

A Comparative Study to Evaluate Eustachian Tube Dysfunction in Chronic Rhinosinusitis Patients before and after Functional Endoscopic Sinus Surgery

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Abstract

Background and Objective: Chronic rhinosinusitis (CRS) is a relatively common medical condition characterized by the inflammation of the nasal and sinus mucosa for more than 12-week duration. CRS has significant association with Eustachian tube dysfunction (ETD). Functional endoscopic sinus surgery (FESS) is considered the standard treatment for CRS, not responding to medical management. The improvement in sinonasal disease should benefit patients with coexisting ETD. The aim of this study is to assess the improvement in ETD in CRS patients using Eustachian tube dysfunction questionnaire-7 (ETDQ-7) and to determine the role of impedance audiometry in detecting ETD in these patients.

Methods: It is a prospective observational study of 35 patients with CRS with ETD who underwent FESS in the Department of ENT of our institution. Clinical examination, ETDQ-7 questionnaire assessment, and impedance audiometry were done before and after the surgery at 1 month and 3 months.

Results and Discussions: In our study, majority of the patients were in the age group of 41–50 years (42.9%). Males were 15 and females were 20. ETD assessment by ETDQ-7 questionnaire showed clinically and statistically significant improvement in the score from 20.7 ± 5.6 preoperatively to 11.1 ± 2.8 and 8.3 ± 1.6 at 1 month and 3 months after FESS. However, impedance audiometry was able to detect ETD only in 3 out of 35 patients, which is statistically insignificant.

Conclusion: FESS helps to improve the symptoms of ETD in CRS as evidenced by the ETDQ-7 score. Impedance audiometry can seldom diagnose ETD in these patients. Hence, FESS can be considered early for ETD in CRS refractory to medical treatment. Impedance audiometry cannot be considered a diagnostic tool in ETD.

Key words: Chronic rhinosinusitis, Eustachian tube dysfunction questionnaire-7, Eustachian tube dysfunction, Functional endoscopic sinus surgery

INTRODUCTION

Rhinosinusitis refers to a group of disorders, characterized by inflammation or infection of mucosa of both nose and the paranasal sinuses.^[1] Rhinosinusitis has been further

divided into acute and chronic based on the duration of symptoms. In acute rhinosinusitis, symptoms lasts for <12 weeks and in chronic rhinosinusitis (CRS) complaints last for more than 12 weeks.^[2] CRS affects approximately 5–15% of the general population. The prevalence of CRS was found to be 2–4%.^[3] CRS is divided into cases with polyps (CRSwNPs) and those without polyps (CRSsNPs) based on endoscopic findings.^[4] Chronic otologic complaints have been experienced by patients with CRS. Among those complaints, Eustachian tube dysfunction (ETD) being a common disorder.^[5] ETD is defined as the impairment of Eustachian tube function, leading to symptoms such as aural fullness, hearing loss, and

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autophony.^[4] Acute ETD can occur due to allergic rhinitis or common cold and is usually transient. Chronic ETD is defined as symptoms lasting for longer than 3 months.^[6] It can be due to obstruction or patulous Eustachian tube. ETD is diagnosed by reported clinical history, Eustachian tube dysfunction questionnaire-7 (ETDQ-7) and impedance audiometry. There is no reference (gold standard) method to diagnose ETD.^[7] One among the most common cause for obstructive ETD is the inflammation of mucosa caused by CRS.^[8] In patients with symptoms of CRS, ETD is never assessed. Symptoms can affect the quality of life of patients, resulting in work absenteeism, decreased social interaction, and hence need to be investigated further. There are reports indicating endoscopic sinus surgery can alleviate ETD associated with CRS, although it remains to be thoroughly studied.^[9] If functional endoscopic sinus surgery (FESS) improves the ear symptoms associated with CRS, it can definitely improve the quality of life of people.^[2] Hence, this comparative study give emphasis to how FESS affects the otologic symptoms associated with CRS with or without polyposis and further improvement in the quality of life. This is done by subjective evaluation of otologic symptoms associated with ETD before and after surgery and objective measurement using impedance audiometry.

METHODS

This study was conducted after procuring the approval of the institutional ethics committee, and written informed consent was obtained from all the patients included in the study.

Study Design

Prospective study (Pre- and Post-FESS comparison).

Study Setting

The study was conducted at the Department of Otorhinolaryngology of Sree Gokulam Medical College and Research Foundation, Venjaramoodu, Kerala, India.

Study Period

The study conducted between November 2020 and June 2022.

Study Population

Patient population was patients with CRS having otologic symptoms, undergoing FESS.

Sample Size

Sample size was obtained based on a previous study by Chang *et al.* in 2020 using SPSS software. The pre-test mean was 25.8 ± 8 and post-test mean was 16.8 ± 8.5 . The required sample size was $n = 35$.^[10]

Inclusion Criteria

Age: 20–50 years, duration of sinusitis >3 months, with or without polyposis, after giving maximum medical treatment, any one of the otologic symptoms such as ear block, ear fullness, hearing loss, otalgia, clicking/popping noises, and tinnitus.

Exclusion Criteria

Patients with a previous history of chronic suppurative otitis media, patients with benign or malignant nasal masses, patients with adenoid hypertrophy or nasopharyngeal masses, and history of ear or nasal surgeries.

Data Collection

A total of 35 participants who met the inclusion and exclusion criteria were enrolled into the study after taking their informed written consent. A questionnaire was given to evaluate the symptoms of CRS and otologic symptoms associated with ETD. Preoperatively, diagnostic nasal endoscopy and CT scan of the nose and paranasal sinuses were done in all the patients for the confirmation of diagnosis and to know the extent of disease. The diagnosis of ETD was done both clinically by examination, ETDQ-7 as well as by using impedance audiometry. From the ETDQ-7 questionnaire, a score of ≥ 14.5 is diagnostic of ETD. During impedance audiometry, a “C type” tympanogram was taken as significant. After appropriate preoperative investigations and pre-anesthetic checkup, FESS was done under general anesthesia. Routine postoperative care and follow-up were done. All patients were reviewed 1 month and 3 months after surgery to reassess the ETD using Valsalva maneuver, ETDQ-7, and impedance audiometry; the clinical examination was repeated, ETDQ-7 score and tympanogram was noted. The pre- and post-operative Eustachian tube functions were compared using Valsalva maneuver, ETDQ-7 score, and tympanogram; the subjective improvement in the symptoms was also assessed.

Statistical Analysis

Data will be entered in Microsoft Excel and analyzed using SPSS software; qualitative variables will be expressed in percentage and quantitative variables will be expressed as a mean (standard deviation) test will be used for testing the effectiveness of FESS on Eustachian tube function in CRS with ETD. $P < 0.05$ is considered statistically significant.

RESULTS

In our study, 35 patients of CRS with ETD, satisfying the inclusion and exclusion criteria were analyzed in the Department of ENT, Sree Gokulam Medical College and Research Foundation from November 2020 to June 2022.

Using a pro forma, detailed clinical evaluation was done, and the data were collected. The results of pre- and post-operative ETDQ-7 score and tympanogram were evaluated and compared.

Age and gender distribution among study participants (n=35)	
Age group	Frequency (%)
21-30	8 (22.9)
31-40	12 (34.3)
41-50	15 (42.9)
Sex	
Male	15 (42.9)
Female	20 (57.1)

Symptomatology	
Symptoms	Frequency (%)
Nasal obstruction	29 (82.9)
Headache	27 (77.1)
Facial pain	20 (57.1)
Post nasal discharge	27 (77.1)
Ear fullness	30 (85.7)
Ear pain	26 (74.3)
Ringing sensation in ears	18 (51.4)
Hard of hearing	13 (37.1)

All the symptoms were present for more than 3 months of duration. Hence, a diagnosis of CRS and ETD was made provisionally.

Tympanic membrane (TM) retraction

Preoperatively, Grade 1 TM retraction was present in 57.1% of patients, and 42.9% of patients had no TM retraction. Follow-up clinical examination was done at 3 months after surgery, which showed Grade 1 TM retraction was present only in 11.4% and 88.6% had no retraction.

The change in tympanic membrane retraction between Pre- and post-operative was statistically significant ($P < 0.05$)

Valsalva Maneuver

Preoperatively, only 37.1% of patients were able to show a positive Valsalva. Both clinically and statistically during 1 month and 3 months follow-up after surgery, 77.1% and 88.6 % of patients showed positive Valsalva, respectively.

The statistical analysis of Valsalva maneuver, pre- and post-FESS at 1 month and 3 months showed a $P < 0.001$ and < 0.01 , respectively, which is statistically significant.

Tympanogram

Among the 35 patients with significant symptoms of ETD, only three patients showed “C” curve on tympanogram, whereas the rest of them had “A” curve. On postoperative follow-up at 1 month and 3 months, there was a change in tympanogram pattern from “C” to “A” in 3 of the patients. The rest of the patients had same pattern of tympanogram.

Table 1: Pre- and post-operative TM retraction-test of significance

TM retraction preoperative	Postoperative		Total	McNemar test
	No retraction	Grade I		
No retraction	14	1	15	$P < 0.001$
Grade I	17	3	20	
Total	31	4	35	

TM: Tympanic membrane

Table 2: Pre- and post-FESS Valsalva manoeuvre - test of significance

	McNemar test
Preoperative versus postoperative 1 month	$P < 0.001$
Preoperative versus postoperative 3 months	$P < 0.01$

FESS: Functional endoscopic sinus surgery

Table 3: Statistical analysis of tympanogram

	Wilcoxon signed rank test
Preoperative versus postoperative 1 month	$P = 0.083$
Preoperative versus postoperative 3 months	$P = 0.083$

Table 4: Pre- and Post-operative ETDQ-7 score at 1 month and 3 months: Test of significance

	N	ETDQ-7				P
		Mean ± sd	Range	Median	IQR	
Pre op	35	20.7 ± 5.6	11 - 29	21	16 - 27	< 0.001
Post op at 1 month	35	11.1 ± 2.8	7 - 16	11	9 - 13	
Post op at 3 months	35	8.3 ± 1.6	7 - 12	7	7 - 10	

Table 5: Evaluation of ETDQ-7

		N	ETDQ -7 Pre-Op	p	ETDQ -7 Post OP 1 months	p	ETDQ-7 Post OP 3 months	p
			mean ± sd		mean ± sd		mean ± sd	
Pre op tm Retraction								
	NO RETRACTIO N	15	22 ± 5.6		12.1 ± 2.6		8.8 + 1.8	
	Grade I	20	19.8 ± 5.5	0.254	10.4 ± 2.8	0.071	8.1 + 1.5	0.18 1
Preop valsalva								
	Negative	22	24.3 ± 3.3		12.4 ± 2.6		8.8 + 1.8	
	Positive	13	14.7 ± 2.3	< 0.001	9 ± 1.6	< 0.001	7.6 + 1	0.03 3
Pre op Tympanogram								
	A curve	32	20.9 ± 5.8		11.1 ± 2.9		8.3 + 1.6	
	C curve	3	18.7 ± 2.5	0.508	11.3 ± 1.2	0.905	9 + 1.7	0.49 3

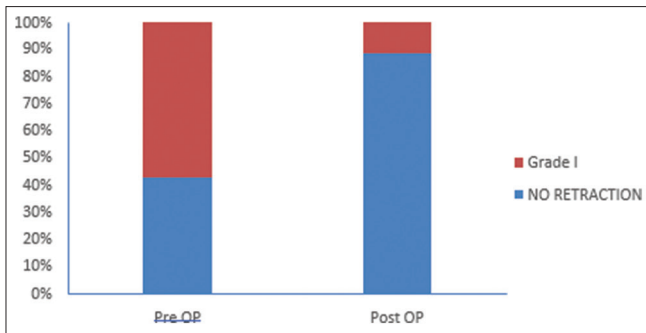


Figure 1: Percentage of pre- and post-operative tympanic membrane retraction

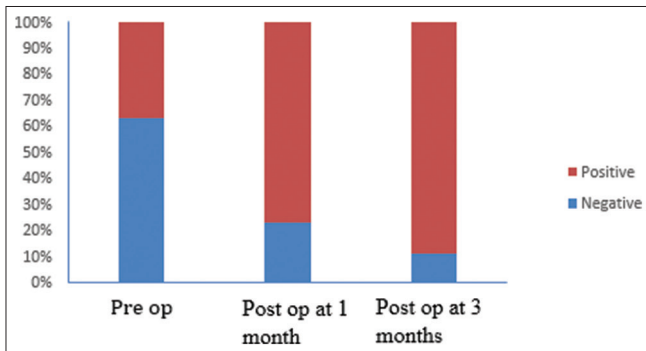


Figure 2: Percentage of positive and negative Valsalva pre- and post-functional endoscopic sinus surgery

On statistical analysis of tympanogram curves pre- and post-FESS, the $P = 0.083$, which is statistically insignificant.

Pre-op ETDQ-7 Score and Post-op ETDQ-7 Score at 1 Month and 3 Months

Assessment of ETD was done before surgery, which showed a mean ETDQ-7 score of 20.7 ± 5.6 . Follow-up assessment using ETDQ questionnaire at 1 month and 3 months after surgery showed a mean ETDQ-7 score of 11.1 ± 2.8 and 8.3 ± 1.6 , respectively. Here, $P < 0.001$. Hence, it is statistically significant [Figures 1 and 2] and [Tables 1-5].

DISCUSSION

Epidemiological studies show that the prevalence of CRS is about 5–12%.^[11] In a cross-sectional study conducted by Klossek *et al.*, the incidence of CRS was found to be 55% in females and 45% in males. In a study conducted by the European academy of allergy and clinical immunology and European rhinology society, it was found that, every 10th European is suffering from a chronic inflammation of nose and paranasal sinuses.^[12]

In patients with CRS, the presence of chronic otologic symptoms has frequently been described. ETD seems to be more prevalent in CRS patients than in general

population where only 1% is affected.^[6] This is based on the observation of clinical manifestations such as inability to maintain middle ear pressure, difficulty in performing Toynbee and Valsalva maneuver, and serous otitis media.^[5]

ETD can be diagnosed using a variety of clinical and paraclinical arguments, either individually or in combination by ETDQ-7 score, tympanometry, audiometry, sonomanometry, or by dynamic video-endoscopy of ET contraction. In a cross-sectional study conducted by McCoul *et al.*, it was found that ETDQ-7 score is a reliable and valid for diagnosis of ETD as this is a disease-specific symptom score assessment. In the same study, it was found that all the patients who met the criteria for ETD had an abnormal tympanogram.^[13]

In a case–control study conducted by Higgins *et al.*, 46% of patients with clinically significant pre-operative ETD showed statistical improvement follow FESS as evidenced by ETDQ-7 ($P < 0.001$).^[14] In a retrospective study conducted by Chang *et al.*, in 302 patients of CRS with ETD, there was a statistically significant improvement in ETD following 2 weeks after FESS ($P < 0.001$).^[15] Thus, the improvement in ETD following has been established by several studies. Doyle *et al.* in a study concluded that Valsalva maneuver had a sensitivity and specificity of 55% and 85% in detecting ETD using tympanometry.^[16] In a study conducted by Smith *et al.* found that no single test could be considered as the “gold standard” for the diagnosis of ET dysfunction, but combining the objective tests and patient-reported outcome measure improves the diagnostic accuracy.^[17]

In our study, we tried to evaluate the effect of surgical management of CRS in the improvement of ETD. A total of 35 patients with CRS with ETD were studied, and there was definite improvement in ETD following FESS as evaluated by pre- and post-operative ETDQ-7 score.

Majority of the patients fell in the age groups of 41–50 years (42.9%). The least number comes under the age group of 21–30 years (22.9%). Post-operative improvement was more with 21–30 age group, but it was not statistically significant. There were 15 males (42.9%) and 20 females (57.1%) in our study and the post-operative improvement in ETD was relatively same in both.

On evaluation of CRS symptoms, out of the 35 patients, 29 (82.9%) had nasal obstruction, 77.1% of patients had headache, 57.1% had facial pain, and 77% had postnasal discharge. The ETD symptoms were evaluated and 85.7% of patients had ear fullness, 74.3% of patients had ear pain, 51.4% of patients had ringing sensation in ears, and only 37.1% had hardness of hearing.

The medical comorbidities such as hypertension and diabetes mellitus had little bearing on the outcome.

The ETDQ-7 score of that category of patients with Pre-op TM retraction showed a definite improvement in the symptoms and ETDQ-7 score, but it was statistically insignificant. In those patients with pre-operative Valsalva was negative, showed improvement in ETDQ-7 score at 1 month and 3 months, which is statistically significant ($P < 0.001$).

In those patients with a definite ETD as evidenced by the ETDQ-7 score, the tympanogram showed a normal curve (A curve) in 32 patients and C curve in only rest of the 3 patients. On evaluation with ETDQ-7 score, this came to be statistically insignificant ($P > 0.05$). On contrary to our study, Chauhan *et al.* in his comparative study proved that in patients with ETD, tympanogram showed type A curve in only 36% of patients, type B curve was obtained in 36% of patients, and type C curve in 28% of patients. The statistical analysis revealed a significant difference ($P < 0.05$), and hence they proved that impedance audiometry can be used as a routine diagnostic test in ETD.^[18]

CONCLUSION

From our prospective study, it can be concluded that FESS helps in significant improvement in the ETD in CRS patients. The otologic symptoms in most of the patients had significantly improved as substantiated by the pre- and post-operative ETD Questionnaire-7 score. This can significantly benefit the patient in terms of morbidity and hence improve the quality of life. Hence, FESS needs to be considered early in cases of ETD in patients with CRS refractory to medical management.

However, the role of impedance audiometry in detecting true cases of ETD in CRS patients was proved to be insignificant as evidenced by the tympanogram.

This is one of the few prospective patient studies, evaluating otologic symptoms in CRS patients and their improvement postoperatively. Further studies with large sample size are required to evaluate the associated factors which help the symptomatic improvement of ETD.

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