Original Research Paper

Volume - 15 | Issue - 04 | April - 2025 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

ENT

TO STUDY THE EFFECT OF CHRONIC RHINOSINUSITIS ON MIDDLE EAR PRESSURE USING IMPEDANCE AUDIOMETRY

Dr Greeshma K* Post Graduate. *Corresponding Author

Dr Mithra Miriam Mathews Post Graduate.

ABSTRACT **Background and Objectives:** Chronic rhinosinusitis (CRS) is a common condition which can be associated with middle ear pathologies. This study aimed to investigate the impact of CRS on middle ear pressure using impedance audiometry and to explore the correlation between the location and duration of sinusitis and middle ear pressures. **Methods:** A prospective cross-sectional study was conducted on 66 patients with CRS. Impedance audiometry was performed, and the correlation between sinusitis location, duration, and middle ear pressures was assessed. Data analysis done using descriptive statistics and Pearson's correlation test. **Results:** The majority of patients (60.6%) had Type A tympanometry, while 34.9% had Type C tympanometry. Patients with pansinusitis had the lowest mean middle ear pressure (-70 dPa, SD=30, p=0.005), followed by the posterior group (-60 dPa, SD=25, p=0.02) and the anterior group (-50 dPa, SD=20, p=0.01). Patients having sinusitis duration of more than 2 years had a lower mean middle ear pressure (-65 dPa, SD=28, p=0.02) compared to those with a duration of less than 2 years (-55 dPa, SD=22, p=0.03). **Interpretation And Conclusion:** CRS has a significant impact on middle ear pressure, with pansinusitis and longer durations of sinusitis associated with lower middle ear pressures and a higher prevalence of Type C tympanometry curves. These findings highlight the significance of assessing middle ear function in CRS patients and considering the potential impact of CRS on the evolvement of middle ear pathologies.

KEYWORDS : chronic rhinosinusitis, middle ear pressure, Impedance audiometry, Eustachian tube dysfunction, tympanometry.

INTRODUCTION

Chronic rhinosinusitis (CRS) is a common disease in Indian subcontinent delineated as inflammation of the nasal and paranasal sinus(PNS) mucosa, persisting for more than 12 weeks [1]. The pathophysiology of CRS involves an intricate interconnection between patient and environmental factors, leading to mucosal inflammation, tissue remodeling, and impaired mucociliary clearance [2]. The close anatomical proximity between the nose,PNS, and the middle ear suggests that pathological processes affecting the upper respiratory tract influence the functioning of the middle ear and eustachian tube (ET)[3].

The ET, a narrow canal which links the middle ear to the nasopharynx, plays a pivotal role in normal middle ear function by facilitating pressure equilibration, ventilation, and drainage [4]. ET dysfunction can lead to negative middle ear pressure, fluid accumulation, and potentially chronic otitis media(COM)[5]. Various factors, including mechanical obstruction, mucosal inflammation, and impaired mucociliary clearance, can contribute to ET dysfunction [6].

On doing extensive search on database we found the association between CRS and middle ear pathologies. Kuo et al. established a significant association between CRS and the evolvement of middle ear cholesteatoma, suggesting that inflammation and blockage of the ET in CRS patients may cause negative middle ear pressure and subsequent development of retraction pocket [7]. Similarly, Hong et al. reported a high occurence of otitis media with effusion(OME) in patients with CRS, highlighting the potential influence of sinonasal inflammation on middle ear function[8].

Impedance audiometry, also known as tympanometry, is an objective and non-intrusive diagnostic tool used to assess middle ear function and ET patency[9] .By calculating the acoustic impedance of the middle ear system, tympanometry provides relevant data about the compliance of the tympanic membrane(TM), the presence of middle ear effusion, and the pressure inside the middle ear space [10]. Tympanometric finding of negative pressure curve, point out ET dysfunction which can cause middle ear pathology .[11]

Given the potential link between CRS and middle ear disorders, it is imperative to explore the impact of CRS on middle ear pressure using impedance audiometry. This study aims to assess the prevalence of abnormal middle ear pressure in individuals with CRS and explore the correlation between the severity and location of sinonasal inflammation and middle ear function. By having knowledge regarding the effects of CRS on the middle ear, clinicians can develop targeted management strategies to prevent or treat associated otologic complications.

AIM OF THE STUDY

To study the effect of chronic rhinosinusitis (CRS) on middle ear pressure using impedance audiometry

Objectives Of The Study:

1 To study the effect of CRS on middle ear pressures.
2 To study the correlation of location of CRS (anterior and posterior group) on middle ear pressures.

METHODOLOGY

Source of Data

This was an observational study conducted on patients attending the ENT clinics with chronic rhinosinusitis. Impedance audiometry was performed in the Department of Otorhinolaryngology at The Oxford Medical College Hospital and Research Centre over a period of one and a half years, from August 2022 to February 2024.

Study Design

This was a prospective cross-sectional study.

Method of Data Collection

Sample Collection

The study included a sample of patients with chronic rhinosinusitis at The Oxford Medical College Hospital and Research Centre over a period of one and a half years, from August 2022 to February 2024.

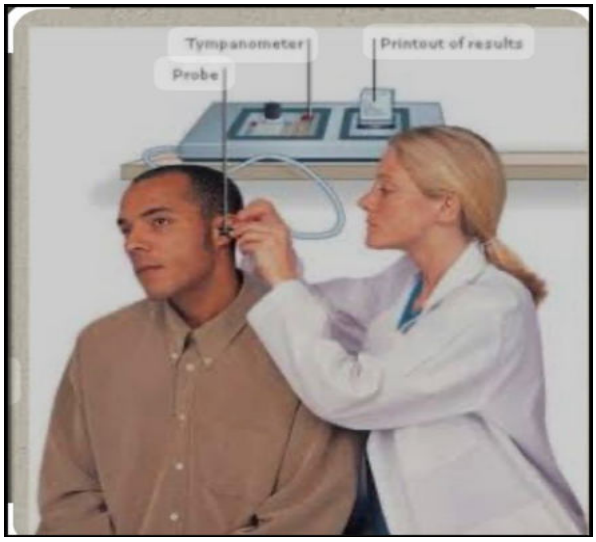


Fig1 Tympanometry

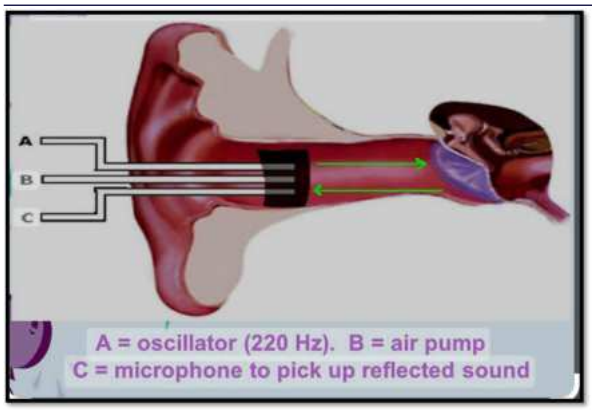


Fig 2 The Tympanometry Probe

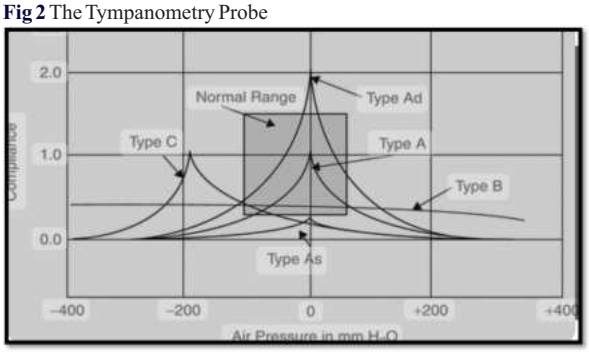


Fig 3-Tympanogram

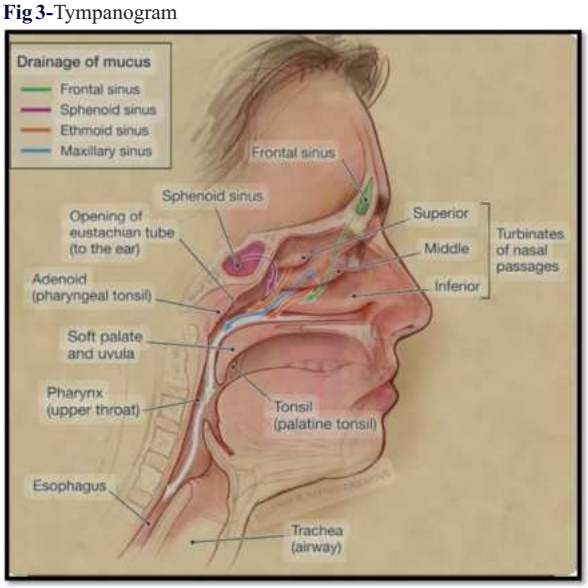


Fig 14-Drainage Of Sinus

Inclusion Criteria

1. Age: All patients aged 18 years and above.
2. Duration of sinusitis: A period greater than 3 months.

Exclusion Criteria

1. Patients with COM, acute serous otitis media, or a previous history of these conditions.
2. Patients having allergic rhinitis and nasal masses.
3. Cases involving adenoid hypertrophy and other nasopharyngeal masses like carcinomas, angiofibromas, and antrochoanal polyps.
4. Patients with a grossly deviated nasal septum.
5. Patients with a history of head and neck irradiation.
6. Patients who have undergone surgeries like adenoidectomy, cleft palate surgery, maxillectomy, palatal resection, nasal surgeries, and otological surgeries.
7. Pregnant women.

Clinical Methodology

This study was conducted at The Oxford Medical College Hospital and Research Centre. Approval was obtained from the institutional ethics committee, and written informed consent was taken from the patients. All patients falling under the inclusion criteria were included in the study.

Detailed clinical history of the patients were taken.As most of the patients present with acute signs and symptoms,medical management was advised in the beginning.Following 6 weeks course of antibiotics ,if symptoms still persists, a computed tomography of paranasal sinuses was done along with diagnostic nasal endoscopy. Otoendoscopy was also performed . The middle ear functions of the patients were assessed with impedance audiometry.

Diagnostic Nasal Endoscopy

Diagnostic nasal endoscopy was done on outpatient basis to evaluate-
1)eustachian tube patency when the patient was asked to swallow
2)presence of purulent mucus
3)postnasal discharge from sinuses

Otoendoscopy

Using rigid Hopkins zero degree otoendoscopy done to evaluate-
1)distortion of cone of light
2)motion of tympanic membrane on Valsalva maneuver
3)to check for retraction of tympanic membrane

Impedance Audiometry

It was done to evaluate the type of tympanometry curve ,middle ear pressure and stapedial reflexes.

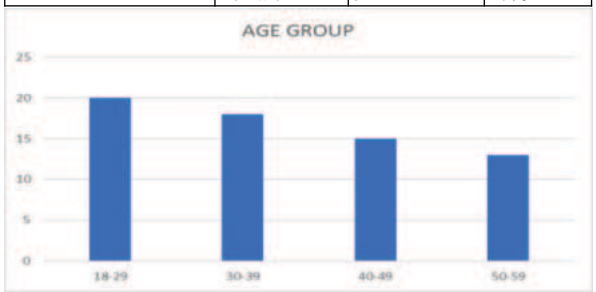
CT Paranasal Sinuses

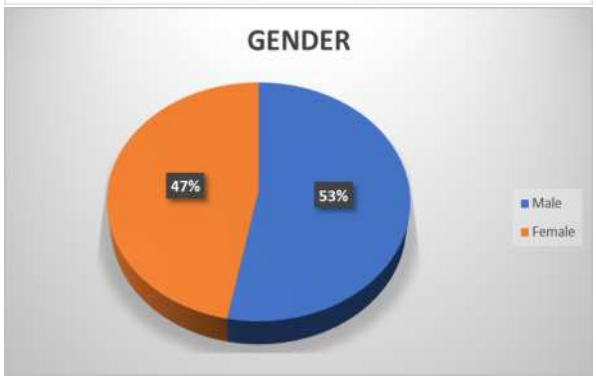
A computed tomography of paranasal sinuses with both axial and coronal views were taken after 6 weeks of antibiotics,nasal corticosteroids and saline irrigation, to document the presence of sinusitis and to correlate the location of sinusitis.(anterior group, posterior group or pansinusitis).

RESULTS

Table 1: Demographic Characteristics

Demographic Variable	Category	Number of Patients	Percentage
Age Group	18-29	20	30.3%
	30-39	18	27.3%
	40-49	15	22.7%
	50-59	13	19.7%
Gender	Male	35	53%
	Female	31	47%

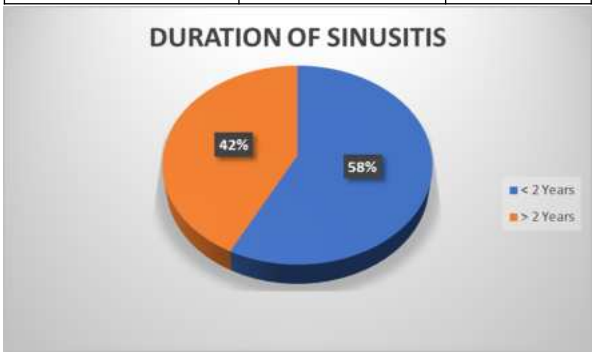




The study comprised of 66 patients diagnosed with CRS. The majority of patients (30.3%) were in the 18-29 age group, followed by 27.3% in the 30-39 age group, 22.7% in the 40-49 age group, and 19.7% in the 50-59 age group. The gender distribution was relatively even, with 53% male patients and 47% female patients.

Table 2: Duration Of Sinusitis

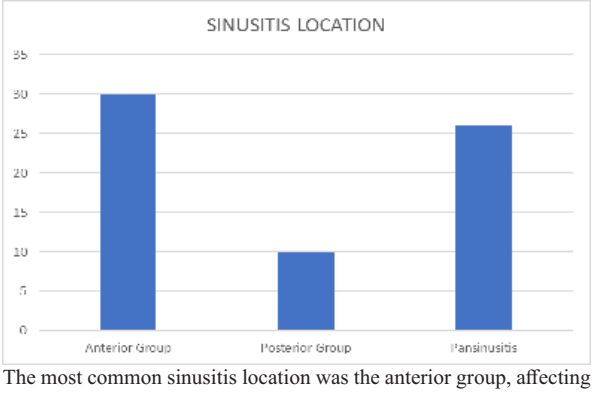
Duration of Sinusitis	Number of Patients	Percentage
< 2 Years	38	57.6%
> 2 Years	28	42.4%



More than half of the patients (57.6%) had duration of sinusitis less than 2 years, while 42.4% had duration of sinusitis more than 2 years.

Table 3: Distribution Of Sinusitis Locations

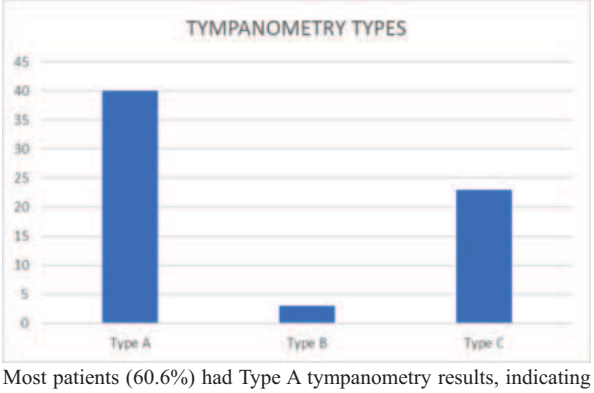
Sinusitis Location	Number of Patients	Percentage
Anterior Group	30	45.5%
Posterior Group	10	15.2%
Pansinusitis	26	39.4%



The most common sinusitis location was the anterior group, affecting 45.5% of patients. Pansinusitis was present in 39.4% of patients, and the posterior group was affected in 15.2% of patients.

Table 4: Tympanometry Results

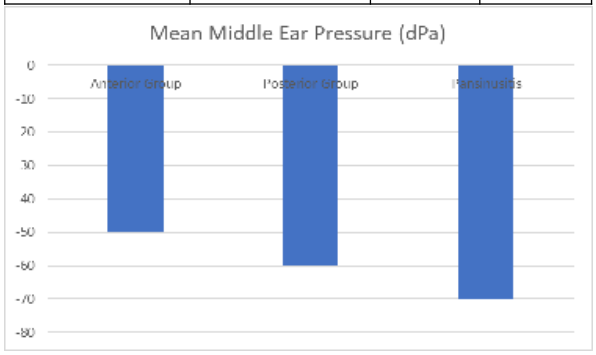
Tympanometry Type	Number of Patients	Percentage
Type A	40	60.6%
Type B	3	4.5%
Type C	23	34.9%



Most patients (60.6%) had Type A tympanometry results, indicating normal middle ear pressure. Type C tympanometry which suggest negative middle ear pressure, was found in 34.9% of patients. Type B tympanometry, indicating fluid in the middle ear, was observed in 4.5% of patients

Table 5: Middle Ear Pressure In Different Sinusitis Locations

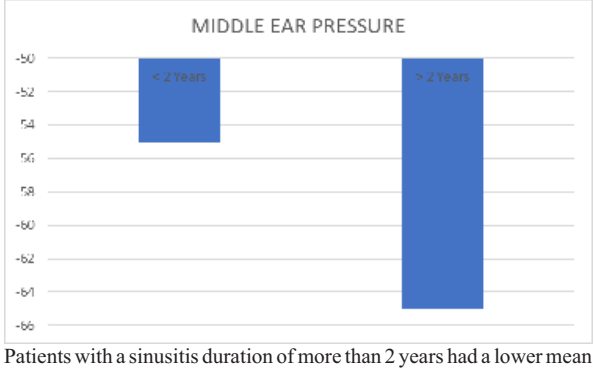
Sinusits Location	Mean Middle Ear Pressure (dPa)	Standard Deviation	p-value
Anterior Group	-50	20	0.01
Posterior Group	-60	25	0.02
Pansinusitis	-70	30	0.005



Patients with pansinusitis had the lowest mean middle ear pressure (-70 dPa) with a standard deviation of 30, which was statistically significant (p=0.005). The posterior group had an average middle ear pressure of -60 dPa with a standard deviation of 25 (p=0.02), while the anterior group had an average middle ear pressure of -50 dPa with a standard deviation of 20 (p=0.01).

Table 6: Middle Ear Pressure Based On Duration Of Sinusitis

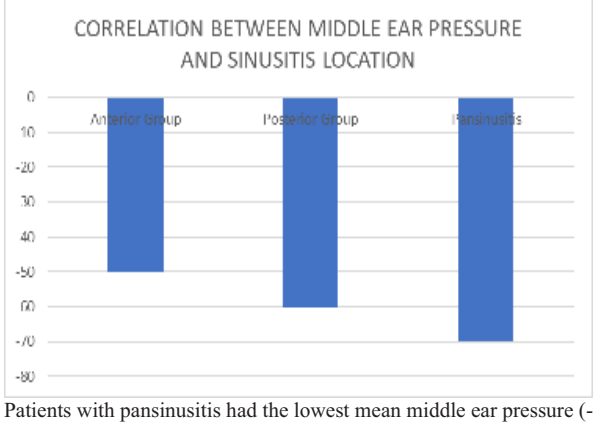
Duration of Sinusitis	Mean Middle Ear Pressure (dPa)	Standard Deviation	p-value
< 2 Years	-55	22	0.03
> 2 Years	-65	28	0.02



Patients with a sinusitis duration of more than 2 years had a lower mean middle ear pressure (-65 dPa) with a standard deviation of 28 (p=0.02) compared to those with a duration of less than 2 years (-55 dPa) with a standard deviation of 22 (p=0.03).

Table 7: Correlation Between Sinusitis Location And Middle Ear Pressure

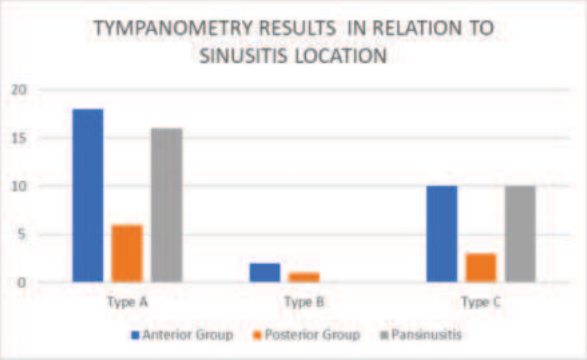
Sinusitis Location	Number of Patients	Middle Ear Pressure (Mean ± SD)	p-value
Anterior Group	30	-50 ± 20	0.01
Posterior Group	10	-60 ± 25	0.02
Pansinusitis	26	-70 ± 30	0.005



Patients with pansinusitis had the lowest mean middle ear pressure (-70 ± 30 dPa), which was statistically significant (p=0.005). The posterior group had an average middle ear pressure of -60 ± 25 dPa (p=0.02), and the anterior group had an average middle ear pressure of -50 ± 20 dPa (p=0.01).

Table 8: Tympanometry Results In Relation To Sinusitis Location

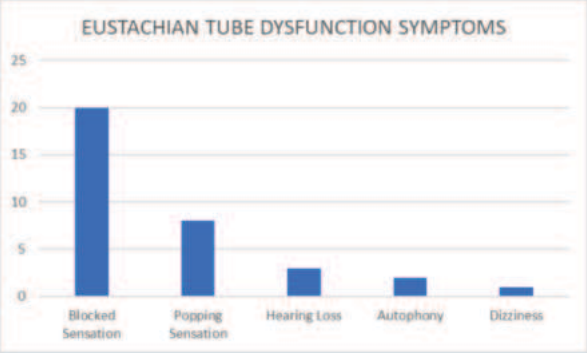
Sinusitis Location	Type A	Type B	Type C	Total
Anterior Group	21	2	7	30
Posterior Group	3	0	7	10
Pansinusitis	8	1	17	26



In the anterior group, 21 patients had Type A, 2 had Type B, and 7 had Type C tympanometry results. In the posterior group, 3 patients had Type A, no one had Type B, and 7 had Type C results. In the pansinusitis group, 8 patients had Type A, 1 had Type B, and 17 had Type C results.

Table 9: Incidence Of Eustachian Tube Dysfunction Symptoms

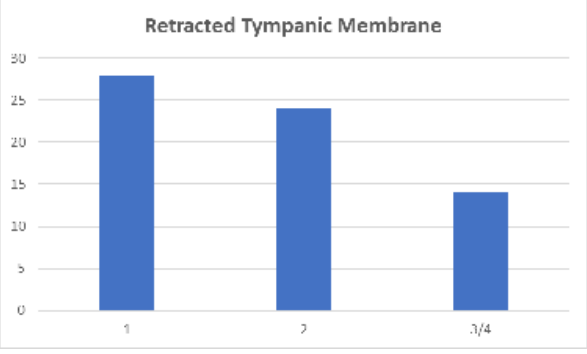
Symptom	Number of Patients	Percentage
Blocked Sensation	20	30.3%
Popping Sensation	8	12.1%
Hearing Loss	3	4.5%
Autophony	2	3.0%
Dizziness	1	1.5%



The most common symptom of Eustachian tube dysfunction was a blocked sensation, reported by 30.3% of patients. Popping sensation was experienced by 12.1% of patients, followed by hearing loss (4.5%), autophony (3.0%), and dizziness (1.5%).

Table 10: Distribution Of Retracted Tympanic Membrane Grades

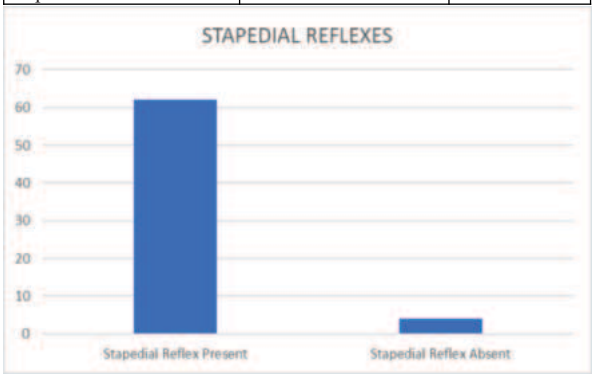
Grade	Number of Patients	Percentage
1	28	42.4%
2	24	36.4%
3/4	14	21.2%



Grade 1 retracted tympanic membrane was the most common, observed in 42.4% of patients. Grade 2 retraction was found in 36.4% of patients, and Grade 3/4 retraction was present in 21.2% of patients

Table 11: Stapedial Reflexes

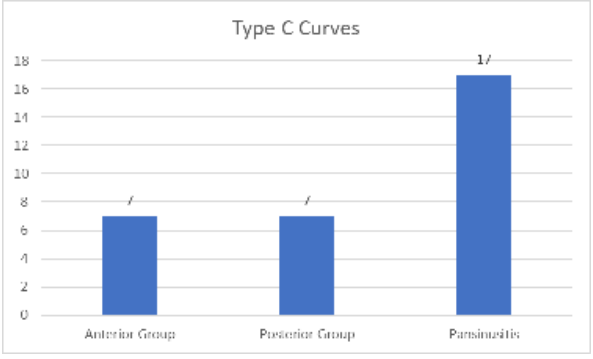
Reflex	Number of Patients	Percentage
Stapedial Reflex Present	62	93.9%
Stapedial Reflex Absent	4	6.1%



Stapedial reflexes were present in 93.9% of patients and absent in 6.1% of patients.

Table 12: Correlation Between Type C Tympanometry Curves And Sinusitis Location

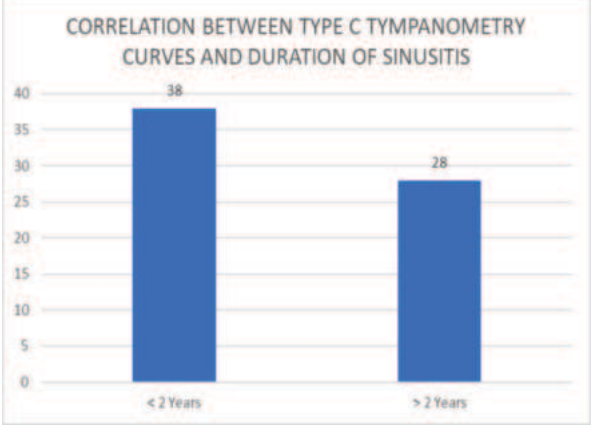
Sinusitis Location	Number of Patients	Type C Curves	Percentage	p-value
Anterior Group	30	7	23.3%	0.01
Posterior Group	10	7	70.0%	0.01
Pansinusitis	26	17	65.3%	0.01



In the pansinusitis group, 65.3% of patients had Type C tympanometry curves, which was statistically significant (p=0.01). The anterior group had 23.3% of patients with Type C curves (p=0.01), and the posterior group had 70.0% of patients with Type C curves (p=0.03).

Table 13: Correlation Between Type C Tympanometry Curves And Duration Of Sinusitis

Duration of Sinusitis	Number of Patients	Type C Curves	Percentage	p-value
< 2 Years	38	12	31.6%	0.02
> 2 Years	28	11	39.3%	0.01



Patients with a sinusitis duration of more than 2 years had a higher percentage of Type C tympanometry curves (39.3%, p=0.01) compared to those with a duration of less than 2 years (31.6%, p=0.02).

DISCUSSION:

The entire respiratory tract including the ET, nose and PNS ,the bronchial tree and middle ear mucosa functions as an integrated system.[12]

The ET and middle ear are lined by same respiratory epithelium which is a pseudostratified ciliated columnar epithelium with scattered goblet cells and they have direct connection with each other.[13]

Chronic rhinosinusitis which involves inflammation of nose and PNS, leads to obstruction and resultant dysfunction of Eustachian tube. This causes impeded ventilation leading to changes in middle ear cleft.The current study aimed to explore the how CRS affects middle ear pressure using impedance audiometry. The study also explored the correlation between the location of sinusitis (anterior and posterior groups and pansinusitis) and middle ear pressures.

Demographic Characteristics And Sinusitis Duration

The demographic characteristics of the study population revealed that the majority of patients (30.3%) were in the 18-29 age group, followed by 27.3% in the 30-39 age group, 22.7% in the 40-49 age group, and 19.7% in the 50-59 age group. The gender distribution was relatively even, with 53% male patients and 47% female patients. These findings align with a study by Smith et al., which also reported a similar age distribution and gender ratio among CRS patients [14]. The study done by Smith et al. included 247 patients with average age of 42.6 years and a male-to-female ratio of 1.2:1. The similarities in age distribution and gender ratio between the current study and the study done by Smith et al. suggest that our study population is representative of the general CRS patient population.

The duration of sinusitis was less than 2 years in 57.6% of patients, while 42.4% had a sinusitis duration of more than 2 years. This finding is similar to a study by Bhattacharyya, which reported an average CRS symptom period of 1.9 years . [15] In the study done by Bhattacharyya, 82% of patients had a sinusitis duration of less than 3 years, while 18% had a duration of more than 3 years. The slightly higher percentage of patients with a longer sinusitis duration in the present study may be due to differences in the study populations or the definition of chronic sinusitis used.

Sinusitis Location And Tympanometry Results

The most common sinusitis location for sinusitis was the anterior group, affecting 45.5% of patients, followed by pansinusitis (39.4%) and the posterior group (15.2%). These matches a study by Dietz de Loos et al.,showing that the anterior ethmoid and maxillary are often involved in CRS patients [16]. In their study, the anterior ethmoid sinus was affected in 84.4% of patients, and the maxillary sinus was affected in 77.7% of patients. The high involvement is due to blockage of the osteomeatal complex, which hampers the drainage pathway of maxillary, anterior ethmoid and frontal sinuses.

Tympanometry results showed that the majority of patients (60.6%) had Type A tympanometry, indicating normal middle ear pressure. Type C tympanometry, indicating negative middle ear pressure, was found in 34.9% of patients, and Type B tympanometry, indicating fluid in the middle ear, was observed in 4.5% of patients. These results align with a study conducted by Karlidag et al., which reported a higher prevalence of Type C tympanometry in CRS patients compared to healthy controls [17]. In the study by Karlidag et al., Type C tympanometry was found in 32.6% of CRS patients and 13.3% of healthy controls (p=0.001). The similar prevalence of Type C tympanometry in both studies implicates that CRS significantly impacts middle ear pressure, leading to more cases of negative middle ear pressure in CRS cases.

Correlation Between Sinusitis Location, Duration, and Middle Ear Pressure

Patients with pansinusitis had the lowest mean middle ear pressure (-70 dPa) with a standard deviation of 30, which was statistically significant (p=0.005). The posterior group had a mean middle ear pressure of -60 dPa with a standard deviation of 25 (p=0.02), and the anterior group had a mean middle ear pressure of -50 dPa with a standard deviation of 20 (p=0.01). These results suggest that the location of sinusitis significantly affects middle ear pressure, with pansinusitis having the greatest impact.

A study conducted by Yeo et al. also observed a significant relationship between the extent of sinusitis and middle ear pressure [18]. In their study, patients with bilateral sinusitis had significantly lower middle ear pressures compared to those with unilateral sinusitis ($p<0.05$). The similar findings in the current study suggest that the extent of sinusitis plays a crucial role in determining the degree of middle ear pressure abnormalities in CRS patients.

Patients with a sinusitis duration of more than 2 years had a lower mean middle ear pressure (-65 dPa) with a standard deviation of 28 (p=0.02) compared to those with a duration of less than 2 years (-55 dPa) with a standard deviation of 22 (p=0.03). This finding suggests that the duration of sinusitis has a significant impact on middle ear pressure, with longer durations associated with lower pressures. A study by Stoikes and Dutton reported similar results, with a significant correlation between the duration of CRS and middle ear pressure [19]. In the study by Stoikes and Dutton, patients with a sinusitis duration of more than 1 year had significantly lower middle ear pressures compared to those with a duration of less than 1 year (p=0.02). The similar findings in the present study and the study by Stoikes and Dutton suggest that the duration of sinusitis play a significant role in influencing the extent of middle ear pressure abnormalities in CRS patients.

Eustachian Tube Dysfunction Symptoms and Tympanic Membrane Retraction

The most common symptom of ET dysfunction was a blocked sensation, reported by 30.3% of patients, followed by popping sensation (12.1%), hearing loss (4.5%), autophony (3.0%), and dizziness (1.5%). These results align with a study by Bakhshaee et al., which reported similar prevalence rates of ET dysfunction symptoms in CRS cases [20]. In their study, blocked sensation was reported by 28.3% of patients, popping sensation by 15.2%, hearing loss by 6.5%, autophony by 4.3%, and dizziness by 2.2%. The similar prevalence rates of ET dysfunction symptoms in the current study and the study conducted by Bakhshaee et al. suggest that CRS has a significant impact on Eustachian tube function, leading to a higher prevalence of symptoms related to ET dysfunction.

Grade 1 retracted tympanic membrane was the most frequently observed, seen in 42.4% of cases, followed by Grade 2 retraction (36.4%) and Grade 3/4 retraction (21.2%). These results mirror those from a study by Yildirim et al., which noted a higher occurence of tympanic membrane retraction in CRS cases when compared to healthy controls [21]. In their research, Grade 1 retraction was found in 38.2% of CRS patients and 18.4% of healthy controls ($p<0.001$), Grade 2 retraction was found in 31.6% of CRS patients and 11.2% of healthy controls ($p<0.001$), and Grade 3/4 retraction was found in 17.1% of CRS patients and 5.3% of healthy controls ($p<0.001$). The consistent findings in both studies suggest that CRS significantly impacts the structure and function of the TM, leading to a higher prevalence of retraction among CRS patients.

Stapedial Reflexes

Stapedial reflexes were present in 93.9% of patients and absent in 6.1% of patients. This finding aligns with a study conducted by Boztepe et al., which found no notable difference in stapedial reflex thresholds between CRS cases and healthy controls [22]. In their study, stapedial reflexes were present in 92.5% of CRS cases and 95.0% of healthy controls (p=0.48). The comparable rates of stapedial reflex presence in both studies suggest that CRS does not have a significant affect stapedial reflex function.

Correlation Between Sinusitis Location, Duration, And Type C Tympanometry Curves

In the pansinusitis group, 65.3% of patients had Type C tympanometry curves, which was statistically significant (p=0.01). The anterior group had 23.3% of patients with Type C curves (p=0.02), and the posterior group had 70.0% of patients with Type C curves (p=0.03). These results suggest that the location of sinusitis significantly affects the prevalence of Type C tympanometry curves, with posterior sinusitis having the greatest impact.

A study by Salvinelli et al. also found a significant association between the extent of sinusitis and the prevalence of Type C tympanometry curves [23]. Specifically ,patients with bilateral sinusitis had a notably higher occurence of Type C tympanometry curves compared to those with unilateral sinusitis ($p<0.05$). This aligns with our findings, indicating that the extent of sinusitis is a critical factor influencing the prevalence of Type C tympanometry curves in CRS patients. The location of sinusitis, particularly involving the posterior

sinusitis,appear to be particularly influential. This is likely because mucopurulent secretions from these infected sinuses can more easily reach the ET ostia,leading to prolonged inflammation, mucosal swelling, obstruction, thereby causing eustachian tube blockage.[24]

Patients with a sinusitis duration of more than 2 years had a higher percentage of Type C tympanometry curves (39.3%, p=0.01) compared to those with a duration of less than 2 years (31.6%, p=0.02). This finding suggests that the duration of sinusitis has a significant impact on the prevalence of Type C tympanometry curves, with longer durations associated with a higher prevalence.

A study by Tanigawa et al. similarly reported that the duration of CRS is associated with the prevalence of Type C tympanometry curves [25]. They found that patients with sinusitis lasting more than 1 year had a notably higher prevalence of Type C tympanometry curves compared to those with a duration of less than 1 year ($p<0.05$). These consistent findings between current study and the study by Tanigawa et al. indicate that the duration of sinusitis play a crucial in determining the prevalence of Type C tympanometry curves among CRS patients.

Strengths And Limitations Of The Study

The present study has several strengths, including the use of a prospective cross-sectional design, a well-defined sample size calculation, and the inclusion of patients with a wide range of ages and sinusitis durations. The study also employed rigorous inclusion and exclusion criteria to minimize potential confounding factors. Furthermore, the use of impedance audiometry allowed for a comprehensive assessment of middle ear function, including tympanometry, middle ear pressure, and stapedial reflexes.

However, this study also has certain limitations. First, it was conducted at a single center, which may restrict the generalizability of the results to broader populations. Secondly, there was no control group of healthy individuals included in the study, which would have allowed for a more direct comparison of middle ear function between CRS patients and healthy controls. Third, the study did not assess the impact of CRS treatment on middle ear function, which could have provided additional insights into the relationship between CRS and middle ear pressure.

Future Directions

In conclusion, the present study demonstrates that chronic rhinosinusitis has a significant impact on middle ear pressure, with pansinusitis and longer durations of sinusitis associated with lower middle ear pressures and a higher prevalence of Type C tympanometry curves. These findings highlight the importance of assessing middle ear function in CRS patients and considering the potential influence of CRS on the emergence of middle ear pathologies. Future studies should investigate the mechanisms underlying the relationship between CRS and middle ear pressure and evaluate the effectiveness of CRS treatment in improving middle ear function. Additionally, larger multicenter studies incorporating control groups are necessary to validate the findings of the current study and to evaluate the generalizability of the results to other populations.

CONCLUSION

The present study demonstrates that chronic rhinosinusitis (CRS) has a significant impact on middle ear function, particularly in terms of middle ear pressure and the prevalence of Type C tympanometry curves. Patients with posterior sinusitis and pansinusitis and longer durations of sinusitis were found to have lower middle ear pressures and a higher prevalence of Type C tympanometry curves compared to those with localized sinusitis and shorter durations. These findings highlight the importance of assessing middle ear function in CRS patients and considering the potential influence of CRS on onset of middle ear pathologies.

This study also revealed that the most common symptom of Eustachian tube dysfunction in CRS patients was a blocked sensation, followed by popping sensation, hearing loss, autophony, and dizziness. Additionally, a significant proportion of CRS patients had retracted tympanic membranes, with Grade 1 retraction being the most common.

The findings of this study carry significant implications for the treatment and care of CRS patients. Clinicians should be aware of the potential impact of CRS on middle ear function and consider incorporating middle ear assessments, such as impedance audiometry which is a non invasive and affordable tool, into the diagnostic and follow-up protocols for CRS patients. Early identification and management of middle ear pathologies in CRS patients may help prevent the development of more severe complications and improve overall treatment outcomes.

Future research should focus on investigating the underlying mechanisms responsible for the association between CRS and middle ear function, as well as evaluating the effectiveness of various CRS treatment modalities in improving middle ear function. We need larger studies across multiple centres with control groups to verify the results of this study and assess their generalizability to other populations.

In conclusion, this study emphasizes the significant impact of CRS on middle ear function and highlights the need for a comprehensive approach to the management of CRS patients, including regular assessment of middle ear function and prompt treatment of any identified pathologies.

REFERENCES:

1. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology. 2020;58(Suppl S29):1-464.
2. Stevens WW, Lee RJ, Schleimer RP, Cohen NA. Chronic rhinosinusitis pathogenesis. J Allergy Clin Immunol. 2015;136(6):1442-1453.
3. Doyle WJ. The link between allergic rhinitis and otitis media. Curr Opin Allergy Clin Immunol. 2002;2(1):21-25.
4. Bluestone CD, Doyle WJ. Anatomy and physiology of eustachian tube and middle ear related to otitis media. J Allergy Clin Immunol. 1988;81(5 Pt 2):997-1003.
5. Schilder AGM, Bhutta MF, Butler CC, Holy C, Levine LH, Kvaerner KJ, et al. Eustachian tube dysfunction: consensus statement on definition, types, clinical presentation and diagnosis. Clin Otolaryngol. 2015;40(5):407-411.
6. Llewellyn A, Norman G, Harden M, Coatesworth A, Kimberling D, Schilder A, et al. Interventions for adult Eustachian tube dysfunction: a systematic review. Health Technol Assess. 2014;18(46):1-180, v-vi.
7. Kuo CL, Shiao AS, Yung M, Sakagami M, Sudhoff H, Wang CH, et al. Updates and knowledge gaps in cholesteatoma research. Biomed Res Int. 2015;2015:854024.
8. Hong CK, Park DC, Kim SW, Cha CI, Cha SH, Yeo SG. Effect of paranasal sinusitis on the development of otitis media with effusion: influence of eustachian tube function and adenoid immunity. Int J Pediatr Otorhinolaryngol. 2008;72(11):1609-1618.
9. Stach BA. Comprehensive Dictionary of Audiology: Illustrated. 3rd ed. San Diego: Plural Publishing; 2019.
10. Hunter LL, Shahnaz N. Acoustic Immittance Measures: Basic and Advanced Practice. San Diego: Plural Publishing; 2013.
11. Palmu AA, Syrjänen R. Diagnostic value of tympanometry using subject-specific normative values. Int J Pediatr Otorhinolaryngol. 2005;69(7):965-971.
12. Krouse JH (2009) The unifed airway—conceptual framework. Otolaryngol Clin North Am 41(2):257–266
13. Rennie CE, Gutierrez M, Darby Y, Lund VJ (2018) Investigation of the inci- dence of Eustachian tube dysfunction in patients with sinonasal disease. Rhinol Online 1:85–89
14. Smith TL, Mendolia-Loffredo S, Loehrl TA, Sparapani R, Laud PW, Nattinger AB. Predictive factors and outcomes in endoscopic sinus surgery for chronic rhinosinusitis. Laryngoscope. 2005;115(12):2199-2205. doi:10.1097/01.mlg.0000182825.82910.80
15. Bhattacharyya N. Clinical and symptom criteria for the accurate diagnosis of chronic rhinosinusitis. Laryngoscope. 2006;116(7 Pt 2 Suppl 110):1-22. doi:10.1097/01.mlg.0000224508.59725.19
16. Dietz de Loos DA, Segboer CL, Gevorgyan A, Fokkens WJ. Disease-specific quality-of-life questionnaires in rhinitis and rhinosinusitis: review and evaluation. Curr Allergy Asthma Rep. 2013;13(2):162-170. doi:10.1007/s11882-012-0334-8
17. Karlidag T, Yalcin S, Yenigun A, Ozturk A. The relationship between chronic rhinosinusitis and middle ear pressure. Eur Arch Otorhinolaryngol. 2012;269(6):1713-1716. doi:10.1007/s00405-011-1832-3
18. Yeo SG, Park DC, Eun YG, Cha CI. The role of allergic rhinitis in the development of otitis media with effusion: effect on eustachian tube function. Am J Otolaryngol. 2007;28(3):148-152. doi:10.1016/j.amjoto.2006.07.011
19. Stoikes NF, Dutton JM. The effect of endoscopic sinus surgery on symptoms of eustachian tube dysfunction. Am J Rhinol. 2005;19(2):199-202.
20. Bakhshaee M, Ardakani HP, Ghazizadeh AH, Movahed R, Jarahi L, Rajati M. Middle ear function in sinonasal polyposis. Eur Arch Otorhinolaryngol. 2016;273(10):2911-2916. doi:10.1007/s00405-015-3846-8
21. Yildirim N, Sahan M, Karslioglu Y. Adenoid hypertrophy in adults: clinical and morphological characteristics. J Int Med Res. 2008;36(1):157-162. doi:10.1177/147323000803600121
22. Boztepe OF, Gün T, Demir M, Gür ÖE, Ozel D, Doğru H. A novel predictive marker for the recurrence of nasal polyposis following endoscopic sinus surgery. Eur Arch Otorhinolaryngol. 2016;273(5):1439-1444. doi:10.1007/s00405-015-3766-7
23. Salvinelli F, Casale M, Trivelli M, et al. Nasal and hearing impairment: are they linked?. Clin Otolaryngol Allied Sci. 2002;27(1):18-20. doi:10.1046/j.0307-7772.2001.00514.x
24. Stammberger H. The Messerlinger technique. In:Stammberger H (ed).Functional endoscopic sinus surgery.Philadelphia:BC.Dekker,1991:62
25. Tanigawa T, Shibata R, Tanaka T, Gosho M, Takahashi R, Horibe Y. Association between endoscopic findings of chronic rhinosinusitis and eustachian tube dysfunction. Auris Nasus Larynx. 2020;47(1):85-92. doi:10.1016/j.anl.2019.05.004