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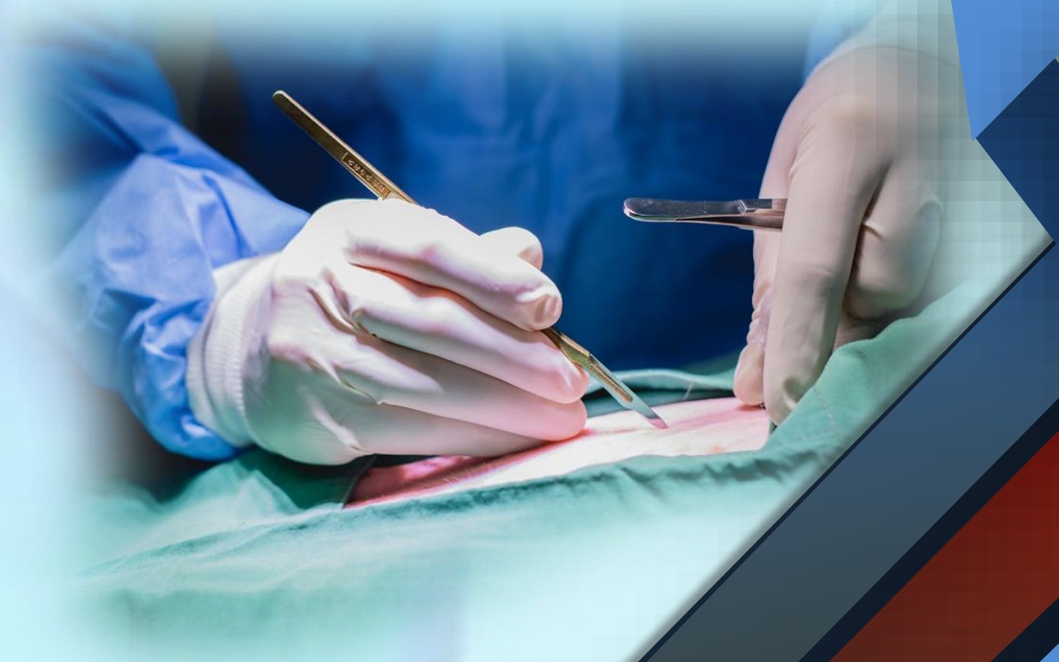

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Original article

Combined FESS and Eustachian Tube Balloon Dilatation Improve Eustachian Tube Functions in Patients having Chronic Rhinosinusitis with Nasal Polyposis and Eustachian Tube Dysfunction

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ABSTRACT

Background: Chronic rhinosinusitis [CRS] is a distressing disease that affects patients' mental and physical health. Eustachian tube dysfunction [ETD] affects approximately 1% of the adult population, especially patients with rhinosinus diseases. Transnasal Balloon Eustachian tuboplasty [BET] is a safe intervention for adult patients with chronic ETD.

Aim of the work: To evaluate the impact of combined Function endoscopic sinus surgery [FESS] for CRS and BET on ETD manifestations compared to FESS only.

Patients and Methods: 45 patients were randomly allocated into Group C underwent FESS, and Group-I underwent FESS and BET. ETD was evaluated using the 7-item Eustachian Tube Dysfunction Questionnaire [ETDQ-7] score, Otoscopy, Valsalva maneuver, and tympanometry. BET was performed using the XprESS ENT Dilation System with balloon inflation to 12 atmospheres for 2-min. Study outcomes were determined after 6-wk.

Results: At 6-wk, the frequency of normal TM position and positive Valsalva's maneuver was significantly higher, and ETDQ-7 scores were significantly improved in all patients, while the frequency of tympanogram type-A was significantly and non-significantly higher in groups I and C, respectively. ROC curve and Regression analyses defined the application of FESS with BET as the significant predictor for normalization of tympanogram to type-A.

Conclusion: Coupling Balloon Eustachian tuboplasty with Function endoscopic sinus surgery provided outcome more superior to Function endoscopic sinus surgery alone. Balloon Eustachian tuboplasty in experienced hands can be performed with a 100% technical success rate

Keywords: Chronic Rhinosinusitis; Eustachian tube dysfunction; Balloon dilatation; Function endoscopic sinus surgery; Eustachian Tube Dysfunction Questionnaire.

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* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

Chronic rhinosinusitis [CRS] with nasal polyps [CRSwNP] is a highly prevalent disease with a significant impact on patients' health and productivity and results in significant healthcare-related costs[1]. CRSwNP is a common hetero-morphic disease with uncertain pathophysiology[2] characterized by polyps rich in eosinophils [3].

Primary treatment modalities for CRSwNP include corticosteroids for their broad anti-inflammatory properties and antibiotics, which are effective in a certain subpopulation of patients, but the level of supporting evidence for the efficacy of medical treatment is generally low[4]. Biotherapeutics such as monoclonal antibodies directed against IgE, IL-5, and IL-4 receptor-α, blocking their activity, demonstrated efficacy in patients with NP with or without asthma [5] and may prove to be an important adjunct for patients with recalcitrant sinus disease [6].

Functional endoscopic sinus surgery [FESS] is the most common surgical technique used to treat CRSwNP, and significant data support its efficacy as a treatment modality[7]. FESS also improves CRS-induced complications, where FESS induces significant improvement in voice characteristics[8] and CRS patients' quality of life[9]. Thus, FESS could be considered as the standard care in medically recalcitrant CRS, and with extensive surgery, the sinus and nasal cavity become more interconnected and functionally interdependent with improved sinus ventilation [10].

Eustachian tube dysfunction [ETD] intends to describe a variety of signs, symptoms, and physical findings[11] that result from the impairment of opening and closure ET function[12]. ETD is considered a common cause of morbidity in adults and children[13] and affects approximately 1% of adults in the general population [14]. Chronic ETD may lead to recurrent or persistent otitis media with effusion[14] hearing loss, and temporary lag in speech development in children, tympanic membrane [TM] retraction, or even cholesteatoma[13]. Eustachian tube dysfunction is a comorbidity of CRS, and ETD symptoms are highly prevalent and more severe among patients with CRS than in ETD-patients who were free of CRS disease[15]. Moreover, the incidence of concurrent ETD symptoms was high in patients with severe CRS[16], and nasal polypectomy was found to be associated with an increased probability of post-FESS normalization and improvement of ETD symptoms[17]. The present study aimed to provide that improvements for manifestations of CRS and ETD by the application of both FESS and BET in the same setting more than FESS alone, and thus the applied procedure could be considered as cost-effective than the two-setting procedure.

AIM OF WORK

This study aimed to evaluate the impact of combined FESS and BET on ETD manifestations compared to FESS only.

PATIENTS AND METHODS

The current prospective comparative single-center clinical trial was conducted according to the conditions cited in the approval of the study protocol by the Local Ethical Committee, all patients presenting to the outpatient clinic of otorhino-laryngology at Al-Jafel Hospitals, Riyadh, KSA with symptoms suggestive of CRS with ETD since Jan 2017 till Jan 2019 were eligible for evaluation. Chronic rhinosinusitis was defined by the presence of ≥2 of its cardinal signs [EPOS definition], including facial pain/pressure, hyposmia/anosmia, nasal drainage, and nasal obstruction for at least 12 consecutive weeks with objective evidence obtained by anterior rhinoscopy, endoscopy, or sinus CT despite medical therapy for four weeks[18]. ETD was suspected on the presence of at least three symptoms, including ear pain and/or pressure, feeling of clogged ears, cracking or popping in ears, tinnitus or muffled hearing, and failed to respond or refractory to medical treatment for at least three months[19].

Patients eligible for evaluation were subjected to the determination of demographic data, general clinical data, and evaluation for inclusion and exclusion criteria. Exclusion criteria included patulous ET, ears tubes in place or an unhealed perforation, temporomandibular joint disorders; Meniere's disease; allergies, or reflux disease not controlled with medication. Patients with acute sinus disease, acute manifestations of ETD, cardiovascular disease, hypertension, bleeding diathesis and maintained on aspirin or other medications affecting coagulation system and

patients with kidney or liver dysfunctions, as well as anemia [Hb<10 g/dl] and body mass index [BMI]>30 kg/m^2 were also excluded from the study. All participants underwent a CT scan of temporal bones. Those who had anatomic conditions that would prevent transnasal access to the ET or carotid artery dehiscence were excluded from the study. Also, patients with a history of head or neck surgery within three months or who refused to sign the written fully informed consent were not eligible for the study inclusion.

Preoperative otorhinolaryngeal evaluation

A-**Assessment of CRS disease**

1. The SNOT-22 questionnaire, which is a validated, patient-reported outcome measure evaluating physical, functional, and emotional consequences of rhinosinusitis [20] and was calculated as the sum of scoring for each question and ranges between zero and 110 [Appendix 1] [21]. The SNOT-22 was also used to assess outcomes, and as previously documented, improvement of at least 8.9 points is considered a minimal clinically important difference [22].
2. Endoscopic evaluation of the extent of sinus disease using Lund & Kennedy[23] grading to bilaterally assess the presence and severity of edema, scarring and crusting of the nasal mucosa, discharge, and polyps and each item was scored by 0-2 [Appendix 2] and total score for both sides was calculated to give a score ranging between zero [0x5x2=0] and 20 [2x5x2=20] [24].
3. Paranasal sinuses CT scanning at both coronal and axial plans with continuous slices of 2.0 and 3.0 mm thickness and the resultant scans were graded according to Lund-Mackay[25] scale ranging between zero and two for each paranasal sinus depending on the level of opacification and the ostiomeatal complex with 0 indicates no obstruction and two indicates total obstruction. Both sides were evaluated to obtain a total score ranging between zero and 24 points.

B- **Assessment of ETD**

1. The 7-item Eustachian Tube Dysfunction Questionnaire [ETDQ-7] score, which is a validated and standardized questionnaire to assess ETD symptom severity [26] and a total score of 14 can be considered as no-to-mild ETD and was taken as a cutoff point for improvement with the lower the score, the more the improvement.
2. Pneumatic otoscopy for assessment of tympanic membrane position; normal or retracted.
3. Valsalva maneuver to assess if the patient was able to clear his ear [positive maneuver] or not [negative maneuver]
4. Tympanometry was performed, and the tympanogram type was reported.

Patients' inclusion & grouping

Patients who were free of exclusion criteria and had CRSwNP with ETDQ-7≥14 with retracted TM and negative Valsalva maneuver were included in the study. Patients were randomly allocated into two groups using sealed dark envelopes containing cards carrying the group label, prepared by an assistant who was blinded about the significance of the label, and envelopes were chosen by the patient him/herself. Study groups are the Intervention group [Group I] that included patients who will undergo FESS and BET and Control group [Group C], which had only FESS patients. All patients will be re-assessed after 2, 4, and 12-weeks after surgery for all the parameters evaluated preoperatively.

For patients of group I, after the end of FESS and assurance of hemostasis, balloon dilation was performed using the XprESS ENT Dilation System [Entellus Medical, Plymouth, MN]. The distal end of the device was characterized by the presence of atraumatic rounded ball tip to provide tactile feedback while accessing the ET and by being reshapable to allow treatment of a variety of patient anatomies. The intervention procedure was performed with the patient was in the supine position. To access the ET, the tip of the device was bent to form an angle of 45 degrees with the main device shaft with an angle head at the mark situated at 2-cm from the tip of the device; this bend allows a positive stop to ensure that the treatment area is confined to the cartilaginous portion of the ET. According to the requirement, the used balloon was

5-7 mm in diameter and 8-20 mm in length. The balloon was inserted through the nose into the orifice of ET and inflated to 12 atmospheres for 2-min and then was deflated and removed.

Sample calculation: Williams et al.[27] defined success as normalization of tympanogram and reported 30% success rate on balloon dilatation alone of 58 ET in comparison to no dilatation, irrespective of undergoing FESS or not; the current study supposed that combined FESS and BET allow approaching a success rate >30% of the number of normal tympanogram over that can be approached with FESS only. Thus, to achieve a study power of 85% with α value of 0.05 and β value of 0.2, the sample size was calculated to include 24 ears per group and to guard against dropout 30 ears per group were included in the study, irrespective of being uni-or bilateral in patients undergoing FESS.

Study outcomes

1. The primary outcome is determined objectively by evaluation of ET function using tympanogram and thus was defined as the significantly higher frequency of ears had tympanogram type-A determined at 6-wk follow-up visit in comparison to preoperative evaluation and in between both study groups.
2. Secondary outcome is defined as the improvement in 6-wk follow-up re-assessment of ETD-7 score, frequency of normal TM position, and positive Valsalva maneuver.

Statistical analysis: Obtained data were presented as mean±SD, numbers, and percentages. Results were analyzed using paired t-test, One-way ANOVA Test, and Chi-square test [X^2 test]. Possible relationships were investigated using Pearson linear regression analysis. Regression analysis [Stepwise method] and the receiver operating characteristic [ROC] curve analysis judged by the area under the curve [AUC] were used for stratification of studied parameters as specific predictors for the outcome. Statistical analysis was conducted using the IBM SPSS [Version 23, 2015; IBM, South Wacker Drive, Chicago, USA] for Windows statistical package. P-value <0.05 was considered statistically significant.

RESULTS

The study included 61 patients who were eligible for evaluation, but 45 patients were found to be fulfilling the inclusion criteria. Fifteen patients had bilateral ETD [n=30 ears] and 30 patients had unilateral ETD [n=30 ears] for a total number of 60 ears. Patients were randomly allocated into two groups equal regarding the number of ears to have BET intervention, so Group C included 23 patients; 7 patients had bilateral ETD, and 16 patients had unilateral ETD, and Group I included 22 patients; 8 had bilateral, and 14 had unilateral ETD [Figure 1]. There was non-significant [P>0.05] differences between enrolment data of patients of both groups [Table 1]. At time of enrollment, all patients had ETDQ-7 score >14 with a mean score of 22.5±5.1; range: 16-36 and non-significant [p=0.506] difference between both groups [22±4.9 & 23.5±5.8 for groups C & I, respectively]. Baseline ETDQ-7 score showed positive significant correlation with ETD bilaterality [r=0.379, p=0.010], SNOT-22 score [r=0.416, p=0.005], duration of disease [r=0.369, p=0.013] and endoscopic scoring [r=0.296, p=0.048], and showed positive non-significant correlation with CT sinus scoring [r=0.191, p=0.209]. At 6-week follow-up visit, subjective re-evaluation using ETDQ-7 showed significant improvement in scores of patients of both groups, in comparison to preoperative scores. Objectively, At 6-wk follow-up visit, the frequency of patients had normal TM position, and patients gave positive results on Valsalva's maneuver were significantly higher in comparison to preoperative evaluation of patients of both groups, while the frequency of patients who had tympanogram type-A was significantly higher among patients of group I, but was non-significantly higher among patients of group C.

Regarding the comparison between 6-wk follow-up evaluation of patients of both groups, follow-up ETDQ-7 scores were significantly [p=0.043] lower with significantly [p=0.0022] higher percentage of change among patients of group I in comparison to those of group C [Figure 2]. Seven patients still had ETDQ-7>14 with significantly [p=0.046] lower frequency among patients of group I. Moreover, the frequency of patients who had normal TM position, positive Valsalva's maneuver, and tympanogram type-A was significantly higher among patients of

group I [p=0.0368, 0.035 & 0.0327. All surgeries were conducted uneventfully without intraoperative complications or canceling for any case. Operative time for FESS showed a non-significant difference between both groups, while total theater time for patients of group I was significantly longer due to time consumed for BET. All patients showed improved SNOT-22 and endoscopic scoring at 6-m follow-up with a non-significant difference between patients [Table 3].

The development of tympanogram type-A at 6-wk follow-up showed a significant positive correlation with the application of FESS and BET procedures, while offered a significant negative correlation with at 6-wk ETDQ-7 and SNOT-22 scores and endoscopic sinus scoring. ROC curve analysis of these variables defined application of FESS and BET procedures and low SNOT-22 score at follow-up as significant predictors for having tympanogram type-A on objective examination [Table 3, Fig. 4]. Regression analysis of these variables defined the application of combined surgical procedure; FESS with BET as the significant predictor for PO normalization of tympanogram to type-A [β=0.377, p=0.011].

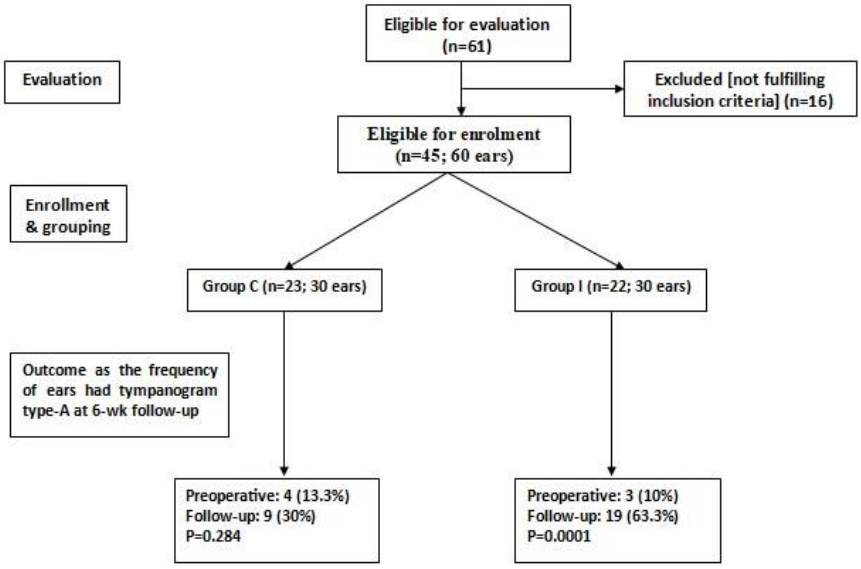

Figure 1: Consort Flow sheet

Table [1]: Demographic and clinical data of studied patients

Data		Group C [n=23]	Group I [n=22]	P-value
Age [years]		42±7	42.7±8.4	0.778
Sex; M:F		13:10	15:7	0.419
Body weight [kg]		83.2±3.7	84.5±5	0.369
Body height [cm]		170±4	170.9±3	0.413
Body mass index [kg/m^2]		28.8±0.7	28.9±1.2	0.681
Sinus-disease related data	Duration of symptoms [m]	9.6±1.6	10.2±1.9	0.778
	SNOT-22 score	59.7±5.9	62.9±5	0.056
	Endoscopic score	7.7±1.7	8.1±2.4	0.441
	CT score	10.3±3.4	9.7±2.7	0.503
Associated general conditions	Allergy	7 [30.4%]	5 [22.7%]	0.625
	GERD	5 [21.7%]	6 [27.3%]	
	Smoking	15 [65.2%]	9 [40.9%]	
	Adenoidectomy	10 [43.5%]	12 [54.5%]	
Laterality of ETD	Unilateral	16 [69.6%]	14 [63.6%]	0.673
	Bilateral	7 [30.4%]	8 [36.4%]	

Data are presented as mean±SD; SNOT-22: Sino-Nasal Outcome Test-22; ETD: Eustachian tube disease; P indicates the significance of the difference between both groups; p<0.05 indicates significant difference; p>0.05 indicates the non-significant difference

Table [2]: 6-wk follow-up evaluation of ET function of studied patients in comparison to preoperative evaluations

Parameter			Group C [n=23]	Group I [n=22]	P1 value
ETDQ-7 score	Preoperative		22±4.9	23.5±5.8	0.339
	Follow-up		12±3.8	10±2	0.043
	P2 value		<0.0001	<0.0001	
	% of change		46±10.4	56±10	0.0022
	Number [%] of patients had score >14		6 [26.1%]	1 [4.5%]	0.046
Otoscopic TM position	Preoperative	Normal	9 [30%]	6 [20%]	0.371
		Retracted	21 [70%]	24 [80%]	
	Follow-up	Normal	19 [63.3%]	26 [86.7%]	0.0368
		Retracted	11 [36.7%]	4 [13.3%]	
	P2 value		0.01	<0.0001	
Valsalva's maneuver	Preoperative	Positive	3 [10%]	4 [13.3%]	0.688
		Negative	27 [90%]	26 [86.7%]	
	Follow-up	Positive	14 [46.7%]	22 [73.3%]	0.035
		Negative	16 [53.3%]	8 [26.7%]	
	P2 value		0.002	<0.0001	
Tympanogram type	Preoperative	A	4 [13.3%]	3 [10%]	0.829
		B	9 [30%]	11 [36.7%]	
		C	17 [56.7%]	16 [53.3%]	
	Follow-up	A	9 [30%]	19 [63.3%]	0.0327
		B	8 [26.7%]	5 [16.7%]	
		C	13 [43.3%]	6 [20%]	
	P2 value		0.284	0.0001	

Data are presented as mean±SD; Group C: Control group; Group I: Intervention group; ETDQ: Eustachian tube disease questionnaire; TM: Tympanic membrane; P1 indicates the significance of the difference between both groups; P2 indicates the significance of the difference between preoperative and follow-up measurements; p<0.05 indicates significant difference; p>0.05 indicates the non-significant difference

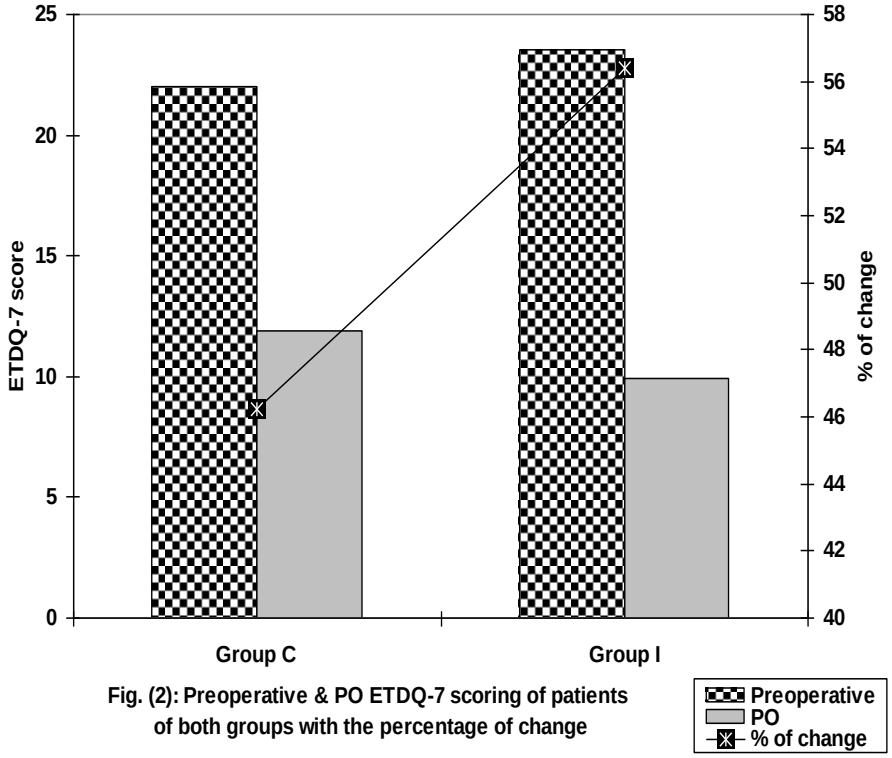

Fig. (2): Preoperative & PO ETDQ-7 scoring of patients of both groups with the percentage of change

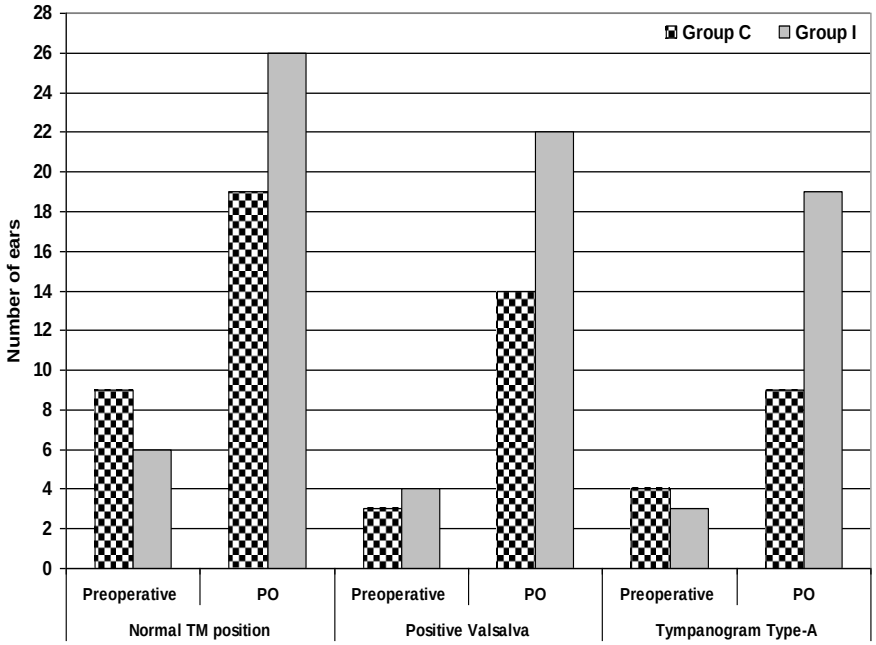

Fig. (3): 6-wk follow-up evaluation of ET function of patients of both groups in comparison to preoperative results

Table [3]: Operative and FESS postoperative data of studied patients

Variables		Group C [n=23]	Group I [n=22]	P-value
Operative time [min]		67.4±14.2	69.5±17.5	0.651
Theater time [min]			94.1±17	<0.001
SNOT-22 score	Preoperative	59.7±5.9	62.8±6.3	0.093
	Follow-up	27.7±5.7	25.5±6.2	0.235
	% of change	53.4±10 [95% CI: 49.313, 57.487]	58.9±11.3 [95% CI: 54.14, 63.66]	0.091
Endoscopic score	Preoperative	7.7±1.7	8.1±2.4	0.437
	Follow-up	4±1.3	3.5±1.3	0.207
	% of change	53.4±10 [95% CI: 41.03, 53.37]	58.9±11.3 [95% CI: 49.22, 62.18]	0.071

Data are presented as mean±SD; Group C: Control group; Group I: Intervention group; SNOT-22: Sino-Nasal Outcome Test-22; CI: Confidence interval; P indicates the significance of the difference between both groups; p<0.05 indicates significant difference; p>0.05 indicates the non-significant difference

DISCUSSION

Chronic rhinosinusitis [CRS], especially if associated with nasal polyposis [CRSwNP], can be considered one of the main etiopathogenic processes for ETD, evidenced by the reported correlation between preoperative ETDQ-7 score and SNOT-22 scores, endoscopic scores, and duration of sinus disease. These findings indicated the prevalence of ETD among CRS patients. They went in hand with previous literature that reported a high incidence of concurrent ETD symptoms in patients with severe CRS with a positive correlation between preoperative ETDQ-7 and SNOT 22 scores [28-30]. Recently, Chang et al.[30] reported ETD prevalence rate of 88%, 68%, and 48% in patients with recurrent acute RS, CRS without or with NP, respectively, and Wu et al.[31] also found a significant percentage of CRS patients suffer from ETD symptoms with a significant correlation between ETDQ-7 and total SNOT-22 score and concluded that otologic symptoms increase with CRS severity

Surgical management of CRS using FESS allowed significant improvement of ETDQ-7 scores

by a percentage of improvements correlated with that of postoperative [PO] improvements in SNOT-22 and endoscopic scorings. Moreover, patients who underwent FESS only showed a significantly higher frequency of ears with normal tympanic membrane position and positive Valsalva's maneuver, but non-significantly higher frequency of ears had tympanogram type-A in comparison to preoperative data. These results are in accordance with Maniakas et al.[28] who reported that ETD suggestive symptoms would decrease after FESS to a level comparable with a non-CRS population and with Bowles et al.[16], who also reported improved ETD symptoms following FESS with a significant increase of positive Valsalva and non-significant increase of Type A tympanogram at 9-m after FESS. Recently, Chang et al. [30] reported improvement of ETD manifestations in 89%, 78%, and 68% of patients with CRS without NP, recurrent acute RS and CRSwNP, respectively; at 6m after FESS and found ETD improvement after FESS was associated with higher preoperative ETDQ-7 and SNOT-22 scores. Also, Wu et al. [31] demonstrated significant improvement in ETDQ-7 scores after FESS.

Patients who had FESS and Balloon Eustachian Tuboplasty [BET] showed more superior outcomes than those with FESS only manifested as significantly higher frequency of patients with type-A tympanogram, normal TM position and positive Valsalva's maneuver in comparison to their preoperative and corresponding items of patients had FESS only. Moreover, patients had dual procedure [FESS and BET] showed significantly lower ETDQ-7 scores and higher percentage of change compared to patients of other group and only one patient still had ETDQ-7 score >14 versus 6 in the other group. These findings point to the efficacy of dual surgical procedures and to the superadded benefit of BET on the outcome of FESS for management of ETD. Similarly, Meyer et al. [32] reported improvements in the ETDQ-7 scores after balloon dilation and Jansen et al. [33] documented that ET balloon dilatation significantly reduced ET opening pressure with significant improvement in symptoms as judged subjectively by ETDQ-7.

Also, Froehlich et al. [34], out of a systematic literature review for the effectiveness of ET balloon dilation for treatment of ETD, reported significantly decreasing ETDQ-7 scores and improving tympanogram with normal otoscopic findings and positive Valsalva maneuver. Moreover, Alper et al. [35] evaluated ET's mechanical function in ETD patients after BET. They reported that ET became easier to open and stayed open longer time with decreased opening and closing pressures. The percentage of middle ear pressure gradient equilibrated with swallows improved significantly for both positive and negative pressures. In support of BET's efficacy for management of ETDQ-7, Meyer et al. [32] and Froehlich et al. [34] reported maintained improvement of ETDQ-7 after balloon dilation till 12-m post-procedure. Moreover, Cutler et al. [36] and Huang et al. [37] documented that balloon dilation results in durable improvements in symptoms and middle ear assessments for patients with persistent ETD at a mean follow-up of >2 years.

Regarding technical success, all trials for catheter insertion and ET dilatation were conducted successfully with a success rate of 100% with no dilatation-related complications, so balloon dilatation of ET can be considered safe, technically feasible, and effective for the management of ETD. Similarly, Meyer et al. [32] documented a technical success of 100%.

Moreover, Ungar et al.[38] assured the safety, feasibility, and accuracy of BET as a method for treating diving-induced ETD and documented that BET can significantly reduce symptoms ETDQ-7 score and pressure-equalizing sensation in all ears, and so enables patients to resume diving. Also, Choi et al.[39] concluded that Image-guided navigation balloon catheters are a potentially valuable tool, technically feasible and safe when performing BET to treat ETD and resulting in progressive decrease of ETDQ-7 scores with PO time of follow-up increase frequency of positive Valsalva maneuver at 6-m post-procedure.

Conclusion: FESS for CRS associated with ETD is an appropriate therapeutic modality resulting in short-term subjective and objective improvements of ET functions. Coupling BET with FESS for these patients provided outcome more

superior to FESS alone, and BET in experienced hands can be performed with 100% technical success rate and without post-procedure complications.

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None

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A: Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how 'bad' it is by circling the number that corresponds with how you feel using this scale ➔	**No problem**	**Very mild problem**	**Mild or slight problem**	**Moderate problem**	**Severe problem**	**Problem as bad as it can be**	
1. Need to blow nose	0	1	2	3	4	5	
2. Sneezing	0	1	2	3	4	5	
3. Runny nose	0	1	2	3	4	5	
4. Cough	0	1	2	3	4	5	
5. Post nasal discharge (dripping at the back of your nose)	0	1	2	3	4	5	
6. Thick nasal discharge	0	1	2	3	4	5	
7. Ear fullness	0	1	2	3	4	5	
8. Dizziness	0	1	2	3	4	5	
9. Ear pain	0	1	2	3	4	5	
10. Facial pain/pressure	0	1	2	3	4	5	
11. Difficulty falling asleep	0	1	2	3	4	5	
12. Waking up at night	0	1	2	3	4	5	
13. Lack of a good night's sleep	0	1	2	3	4	5	
14. Waking up tired	0	1	2	3	4	5	
15. Fatigue	0	1	2	3	4	5	
16. Reduced productivity	0	1	2	3	4	5	
17. Reduced concentration	0	1	2	3	4	5	
18. Frustrated/restless/ irritable	0	1	2	3	4	5	
19. Sad	0	1	2	3	4	5	
20. Embarrassed	0	1	2	3	4	5	
21. Sense of taste/smell	0	1	2	3	4	5	
22. Blockage/congestion of nose	0	1	2	3	4	5	
	TOTAL:	____	____	____	____	____	
						GRAND TOTAL:	

Appendix [1]: Snot-Nasal Test 22 questionnaire [Quoted from Kennedy et al. [21]]

Lund-Kennedy endoscopic grading system

Characteristics:	**Score definition**
Nasal polyps	0 = none; 1=confined to middle meatus; 2=beyond middle meatus
Discharge	0 = none; 1=clear and thin; 2=thick and purulent
Edema	0=absent; 1=mild; 2=severe
Scarring	0=absent; 1=mild; 2=severe
Crusting	0=absent; 1=mild; 2=severe

Appendix [2]: Lund-Kennedy endoscopic grading system [Quoted from DeConde et al. [24]

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