

## Contemporary Management of Eustachian Tube Dysfunction: Balloon Eustachian Tuboplasty

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### Abstract

#### *Introduction*

Eustachian tube dysfunction is defined by symptoms and signs of pressure dysregulation in the middle ear. This can result in a sensation of aural fullness, popping and crackling sounds, ear discomfort, muffled hearing and tinnitus. We present our early experience with balloon eustachian tuboplasty.

#### *Methods*

Three patients underwent balloon eustachian tuboplasty. Patients were evaluated pre and post operatively using the Eustachian Tube Dysfunction Questionnaire (ETDQ-7).

#### *Results*

All patients underwent a technically successful operation under general anaesthetic. Pre and post-operative ETDQ-7 scores improved for all three patients at 6 week follow up. There was a mean improvement of ETDQ-7 scores of 76% at 6 weeks. There were no intraoperative complications.

#### *Discussion*

Balloon eustachian tuboplasty is a safe treatment that can be offered to select patients with chronic eustachian tube dysfunction.

### Introduction

Balloon eustachian tuboplasty (BET) is a treatment that can be offered to patients with eustachian tube dysfunction (ETD) refractory to medical management. The eustachian tube runs from the middle ear to the post nasal space and measures approximately 35mm. The portion of the tube closest to the middle ear lies within the temporal bone and thus has a bony wall, whereas the remainder of the tube is lined by soft tissue and cartilage. The eustachian tube has distinct functions; to equalise pressure and ventilate the middle ear,

provide mucociliary clearance of middle ear secretions and protection of the middle ear from sounds and pathogens within the nasopharynx.<sup>1</sup>

ETD is defined by symptoms and signs of pressure dysregulation in the middle ear including fullness, popping, discomfort, muffled hearing, or crackling. Clinical assessment is variable but generally includes detailed history, ETDQ7 score, otoscopy, tympanometry, audiometry and visualisation of the nasopharynx by flexible nasendoscopy. Acutely the eustachian tube can become blocked after an upper respiratory illness or allergic rhinitis, however if symptoms persist treatment may be necessary. Medical treatment includes nasal corticosteroids and decongestants. Patients may be advised to auto-inflate the eustachian tube by forced exhalation against a closed mouth and nose (Valsalva manoeuvre). In some cases ventilation tubes or grommets may be offered, however there is an associated risk of tympanic membrane perforation of 1-4%, and once the tube extrudes the issue can recur as no direct treatment to the eustachian tube has occurred. Balloon dilatation of the eustachian tube involves introducing a balloon mounted catheter into the eustachian tube and inflating to a pressure of 10-12 bars for two minutes. The aim of the procedure is to dilate the eustachian tube and improve its function. In the literature to date, outcome measures vary as per surgeons preference. We present the first Irish data on our early experience with BET.

## Methods

We introduced this procedure in our unit in July 2023. Five BET procedures were performed on three patients, two unilateral and one bilateral. All patients had a history of chronic ETD and were assessed pre and post operatively using the Eustachian Tube Dysfunction Questionnaire (ETDQ-7). All procedures were performed under general anaesthetic. The procedures were performed using a 0-degree rigid scope, locating the eustachian tube orifice in the nasopharynx and engaging it with an angled introducer. (*Figure 2*) The balloon mounted catheter was advanced through the angled introducer when no resistance is felt to approximately 20mm. The balloon was then inflated to 10 atmospheres using saline and held in place for two minutes. The balloon is then deflated and withdrawn from the eustachian tube under vision. (*Figure 3*) There were no immediate post-operative complications. Patients were discharged home the same day and reviewed in clinic 6 weeks post procedure. All patients were advised not to perform a valsalva for 48 hours, then to Valsalva five times per day for two week, followed by two to three times per day. Patients were also advised to administer betamethasone steroid drops intranasally.

## Results

Three patients underwent the procedure, all female with a mean age of 52 years. (*Table 1*) Patient 1 had multiple previous grommet insertions and associated Sade Grade 4 and Tos grade 3 tympanic membrane retraction, patient 2 had a single unilateral grommet in 2017 and patient 3 had no previous treatment. Pre operative tympanometry for patient 1 and 2 showed normal type A on the right side and type C on the left and type B on the right for patient 3. Pre operative ETDQ-7 scores were 44, 30 and 49. All patients had an improvement in their score at 6 week follow up. (*Table 1*). The mean ETDQ7 improvement was 76%.

## Discussion

The middle ear is an air filled space that lies within the temporal bone between the tympanic membrane laterally and osseous labyrinth medially. The eustachian tube (ET) functions to ventilate the middle ear, allow sound transmission via vibrating air particles and to equalise pressure across the tympanic membrane. The ET is approximately 35mm in length, runs downwards from the middle ear at a 45 degree angle and turns forwards and medially. The lateral one third is bony which joins a cartilaginous portion ending in the nasopharynx. The carotid canal lies medially on the bony portion of the ET. Peri-tubal muscles including the tensor palati, salpingopharyngeus and levator palati control the ET and follow the nasal cycle under tonic control. The ET is a dynamic structure and uncertainties still remain due to its complex anatomy and multiple functions.

ETD describes impairment of ET function leading to an array of symptoms and clinical findings. There are three main categories of ETD; obstructive, baro-challenge and patulous. Obstructive is due to structural or functional issues, patulous is due to an abnormally patent ET and baro-challenge is due to acute pressure changes such as airplane travel or scuba diving.<sup>2,3</sup> This paper focuses on obstructive ETD. Dysfunction may be acute, during an upper respiratory illness or allergies, or chronic where symptoms persist beyond three months. However it is a poorly defined condition that affects about 1 to 4.6% of the population.<sup>4,5</sup> In ETD where the middle ear is deprived of air, the stiffness of the system is changed which leads to low frequency hearing loss. With further progression fluid can accumulate in the middle ear which leads to high frequency hearing loss. ETD in adults is a distinct entity compared with children who have an inherent preponderance to developing ETD due to adenoidal hypertrophy, a developing ET and frequent respiratory illness. In adults mucosal inflammation within the cartilaginous ET is thought to be the most common cause of ETD. Patients should therefore be questioned regarding allergic rhinitis, chronic rhinosinusitis and laryngopharyngeal reflux symptoms.<sup>6,7</sup>

A large variety of tests and methods have been employed to assess ET function. However none alone are able to assess all aspects of ET physiology and pathology and there is currently no universally accepted functional test or symptom score. There is a varied presentation of ETD and many patient reported symptoms are non-specific which makes history taking difficult. Clinical assessment includes otoscopy with observed valsalva, audiological evaluation including tympanometry and assessment of the ET orifice with nasendoscopy. Radiological evaluation is not required unless an alternate diagnosis is suspected. Patient reported outcomes measures, although important, can be non-specific and have a low diagnostic yield. Given the low reliability of patient reported symptoms and variability of presentations there is a clear need for direct measures of ET function. A number of tests to assess the ventilatory function of the ET have been developed including tubomanometry, sonotubometry and pressure chamber tests.<sup>8</sup> Equipment for these tests are not widely available and are used mainly in research settings. Middle ear function can be assessed by impedance audiometry which measures compliance and pressure of the system by tympanometry. The Eustachian Tube Dysfunction Questionnaire (ETDQ-7) is a questionnaire that has undergone validation studies and scores ETD.<sup>9</sup> (*Table 2*) It is a useful and reliable scoring tool that can aid in diagnosis and treatment response. In summary the diagnosis of ETD is made through audiometry with tympanometry, patient reported symptoms and clinical examination.

Medical management consists of nasal corticosteroids and decongestants.<sup>10</sup> There is limited evidence for saline irrigation of the nose or mechanical inflation of the middle ear (Politzer maneuver).<sup>11</sup> A recent meta-analysis found intranasal corticosteroids ineffective for chronic ETD.<sup>12</sup> Grommet insertion may be offered, however tend to be less effective than in children.<sup>13</sup> Balloon eustachian tuboplasty (BET) involves dilatation of the cartilaginous portion of the ET. This surgical technique was developed simultaneously in Germany and USA in 2009.<sup>14, 15</sup> Research using cadavers suggests that the mucosal lining of the ET is compressed and the cartilage is fractured during BET.<sup>15</sup> It has also been hypothesised that patients with ETD have unhealthy mucosa lining the ET and BET may crush abnormal unhealthy mucosal leading to replacement with healthy tissue.<sup>16</sup> There have been many studies that have demonstrated its safety and short term efficacy, however despite its potential as a management strategy for chronic ETD many remain sceptical.<sup>17, 18</sup> A recent multicentre study of 248 patients with 12-24 month follow up found an improvement of 78–79% in the tympanogram, normalised otoscopy in 45–46%, effective Valsalva manoeuvre in 66–67% and a decrease in ETDQ-7 to normal values (10.5–12.3) after BET.<sup>19</sup> Reported complications following BET include surgical emphysema, patulous ET, minor bleeding and transient tinnitus.<sup>20</sup> Research in this area remains challenging due to a lack of gold standard test by which to measure ET function. More long term studies with uniform diagnostic and outcome

criteria as well as placebo controlled studies are required. National Institute for Health and Care Excellence (NICE) recommends that the procedure only be used in chronic ETD refractory to medical treatment and that there is little evidence for repeat procedures.<sup>21</sup>

We report the first data on short term BET outcomes in Ireland. Further high quality research is required to assess long term outcomes in these patients. However current evidence suggests it a safe and potentially effective treatment for chronic ETD.

#### **Declaration of Conflicts of Interest:**

None declared.

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Table 1: Patient Characteristics

	Age	Gender	Indication	Laterality	Previous Treatment	EDT-Q7 (day of surgery)	EDT-Q7 (6 weeks post op)	% change
<b>Patient 1</b>	45	F	Adhesive Otitis Media	Bilateral	Multiple previous grommets	44	30	31.8
<b>Patient 2</b>	42	F	ETD	Right	Left Grommet (2017)	30	0	100
<b>Patient 3</b>	70	F	Recurrent Middle Ear Effusion	Right	Nil	49	2	95.9

Table 2: ETDQ-7 Score

Over the past 1 month, how much has each of the following been a problem for you?	No problem		Moderate problem			Severe problem	
	1	2	3	4	5	6	7
1. Pressure in the ears?	1	2	3	4	5	6	7
2. Pain in the ears?	1	2	3	4	5	6	7
3. A feeling that your ears are clogged or 'under water'?	1	2	3	4	5	6	7
4. Ear symptoms when you have a cold or sinusitis?	1	2	3	4	5	6	7
5. Crackling or popping sounds in the ears?	1	2	3	4	5	6	7
6. Ringing in the ears?	1	2	3	4	5	6	7
7. A feeling that your hearing is muffled?	1	2	3	4	5	6	7

Figure 1: Otoscopic image of Patient 2 right ear showing a retracted pars tensa and flaccida as well as tympanosclerosis



Figure 2: Endoscopic image of the right ET orifice engaged by an angled introducer





*Figure 3: Endoscopic image of the right ET, with the catheter mounted balloon deflated and being withdrawn from the ET*







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