aimed at improving velopharyngeal competence [21-22].

- A submucosal cleft in the soft palate may indicate deficiency of the muscles that open the Eustachian tube. This is an excellent indication for ETRT when the patient exhibits symptoms of Eustachian tube dysfunction. [23]

- Minor symptoms of Eustachian tube dysfunction during sport activities indicate a functional disorder with no structural soft palate defect. The contribution of muscle factors is difficult to evaluate in this situation. However, ETRT can help patients who experience pressure equalization difficulties during altitude changes, most notably air travel. Professional and recreational divers can benefit also. ETRT was first used in divers [7].

It should be born in mind that ETRT does not focus solely on improving the efficiency of the muscles that open the Eustachian tubes. Although poor muscle function is not the only factor in Eustachian tube dysfunction, middle ear ventilation is often felt to be the best approach, as shown by the fact that grommet insertion is the treatment of reference Thus, regarding middle ear disorders, ETRT can be recommended whenever improved middle ear ventilation is expected to exert therapeutic effects.

- Otitis media with effusion: ETRT can be used alone or in combination with medications [4, 11]. It can also be recommended when grommet insertion fails.

- Retraction pockets: the results are less dramatic because retraction pockets indicate a more advanced stage of Eustachian tube dysfunction. An effect of ETRT can be expected only if the pockets are still mobile [24].

- After surgery for cholesteatoma: ETRT can be used to prevent the development of a retraction pocket within the graft, which can lead to recurrent cholesteatoma formation by invagination, most notably in children. [24]

A history of petrous bone fracture contraindicates autoinsufflation maneuvers. All the other exercises can be performed. ETRT is neither effective nor useful in patients with patulous Eustachian tubes, in which obstruction plays no role.

RESULTS OF EUSTACHIAN TUBE REHABILITATION THERAPY

Most of the published data were obtained in pediatric patients who had OME. In a study of 86 patients, Jacobs [3] noted good results in 70% of cases, fair results in 14%, and complete failure in 7%. However, the methodology is flawed: the method used for outcome classification is not explained in detail, being merely described as dependent on the appearance of the tympanic membrane, the result of the Valsalva maneuver, impedancemetry data (tympanogram and stapedial reflexes), and audiometric Rinne tests (at 500, 1000, and 2000 Hz). In several patients, ETRT was successful after failure of repeated grommet insertion [3]. Gersdorff [10] et al. used the same method to investigate outcomes in 28 children and adults with OME. Tympanogram data

were used to assess the results. A number of reasons make the study difficult to interpret: no statistical tests were done, the patient group was heterogeneous, and several errors occurred in the reported numbers. Factors associated with good outcomes included age, motivation, collaboration, and compliance with the exercise regimen.

In a 5-month study, Deggouj et al. [4] separated 95 patients with OME into four groups based on whether they received ETRT and medications (a triprolidine hydrochloride plus pseudoephedrine hydrochloride combination and acetylcysteine). Recovery rates were 40% with ETRT only, 28% with medications only, and 60% with both. Although the study did not include statistical tests, Kouwen et al. recently revisited the data [11]. ETRT (with or without medications) was significantly more effective than no ETRT (with or without medications): the P value was 0.013 by a chi-square test with Yates' correction [11].

Kouwen et al. [11] conducted their own prospective randomized pilot study with a control group. Follow-up was 3 months, and outcomes were evaluated based on tympanogram data. The difference was not statistically significant (P=0.054) but the sample size was small (15 cases and 17 controls).

We evaluated the results of ETRT in our patients in 1995 [24]. All the patients were treated by the same speech therapist, who was involved in the study. We evaluated consecutive patients regardless of the reason for ETRT. Because the number of patients was large, we were unable to obtain control groups, and the amount of missing data was substantial. The age range was 4 to 15 years. The patients were separated into three groups according to whether ETRT was performed because of OME, retraction pockets, or cholesteatoma surgery.

1. OME: 152 patients were followed-up during ETRT for a mean of 5.2±1 months. Patients were included if the mean audiometric Rinne test result at 250, 500, 1000, and 2000 Hz was greater than 10 db. Patients were separated into two subgroups based on whether they had a history of surgery for OME (grommet with or without adenoidectomy). Of the 24 patients without prior surgery, 14 (58.3%) experienced a return to normal of the audiometric Rinne test (four-frequency mean≤10 db). Thus, ETRT obviated the need for grommet insertion in over half the cases. Of the 128 patients who underwent ETRT after grommet insertion (with or without adenoidectomy), 113 (88.3%) experienced a return to normal of the audiometric Rinne test. For comparison, the outcome of OME was spontaneously favorable in only 26% of patients after 6 months [25].

2. Retraction pockets: 59 children with retraction pockets stage I or II according to Sade [16] or stage I according to Charachon [27] were followed up for 2 years. At the end of the 2-year period, a repeat otomicroscopy evaluation was performed by the same person who evaluated the patients at baseline. The appearance of the tympanic membrane was normal in 21 (35.6%) patients.

3. Cholesteatoma surgery: 26 children underwent ETRT after cholesteatoma surgery. Follow-up duration was 2 years, during which retraction pocket development was noted in only 2 (7.7%) patients. In earlier studies, retraction pocket rates ranged from 20% to 36% [28-29] after surgery with connective tissue implantation, as in our patients (perichondrium).

The best predictors of successful ETRT seemed to be strong motivation and involvement of the parents. We found that good results were correlated to parental authority and the socioeconomic setting, with the best results occurring in children of teachers.

DISCUSSION

Although ETRT can produce good results, it has received little attention in the medical literature. The reasons deserve to be discussed. A low level of awareness of ETRT among otorhinolaryngologists, speech therapists, and physical therapists is an obvious obstacle. Time must be invested in learning and carrying out the exercises in order to ensure good compliance of the patient with this long-term treatment. Therapists may encounter difficulties in achieving proper exercise performance by the children and in obtaining strong support from the parents. In our experience, most children aged 7-8 years are capable of carrying out the exercises, and mature children as young as 5 years of age may perform them successfully. The initial level of commitment, most notably regarding time, is essential, as well as the ability of the therapist to convince the patient (and parents) of the need to perform the exercises regularly and as instructed. The tediousness of ETRT explains that either the therapist or the patient (and parents) may lose their motivation along the way.

ETRT has been used for more than a quarter of a century. It was introduced at a time when OME was believed to stem solely from tubal obstruction, the role for inflammation being largely unrecognized. The term

"physical therapy" is too narrow, as it suggests that only muscle strengthening is involved. ETRT uses a combination of methods to improve middle ear ventilation. Grommet insertion, which is the reference standard for OME, pursues the same objective. ETRT complements, rather than competes with, grommet insertion.

Autoinsufflation is only one of the three components of ETRT. When used alone, autoinsufflation can produce good results in the short term [5]. We believe that maintaining these benefits in the longer term requires not only repeated autoinsufflation, as suggested by Stangerup et al. [5], but also concomitant use of the other components of ETRT, namely, muscle strengthening exercises and improved nasal breathing.

None of the drugs used to treat chronic OME has been proved effective. The lack of effectiveness of antimicrobials, nonsteroidal antiinflammatory drugs, glucocorticoids, and fluidifiers is widely recognized [30]. Nasal hygiene to enhance ventilation is the only medical treatment that is universally considered effective. Nasal hygiene plays an important part in our ETRT program.

Critics of ETRT emphasize the lack of objective evaluations based on tympanometry or on visualization of the effusion by computed tomography [31] or magnetic resonance imaging [32]. Middle ear pressure can be measured [33] and could serve as an evaluation criterion in randomized trials [34]. We believe it is time to conduct a carefully designed study of ETRT, if possible in multiple centers [34].

ETRT is a noninvasive means of treating Eustachian tube dysfunction. Compared to grommet insertion, ETRT has the advantage of being absolutely safe [35]. The cost-effectiveness of ETRT deserves to be studied. ETRT is probably fairly inexpensive, since it relies chiefly on the personal efforts of the patient and family.

CONCLUSION

ETRT is a promising treatment tool that has received little research attention and is obviously rarely used. It is part of a sparsely equipped therapeutic armamentarium [36] and, in the current era of cost containment, holds potential as a complement to surgery. Furthermore, we believe that ETRT can often be recommended prior to surgery in patients who are free of risk factors for delayed speech development or poor school performance. When effective, ETRT may obviate the need for grommet insertion.

The techniques for performing the exercises are now well standardized. They should be taught by a speech therapist, who should then check regularly that they are properly performed. ETRT requires an investment in time and perseverance from all those involved.

Inadequate tube opening, most notably when muscle weakness may be a factor, is the indication of choice. Examples include cleft palate and submucosal soft-palate cleft. However, ETRT may be beneficial whenever improved middle ear ventilation is desirable, the most common situation being OME. Education of the parents is crucial, as the effectiveness of ETRT depends largely on the involvement of the parents.

The effectiveness of ETRT in the treatment of Eustachian tube dysfunction deserves to be investigated in carefully designed, vast, multicenter studies comparing outcomes with and without ETRT in several disorders, most notably OME.

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