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# Middle Ear Function in Sino Nasal Polyposis

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## Abstract

One of the major ENT complaints is chronic nasal obstruction. A definite relation between nasal obstruction and middle ear diseases, where Eustachian tube dysfunction (ETD) caused by nasal obstruction, that may cause middle ear hypoventilation resulting in otitis media with effusion (OME), that may be definitely diagnosed through use of otoscopic findings associated with type B tympanogram. This paper aimed to compare the effect of sinonasal polyposis and non-polyposis nasal obstruction on middle ear and Eustachian tube (ET) functions. Case control study was conducted on 90 randomly selected patients, above15 years, divided into three groups Group (1): included 30 patients with nasal obstruction due to sinonasal polyposis. Group (2) included 30 patients with nasal obstruction due to nasal allergy. Group (3) (control): included healthy people free of nasal obstruction. Patients were subjected to detailed history taking proper clinical examination, Computed tomography scan of the nose and para nasal sinuses, Eustachian tube functions, audiometry and tympanometry. There was a statistically significant difference between groups according to complaints, Tympanogram, degree of hearing loss and Eustachian tube function, higher in group (1) than group (2) and control. The ET functions (Tympanometry, Swallowing step and Toynbee test) in the polyposis patients and allergic patients without polyposis seems to be disturbed. This is probably due to the inflammation and infection associated with polyposis and allergy.

**Keywords:** Chronic nasal obstruction, Sino nasal polyposis, Allergic rhinitis, Eustachian tube function, Middle ear pressure.

## 1. Introduction

Sinonasal polyposis (SNP) is a chronic disease of nasal and paranasal sinus mucosa that is hyperplasia and protrusion of sinus mucosa secondary to chronic inflammation. The most common sites of involvement are the ethmoid cells **Lotfi et al., [1].** The primary physiological functions of the eustachian tube (ET) are the ventilation of the middle ear and the balancing of the pressure of the external environment with that of the middle ear. In addition, protecting the middle ear from

nasopharyngeal secretions and emptying the middle ear secretions into the nasopharynx are also among its functions. Eustachian tube dysfunction causes effusion, infection, and chronic inflammation in the middle ear **Iannella et al., [2].** Sinonasal polyposis cause Eustachian tube dysfunction (ETD) through inflammation and infection associated with the disease or through obstruction of ET orifice that leads to negative middle ear pressure and stasis of middle ear secretions resulting in otitis media with effusion (OME), atelectasis of the middle ear, chronic otitis media (COM) with tympanic membrane perforation, tympanic membrane retraction (TMR), and cholesteatoma **Juszczak and Loftus, [3].**
So, we proceeded to this study to compare the effect of sinonasal polyposis and non-polyposis nasal obstruction on the middle ear and ET functions. This study aimed to compare the effect of sinonasal polyposis and non-polyposis nasal obstruction on the middle ear and ET functions.

## 2. Patients and Methods

This study was a case-control study. This study was conducted at the Otorhinolaryngology Department of Al-Zahraa University Hospital from January (2021) to November (2021).
**This case-control study included 90 randomly selected patients, which divided into three groups:**
**Group (1):** included 30 patients with nasal obstruction due to sinonasal polyposis. (most of them with high grades (grade 2& grade 3), **Group (2):** included 30 patients with nasal obstruction due to nasal allergy, and **Group (3) (control):** included 30 healthy persons free of nasal obstruction.
The study protocol was approved by the hospital's ethics board and written informed consent was taken.

### 2.1 Inclusion Criteria

Patients with a confirmed diagnosis of bilateral Sino nasal polyposis, Patients with intact tympanic membrane, and patients aged 15-50 years were included and both genders were involved.

### 2.2 Exclusion Criteria

Patients aged below 15 years, patients who refuse to undergo evaluation, patients receiving steroid therapy during the past 3 weeks, craniofacial disorders such as cleft palate and nasopharynx tumors, acute sinusitis or acute otitis media.

### 2.3 History Taking

A comprehensive history was obtained from each patient, including:

#### 2.3.1 Personal History

Name, age, gender, residence, occupation, and special habits of medical importance were recorded.

#### 2.3.2 Chief Complaint and Present History

Nasal symptoms such as nasal obstruction, allergic nasal symptoms (sneezing, itching, and post-nasal discharge), headache, epistaxis, smell disorder, snoring, and sleep apnea were noted, along with their onset, course, and duration. Symptoms of ear diseases, including discharge, hearing impairment, otalgia, tinnitus, and vertigo, were also recorded with their onset, course, and duration.

#### 2.3.3 Past History

General medical problems (hypertension, bronchial asthma, diabetes mellitus, and liver disease) and history of previous medication and ear or nasal surgery, including when and where they were performed, were documented.

#### 2.3.4 Family History

Any family history of similar conditions was noted.

### 2.4 Physical Examination

#### 2.4.1 General Examination

The patient's appearance, consciousness, co-operation, build, nourishment, vital signs, and examination of the central nervous system, cardiovascular system, respiratory system, and gastrointestinal system were assessed.

#### 2.4.2 E.N.T Examination

##### 2.4.2.1 Nose Examination

Inspection was performed to assess the color of the skin, shape, presence of scars, masses, or deformities. Palpation was conducted to evaluate tenderness and swelling. Anterior rhinoscopy was performed to examine the nasal mucosa, nasal septum, floor of the nose, and anterior parts of the inferior and middle turbinates. All patients underwent a bilateral endoscopic nasal examination to characterize the degree of nasal polyposis (NP) on each side.

##### 2.4.2.2 Ear Examination

Inspection was performed to assess size, contour changes, and scars from previous operations. Palpation was conducted to evaluate tenderness and swelling. An otoscopic examination of the ear was performed to examine the external auditory canal and tympanic membrane. Tuning fork tests were conducted for hearing assessment.

##### 2.4.2.3 Throat Examination

The gums, teeth, oral cavity, salivary ducts, palate, and oropharynx (tonsils) were examined.

#### 2.4.3 E.T Function Tests

##### 2.4.3.1 Valsalva Maneuver

To evaluate the ability to actively inflate the middle ear, patients were asked to pinch their nose and inflate their cheeks through forced expiration with their mouth closed until a sensation of fullness was achieved in the ears. Patients were then instructed to release their nose and abstain from further swallowing or mandibular movement, and an experimental tympanogram was obtained from each ear. A tympanometric peak pressure shift is generally positive El-bary et al., [4].

##### 2.4.3.2 Toynbee Maneuver

To evaluate the capacity to equalize middle ear pressure and nasopharyngeal pressure, patients were asked to swallow while pinching their nose. Patients were then instructed to release their nose and refrain from further swallowing and mandibular movement, and an experimental tympanogram was obtained from each ear. The tympanometric peak shift is generally negative Awad et al., [5]. In both Valsalva and Toynbee maneuvers, a tympanometric peak pressure shift less than 10 daPa indicated poor eustachian tube function, whereas a shift greater than 10 daPa indicated good function El-bary et al., [4].

#### 2.4.4 Investigations

The following investigations were performed: tympanometry, pure tone audiometry, CT nose & paranasal sinuses, and tympanometry. Tympanometry was conducted using a Maico diagnostic Gmbn impedance meter to provide additional information regarding the patient's middle ear function and assess eustachian tube dysfunction. The nose examination consisted of three components: inspection, palpation, and anterior rhinoscopy. During inspection, the color of the skin, shape, and presence of scars, masses, or deformities were noted. Palpation was performed to assess tenderness and swelling. Anterior rhinoscopy was conducted to examine the nasal mucosa, nasal septum, floor of the

nose, and anterior parts of the inferior and middle turbinates. Additionally, all patients underwent a bilateral endoscopic nasal examination to characterize the degree of nasal polyposis (NP) on each side.

**Figure (1):** Maico diagnostic Gmbh impedance Meter

### 2.4.4 Tympanometry

Tympanograms were classified according to middle ear pressure into three main types: type A (middle ear pressure peak between +50 and −100 daPa), type C (middle ear pressure peak of −100 daPa or more negative), and type B (flattened peak or no peak) (Pratt, 2008) [16].

### 2.4.5 Pure Tone Audiometry (PTA)

PTA was performed to measure the patient's hearing threshold. The test was conducted using an audiometer (Piano Plus VRA) with earphones for air conduction (AC) and a bone conduction (BC) vibrator over the mastoid for bone conduction. The following frequencies were tested: 250, 500, 1000, 2000, 4000, and 8000 Hz. The resultant AC and BC curves were plotted on an audiogram to determine the degree and type of hearing loss.

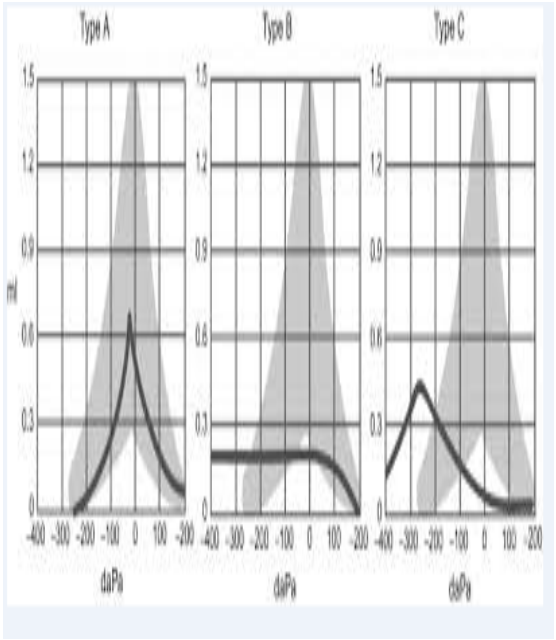


**Figure (2):** Types of tympanograms **(Pratt,2008)**.


**Figure (3):** Audiometer Piano Plus VRA.

### 2.4.6 CT Nose & Paranasal Sinuses

CT imaging was performed to detect the site and extension of nasal polyps. The Lund-Mackay staging system Lund and Mackay, 1993 was used to quantify the extent of the disease. Each Sinus taking score:0 =No mucosal thickening,1< Partial opacification,2=Total opacification *No score (1) is given for osteomeatal complex but (0 or 2) Lund and Mackay, 1993. A four-stage polyp grading system was used: (0) no visible NP; (1) small amount of polypoid disease confined within the middle meatus; (2) multiple polyps occupying the middle meatus; (3) polyps extending beyond the middle meatus; and (4) polyps completely obstructing the nasal cavity (Meltzer et al., 2006).

| Sinus System |
|---|
| Maxillary (0,1,2) |
| Anterior ethmoid (0,1,2) |
| Posterior ethmoid (0,1,2) |
| Sphenoid (0,1,2) |
| Frontal (0,1,2) |
| Osteomeatal complex (0 or 2 only |
| Total |

**Figure (4):** Lund–Mackay sinus CT grading system.

### 2.5 Case Examples

### 2.5.1 Group 1: Sinonasal Polyposis

A 25-year-old male patient presented with bilateral nasal obstruction, allergic nasal symptoms (sneezing, itching, and post-nasal discharge), aural fullness, and tinnitus. Endoscopic nasal examination revealed Grade III polyposis according to the polyp grading system (Figure 6). CT imaging showed opacity of all sinuses, corresponding to a Lund-Mackay score of 24 (full opacity) (Figure 7).

### 2.5.2 Group 2: Allergic Rhinitis without Polyposis

A 20-year-old female patient presented with bilateral nasal obstruction, allergic nasal symptoms (sneezing, itching, and post-nasal discharge), aural fullness, and tinnitus. Endoscopic nasal examination showed no visible polyps (Grade 0) according to the polyp grading system. CT imaging revealed no opacity of the sinuses, corresponding to a Lund-Mackay score of 0.

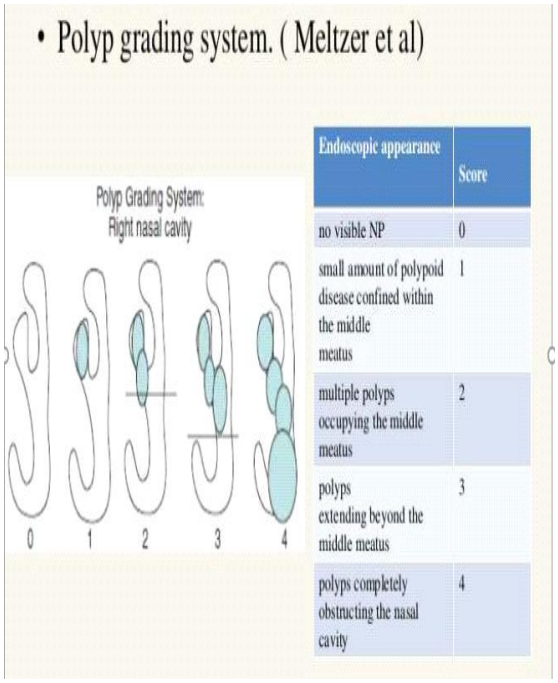


**Figure (5):** Endoscopic nasal examination: to assess the degree of polyp.

**Figure (6):** Endoscopic examination of the nasal cavity that shows grade III of polyp.

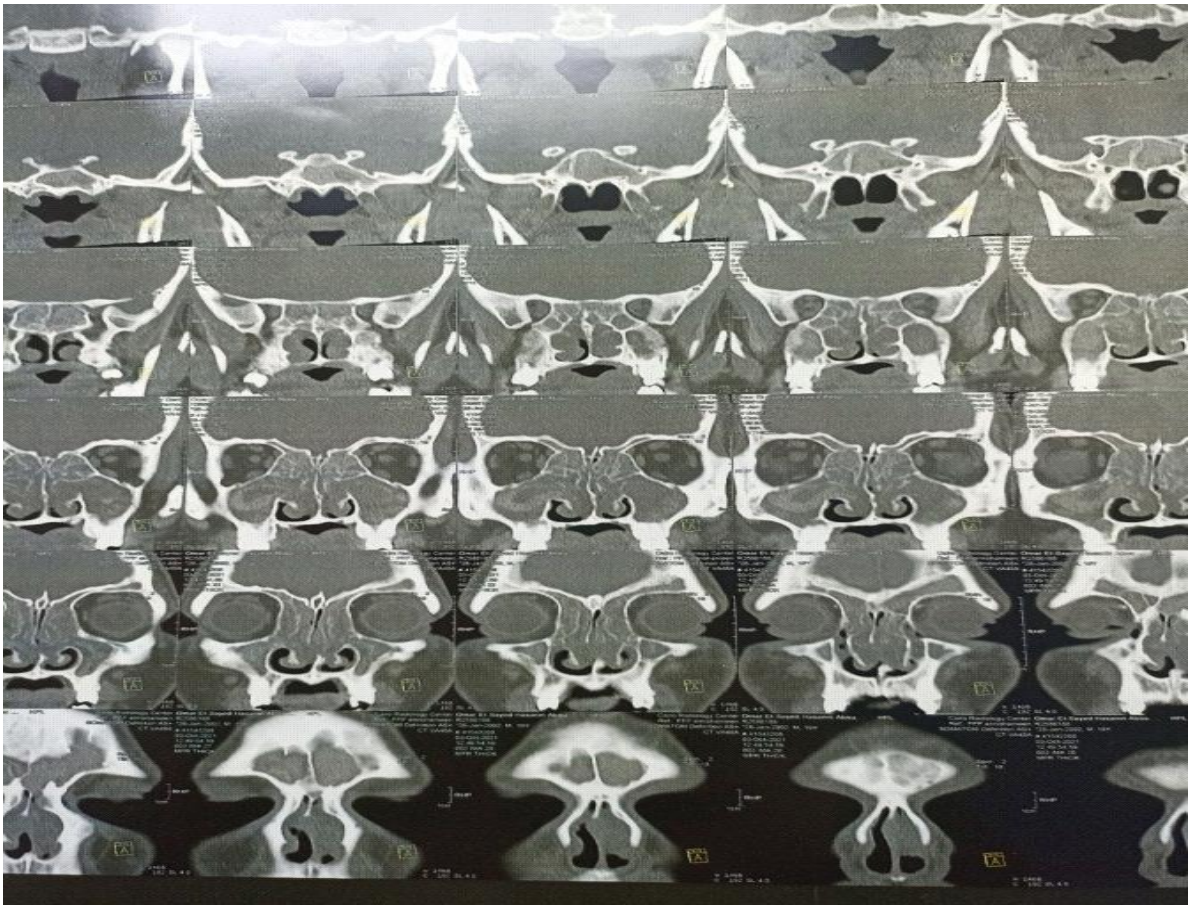

**Figure (7):** CT Nose & Para nasal sinus show full opacity of sinus

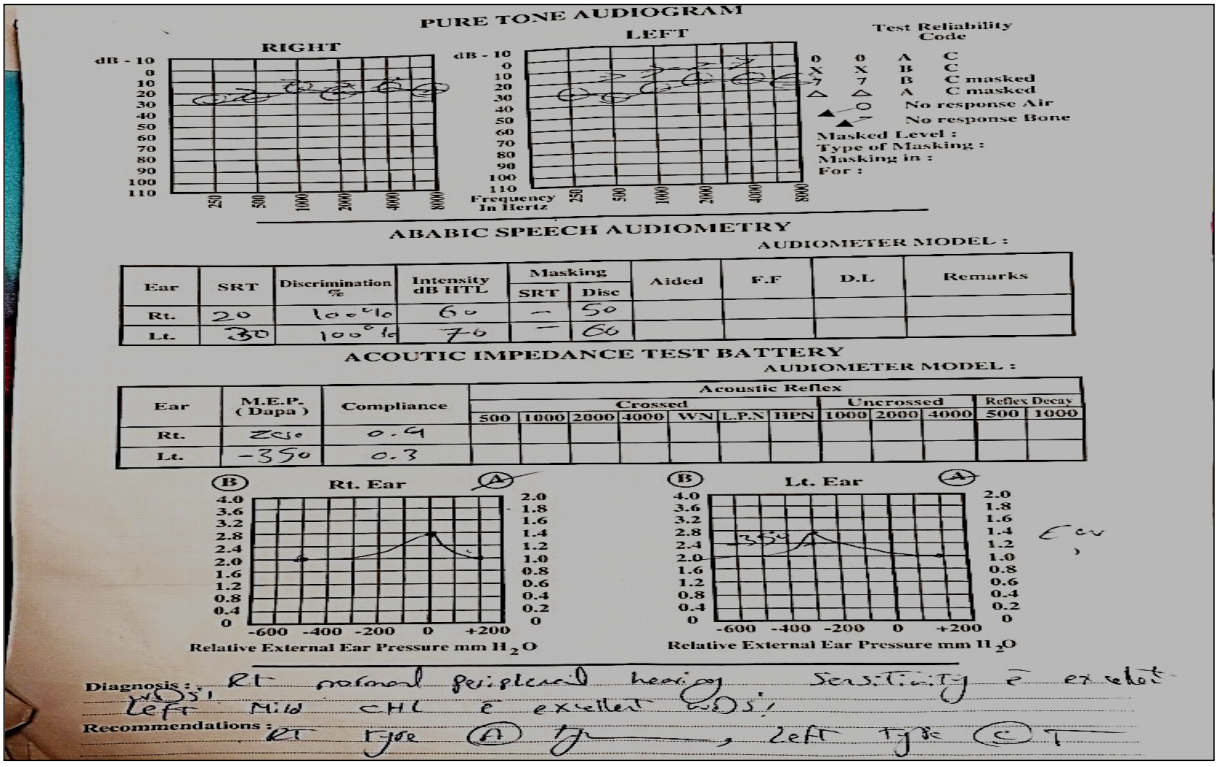


**Figure (8):** Show PTA that shows right normal hearing-left: mild CHL & Tympanometry that show right type A & left type C.

**Figure (9):** Show no opacity of sinuses according to Lund–Mackay score.

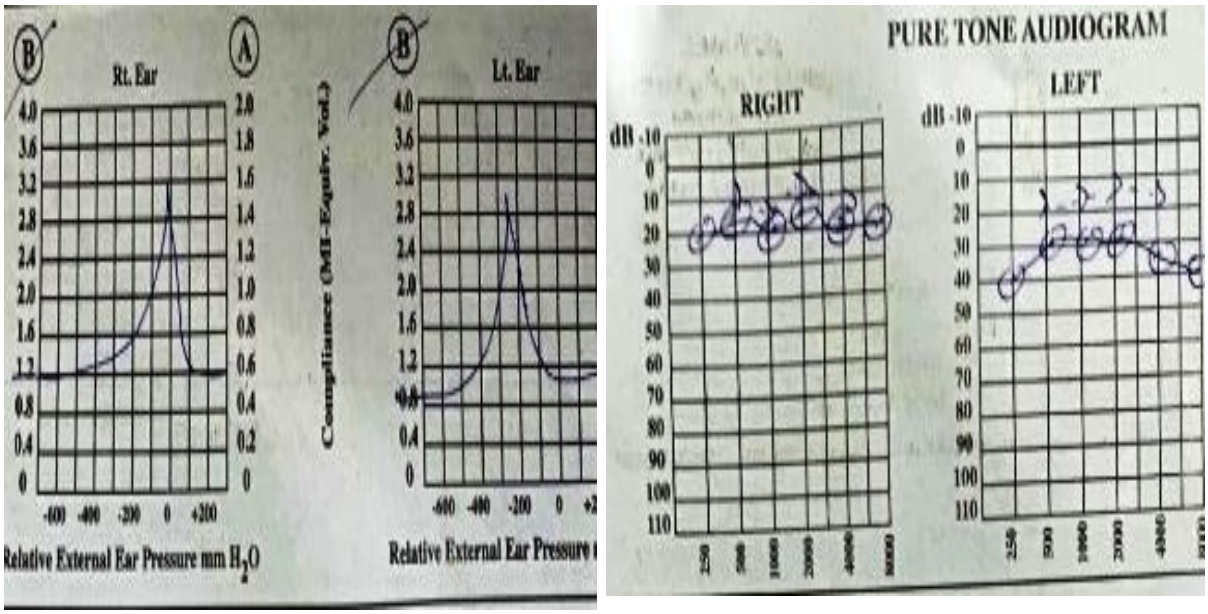


**Figure (10):** Show PTA that show right normal hearing & left mild CHL & tympanometry that show right type A & left type C.

## 2.6 Statistical Analysis

Recorded data were analyzed using the statistical package for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA). The quantitative data were presented as mean ± standard deviation and ranges.

## 3. Results

Table .1 shows that there was no statistically significant difference between the three studied groups regarding age, and gender, with p-value> 0.05 NS. Table .2 shows that there was a statistically significant difference between the three groups higher in group I than group II and control according to the degree of hearing loss, with p-value v<0.05 S (in Right ear) and p-value < 0.01 S (in Left ear). Table .3 shows that there was a statistically significant difference between groups according to complaint Group 1 vs Group 2 & Group 2 vs Group 3, higher in group I than group II and control, with p-value < 0.01: significant (S). Table .4 shows there was a statistically significant difference between groups according to tympanogram, Group 1 vs Group 2 & Group 2 vs Group 3 higher in group I than group II and control (Type C) with p-value < 0.01: significant (S) but no significant difference between group II and control group with p-value > 0.05(NS).

**Table (1):** Comparison between Group 1 (with Sino nasal polyposis) Group 2 (with nasal allergy without polyposis and the control group according to Age & gender.

| | | Group 1 (with Sino nasal polyposis) | Group 2 (with nasal allergy without polyposis) | Group 3 (control group) | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|
| | | **No. = 30** | **No. = 30** | **No. = 30** | | | |
| Age | Mean ± SD | 34.16 ± 8.71 | 31.37 ± 7.92 | 35.57 ± 7.66 | 2.086 | 0.130 | NS |
| | Range | 16 – 50 | 19 – 46 | 18 – 48 | | | |
| Gender | Female | 13 (43.3%) | 15 (50.0%) | 13 (43.3%) | 0.358 | 0.836 | NS |
| | Male | 17 (56.7%) | 15 (50.0%) | 17 (56.7%) | | | |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS).** *Chi-square test; •: One Way ANOVA test**.**

**Table (2):** Comparison between Group 1 (with Sino nasal polyposis) & Group 2 (with nasal allergy without polyposis) and (control group) according to Degree of hearing loss.

| Degree of hearing loss | | Group 1 (with Sino nasal polyposis) | | Group 2 (with nasal allergy without polyposis) | | Group 3 (control group) | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Right | Normal | 20 | 66.7% | 29 | 96.7% | 30 | 100.0% | 19.504 | 0.001 | S |
| | Minimal | 6 | 20.0% | 0 | 0.0% | 0 | 0.0% | | | |
| | Mild | 4 | 13.3% | 1 | 3.3% | 0 | 0.0% | | | |
| Left | Normal | 16 | 53.3% | 29 | 96.7% | 30 | 100.0% | 29.880 | 0.000 | S |
| | Minimal | 9 | 30.0% | 0 | 0.0% | 0 | 0.0% | | | |
| | Mild | 5 | 16.7% | 1 | 3.3% | 0 | 0.0% | | | |

| | Post Hoc analysis by Chi-square test | | |
|---|---|---|---|
| | **Group 1 Vs Group 2** | **Group 1 Vs Group 3** | **Group 2 Vs Group 3** |
| Degree of hearing loss | | | |
| Right | 0.009 | 0.002 | 0.601 |
| Left | 0.000 | 0.000 | 0.601 |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS),** *: Chi-square test.

**Table (3):** Comparison between Group 1 (with Sino nasal polyposis) & Group 2 (with nasal allergy without polyposis and the control group according to the complaint (tinnitus, aural fullness, Allergic symptoms and hearing loss).

| Complain | | Group 1 (with sino nasal polyposis) | | Group 2 (with nasal allergy without polyposis) | | Group 3 (control group) | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Tinnitus | No | 17 | 56.7% | 27 | 90.0% | 30 | 100.0% | 21.132 | 0.000 | S |
| | Yes | 13 | 43.3% | 3 | 10.0% | 0 | 0.0% | | | |
| Aural fullness | No | 16 | 53.3% | 26 | 86.7% | 30 | 100.0% | 21.667 | 0.000 | S |
| | Yes | 14 | 46.7% | 4 | 13.3% | 0 | 0.0% | | | |
| Allergic symptoms | No | 0 | 0.0% | 0 | 0.0% | 30 | 100.0% | 90.000 | 0.000 | S |
| | Yes | 30 | 100.0% | 30 | 100.0% | 0 | 0.0% | | | |
| Hearing loss | No | 25 | 83.3% | 30 | 100.0% | 30 | 100.0% | 10.588 | 0.005 | S |
| | Yes | 5 | 16.7% | 0 | 0.0% | 0 | 0.0% | | | |

| | Post Hoc analysis by Chi-square test | | |
|---|---|---|---|
| | **Group 1 Vs Group 2** | **Group 1 Vs Group 3** | **Group 2 Vs Group 3** |
| Tinnitus | 0.004 | 0.000 | 0.076 |
| Aural fullness | 0.005 | 0.000 | 0.038 |
| Allergic symptoms | 1.000 | 0.000 | 0.000 |
| Hearing loss | 0.020 | 0.020 | 1.000 |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS),** *: Chi-square test.

**Table (**4**):** Comparison between Group 1 (with sino nasal polyposis) & Group 2 (with nasal allergy without polyposis) and the control group according to tympanogram.

| Tympanogram | | Group 1 (with sino nasal polyposis) | | Group 2 (with nasal allergy without polyposis) | | Group 3 (control group) | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Right | Type A | 20 | 66.7% | 29 | 96.7% | 30 | 100.0% | 18.849 | 0.000 | S |
| | Type C | 10 | 33.3% | 1 | 3.3% | 0 | 0.0% | | | |
| Left | Type A | 17 | 56.7% | 28 | 93.3% | 30 | 100.0% | 23.520 | 0.000 | S |
| | Type C | 13 | 43.3% | 2 | 6.7% | 0 | 0.0% | | | |

| | Post Hoc analysis by Chi-square test | | |
|---|---|---|---|
| | **Group 1 Vs Group 2** | **Group 1 Vs Group 3** | **Group 2 Vs Group 3** |
| Tympanogram | | | |
| Right | **0.003** | **0.001** | **0.313** |
| Left | **0.001** | **0.000** | **0.150** |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS),** *: Chi-square test.

Table .5 shows there was a statistically significant difference between groups according to Eustachian tube function tests when Group 1 is vs Group 2 & Group 2 vs Group 3 and Group1 vs Group3 number of patients with ET dysfunction was more in Group I and Group II than control group (right & left ears) with P-value< 0.01(S). Table .6 shows that we illustrated that there was no statistically significant difference between groups according to SRT with P-value >0.05: Non-significant (NS). Table .7 shows that there was a statistically significant difference between groups according to compliance of middle ear, a smaller value of ME compliance was found in the polyposis cases in comparison with Group (2) and healthy controls (Group 3), with p-value < 0.01 S. Table .8 shows that IN the current study we found in Group (1) with Sino nasal polyposis according to polyp grading system (18) patients with grade II & (11) patients with grade III and (1) patient with grade IV on the right side while in the left side we found (9) patients with grade II& (18) patients with grade III and (3) patients with grade IV.

**Table (5):** Comparison between Group 1 (with Sino nasal polyposis) & Group 2 (with nasal allergy without polyposis and the control group according to Eustachian tube function tests (William test).

| Eustachian tube function tests (William test) | | Group 1 (with sino nasal polyposis) | | Group 2 (with nasal allergy without polyposis) | | Group 3 (control group) | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Right | Good | 18 | 60.0% | 21 | 70.0% | 30 | 100.0% | 15.391 | 0.004 | S |
| | Fair | 6 | 20.0% | 6 | 20.0% | 0 | 0.0% | | | |
| | Poor | 6 | 20.0% | 3 | 10.0% | 0 | 0.0% | | | |
| Left | Good | 16 | 53.7% | 20 | 66.7% | 30 | 100.0% | 18.442 | 0.001 | S |
| | Fair | 5 | 16.0% | 5 | 16.7% | 0 | 0.0% | | | |
| | Poor | 9 | 30.3% | 5 | 16.7% | 0 | 0.0% | | | |

| Eustachian tube function tests (William test) | Post Hoc analysis by Chi-square test | | |
|---|---|---|---|
| | **Group 1 Vs Group 2** | **Group 1 Vs Group 3** | **Group 2 Vs Group 3** |
| Right | 0.540 | 0.001 | 0.005 |
| Left | 0.452 | 0.000 | 0.002 |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS).**

**Table (6):** Comparison between Group 1 (with Sino nasal polyposis) & Group 2 (with nasal allergy without polyposis and the control group according to SRT.

| SRT | | Group 1 (with Sino nasal polyposis) | Group 2 (with nasal allergy without polyposis) | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|
| | | **No. = 30** | **No. = 30** | | | |
| Right | Mean ± SD | 19.67 ± 3.46 | 20.17 ± 3.07 | -0.592 | 0.556 | NS |
| | Range | 15 – 35 | 15 – 35 | | | |
| Left | Mean ± SD | 19.83 ± 3.34 | 20.17 ± 3.34 | -0.386 | 0.701 | NS |
| | Range | 15 – 30 | 10 – 35 | | | |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), *: Chi-square test.**

**Table (7):** Comparison between Group 1 (with Sino nasal polyposis) & Group 2 (with nasal allergy without polyposis and the control group according to compliance.

| Compliance (Type A) | | Group 1 (with sino nasal polyposis) | Group 2 (with nasal allergy without polyposis) | Group 3 (control group) | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|
| | | **No. =** | **No. =** | **No. =** | | | |
| Right | Mean ± SD | 0.38 ± 0.09 | 0.41 ± 0.03 | 0.86 ± 0.06 | 524.169 | 0.000 | HS |
| | Range | 0.3 – 0.6 | 0.4 – 0.5 | 0.8 – 1 | | | |
| Left | Mean ± SD | 0.44 ± 0.09 | 0.43 ± 0.04 | 0.90 ± 0.06 | 496.036 | 0.000 | HS |
| | Range | 0.3 – 0.6 | 0.4 – 0.5 | 0.8 – 1 | | | |

| | Post Hoc analysis by Chi-square test | | |
|---|---|---|---|
| | **Group 1 Vs Group 2** | **Group 1 Vs Group 3** | **Group 2 Vs Group 3** |
| Compliance | | | |
| Right | **0.080** | **0.000** | **0.000** |
| Left | **0.404** | **0.000** | **0.000** |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), •: One Way ANOVA test.**

**Table (8):** Endoscopic examination of the nasal cavity (polyp grading system) in group (1) with sino nasal polyposis (right & left).

| | | **No.** | **%** |
|---|---|---|---|
| Endoscopic examination of the nasal cavity (polyp grading system) right | Grade 2 | 18 | 60.0% |
| | Grade 3 | 11 | 36.7% |
| | Grade 4 | 1 | 3.3% |
| Endoscopic examination of nasal cavity (polyp grading system) left | Grade 2 | 9 | 30.0% |
| | Grade 3 | 18 | 60.0% |
| | Grade 4 | 3 | 10.0% |

Table .9 shows that according to CT staging system in the same group (1) we found that the degree of opacity of sinuses ranges from (11-22) according to Tomedian 17 & Lund-Mackay sinus CT grading system. Table .11 shows that there was no statistically significant difference in the group (1) between Endoscopic examination (polyp grading system) and type of Tympanogram (type C) and ET functions in the (right & left ear), with p-value >0.05 NS. Table .13 shows that there was no statistically significant difference in the group (1) between CT staging system and type of Tympanogram (type C) and ET functions in the (right & left ear) ear, with p-value >0.05 NS.

**Table (9):** CT staging system in group (1) with Sino nasal polyposis (right & left).

| | | No. = 30 |
|---|---|---|
| CT staging system right | Median (IQR) | 8 (8 - 9) |
| | Range | 5 – 11 |
| CT staging system left | Median (IQR) | 9 (7 - 10) |
| | Range | 5 – 12 |
| Total CT staging system | Median (IQR) | 17 (15 - 18) |
| | Range | 12 – 22 |

**Table (10):** Comparison between Endoscopic examination of the nasal cavity (polyp grading system) and type of tympanogram & ET functions in the group (1) (right).

| | | Endoscopic examination of nasal cavity (polyp grading system) right | | | | | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Grade 2** | | **Grade 3** | | **Grade 4** | | | | |
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Tympanogram | Type A | 13 | 72.2% | 7 | 63.6% | 0 | 0.0% | 2.295 | 0.317 | NS |
| | Type C | 5 | 27.8% | 4 | 36.4% | 1 | 100.0% | | | |
| ET function | Good | 12 | 66.7% | 6 | 54.5% | 0 | 0.0% | 4.697 | 0.320 | NS |
| | fair | 3 | 16.7% | 3 | 27.3% | 0 | 0.0% | | | |
| | poor | 3 | 16.7% | 2 | 18.2% | 1 | 100.0% | | | |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), *: Chi-square test.**

**Table (11):** Comparison between Endoscopic examination of nasal cavity (polyp grading system) and type of tympanogram & ET functions in the group (1) (left).

| | | Endoscopic examination of nasal cavity (polyp grading system) left | | | | | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Grade 2** | | **Grade 3** | | **Grade 4** | | | | |
| | | **No.** | **%** | **No.** | **%** | **No.** | **%** | | | |
| Tympanogram | Type A | 8 | 88.9% | 8 | 44.4% | 1 | 33.3% | 5.566 | 0.062 | NS |
| | Type C | 1 | 11.1% | 10 | 55.6% | 2 | 66.7% | | | |
| ET function | Good | 8 | 88.9% | 7 | 38.9% | 1 | 33.3% | 8.877 | 0.064 | NS |
| | Fair | 0 | 0.0% | 5 | 27.8% | 0 | 0.0% | | | |
| | Poor | 1 | 11.1% | 6 | 33.3% | 2 | 66.6% | | | |

***: Chiue >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), *: Chi-square test**

**Table (12):** Comparison between CT staging system and type of tympanogram & ET functions in group (1) (right).

| | | CT staging system right | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|
| | | **Median (IQR)** | **Range** | | | |
| Tympanogram right | Type A | 8 (8 – 8.5) | 5 – 11 | -0.684 | 0.494 | NS |
| | Type C | 8 (8 – 10) | 6 – 11 | | | |
| ET function | Good | 8 (8 – 9) | 5 – 11 | 0.119 | 0.942 | NS |
| | Fair | 8 (8 – 10) | 6 – 11 | | | |
| | Poor | 8 (7 – 10) | 6 – 11 | | | |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS), ‡: Mann Whitney test; ‡‡: Kruskal Wallis test.**

**Table (13):** Comparison between CT staging system and type of tympanogram & ET functions in group (1) (left).

| | | CT staging system left | | Test value | P-value | Sig. |
|---|---|---|---|---|---|---|
| | | **Median (IQR)** | **Range** | | | |
| Tympanogram left | Type A | 8 (7 – 10) | 5 – 11 | -1.448 | 0.148 | NS |
| | Type C | 9 (9 – 10) | 6 – 12 | | | |
| ET function | Good | 7 (6.5 – 9.5) | 5 – 12 | 3.961 | 0.138 | NS |
| | Fair | 9 (9 – 9) | 7 – 10 | | | |
| | Poor | 10 (10 – 10) | 6 – 12 | | | |

**P-value >0.05: Non-significant (NS); P-value <0.05: Significant (S); P-value< 0.01: highly significant (HS)‡: Mann Whitney test; ‡‡: Kruskal Wallis test.**

## 4. Discussion

Otitis media is one of the most common diseases of the middle ear. The Eustachian tube (ET) is widely thought to be involved in the pathogenesis of otitis media. Among the influencing factors, nasal pathologies such as upper respiratory tract infections (URI) or allergic inflammations are notable. Nasal polyposis, a well-known etiology for upper respiratory obstruction, can be either symptomatic or asymptomatic. It is more frequently seen in association with certain pathologies such as cystic fibrosis, asthma, eosinophilia, Churg-Strauss syndrome and sarcoidosis, but the exact etio pathogenesis is yet unclear Zernotti et al., [6]. This study aimed to compare the effect of sinonasal polyposis and non-polyposis nasal obstruction on middle ear and Eustachian tube (ET) functions. The current study included 90 patients **,** who were admitted to the Department of Otorhinolaryngology at Al-Zahraa University Hospital, during the period from (Jan.2021 to Nov.2021) they were divided into three groups: Group (A) included (30) patients(13 female&17male) with (mean age & Standard deviation)(34.16 ± 8.71) ranged between(16 – 50)years with Nasal obstruction due to Sino nasal polyposis,

Group B included (30) patients(15 female and 15male) with (mean age & Standard deviation) (31.37 ± 7.92) ranged between(19 – 49) years Nasal obstruction due to allergy without polyp and Group C included (30) patients (13 female&17male) with (mean age & Standard deviation)(35.57 ± 7.66) ranged between (18 – 48) years free patients of nasal obstruction.

This study showed that there was no statistically significant difference between the three studied groups regarding age, gender, with p-value> 0.05 NS as shown in (table 1).

Bakhshaee et al. [7] agree with this study that among 90 participants in his study, 44 (48.89 %) had polyposis (Group 1) and 46 did not have polyposis (controls), among the controls, 23 individuals (25.56 %) had a nasal obstruction without polyposis (Group 2) and 23 (25.56 %) were healthy, symptom-free controls (Group 3). The mean ages in Groups 1, 2 and 3 were 42.47 ± 12.75, 40.91 ± 15.38, and 38.42 ± 11.40 years, respectively (p-value> 0.005). No significant difference was observed between the three groups regarding gender (p > 0.005).

Also, Rajati et al. [8] agrees with this study that the patients' mean age was approximately 40 years, and the three groups were matched for age and for gender. There were more males than females in both the nasal obstruction and polyposis groups, although this was not statistically significant.

This study showed that there was a statistically significant difference between the three groups higher in group I than group II and control according to degree of hearing loss, with p-value v<0.05 SN (in Right ear) and p-value < 0.01 SN (in Left ear). In this study there was in group (I) 6 (20.0%) patients have a conductive impairment and 4(13.3%) patients have mild CHL on **the** right ear while 9(30.0%) patients have a conductive impairment, and 5(16.7%) patients have mild CHL on left ear.

But in group (II) 1(3.3%) patient has mild CHL on right ear while 1 (3.3%) patient has mild CHL on left ear and all subjects in control group have normal hearing (as shown in (Table 2).

The CHL present in group(I) may be due to morphological and/or functional changes of the eustachian tubes of CRS patient that caused by inflammation spread, stimulation of inflammatory secretions, and accumulation of paranasal sinus secretions can cause conduction deafness through retrograde infection of the middle ear Lin et al., [9].

Lin et al. [9] disagree with this study that found that sensorineural hearing loss was found in (30 ears) out of 82 patients. The median age of the study and control groups was 28 years (13–40) and 26 years (17–40), respectively. with CRS (164 ears) in the study group (18.3%, 30/164), which was significantly higher than in the control group (2.4%, 1/42, P=0.007).

The SNHL in the study by Lin et al. [9] may be due to the invaded pathogenic microbes in the paranasal sinuses and lymphocytes activated by inflammatory reactions may migrate to the inner ear, where the endolymphatic sac induces immune response antigens generated by nasal mucosa-associated lymphoid tissue, The induced immune response can cause immune-mediated inner ear injury and result in sensorineural deafness. In addition, inner ear injury caused by cytokines (such as tumor necrosis factor, TNF) released during inflammation can also produce sudden deafness Hung et al., [10].

This study showed that there was a statistically significant difference between groups according to complaint Group I vs Group II & Group II vs Group III (control), higher in group I than Group II and control, with p-value< 0.01: significant (S) as shown in (Table 3).

In this study**,** we found that in group(I) 13(43.3%) patients have tinnitus while 14(46.7%) patients have aural fullness, 30

(100.0%) patients have allergies and 5 (16.6%) have hearing loss.

But in group (II) 3 (10.0%) patients had tinnitus while 4 (13.3%) patients had aural fullness, and 30 (100.0%) patients had allergy, while in the control group, all subjects were free.

Bakhshaee et al. [7] & Rajati et al. [8] agree with the current study that there is a significant difference in aural fullness and hearing loss when Group 1(patients with nasal obstruction due to nasal polyposis) is compared with Group 3 (persons free of nasal obstruction) ($p = 0.023$ and $p = 0.026$, respectively). In the current study, there was a statistically significant difference between groups according to the tympanogram, Group 1 vs Group 2 & Group 2 vs Group 3 higher in Group I than Group II and control (Type C) with p-value< 0.01: significant (S) but no significant difference between group II and control group with p-value> 0.05(NS) as shown in (Table. 4)

In this study, we found that in group (I) 10 (33.3%) patients had type (C) tympanogram on the right ear and 13(43.3%) patients had type(C) tympanogram on the left ear, but in group (II) 1(3.3%) patient has type(C) tympanogram on right ear while 2 (6.7%) patients have type (C) tympanogram on left ear while all subjects in control group have normal tympanogram. Bakhshaee et al. [7] & Rajati et al. [8] agree with the current study that, all tympanograms were type A in all controls (Groups 2 and 3). However, in the polyposis group, the right ear of three cases and the left ear of five patients were type B (two patients had bilateral effusion). This difference was statistically significant.

In the current study, there was a statistically significant difference between groups according to Eustachian tube function tests when Group 1 is vs Group 2 & Group 2 vs Group 3 and Group1 vs Group 3 number of patients with ET dysfunction was more in group I and group II than the control group (right & left ears) with P-value< 0.01(S) as shown in (Table 5).

In this study among the group (I) 12 (40.0%) patients have poor ETF&6(20.0%) patients have fair ETF on right ear and 14(46.7%) patients have poor ETF&5(16.7%) patients have fair ETF on left ear.

But in group (II) 9 (30.0%) patients have poor ETF on right ear while 10 (33.3%) patients have poor on left ear and all subjects in the control group have normal ETF.

Bakhshaee et al. [7] & Rajati et al. [8] & Lazo-Sáenzet al. [11] and Sente et al. [12] agree with the current study found that ET functional tests showed inadequate movement in 43.2 and 36.4 % of the polyposis patients during the Valsalva and Toynbee tests, respectively which was significant when compared with the normal controls (Group 3).

Georgitis et al. [13] revealed that mild forms of allergic rhinitis do not interfere significantly with middle ear function.

The cause of ET dysfunction in sino-nasal polyposis could be because of inflammation due to allergies or infection associated with polyposis leading to ET dysfunction as suggested by Rajati et al., [8].

The cause of ET dysfunction in allergic rhinitis may be through either of 2 ways: eustachian tube dysfunction caused by allergic reaction of nasal mucosa or an impaired mucociliary function.

Also, 3 mechanisms that explain eustachian tube dysfunction due to allergic rhinitis: (1) dysfunction may represent a retrograde spread of edema and congestion of nasal mucosa; (2) mucociliary activity may cause the secretion to cover the ostium and lead to intraluminal inflammation; and (3) obstructed lumen of the eustachian tube could be the result of hypersecretion by seromucous glands. On the other hand, it has been proven that an antigen placed in the nasal mucosa of allergic rhinitis patients can induce the release of inflammation mediators, which favours obstruction of the Eustachian tube Lazo-Sáenz et al., [11].

In the current study, ETD is more affected in Group (1) with sinonasal polyposis than Group (2) with allergic rhinitis may be due to the combined effect of sinonasal polyposis that causes Mechanical obstruction of ET orifice &Increased secretions from seromucous glands in the pharyngeal portion of ET that accumulate and block the tube as we found in our study (3) patients with grade IV of nasal polyposis as shown in table (4&5) Thompson and Crowther, [14].

In the current study, we found that the incidence of ETD more than in abnormal tympanograms this may be due to Type Atympanogram does not always mean a good ETF, but the patient may have poor ETF with Eustachian tube dysfunction despite type A tympanogram Hsiehet al., [15].

In this study, we illustrated that there was no statistically significant difference between groups according to SRT with P-value >0.05: Non-significant (NS) as shown in (table 6)

Bakhshaee et al. [7] & Rajati et al. [8] disagree with this study and found that as regards SRT, significant differences were found between Group 1 with sinonasal polyposis and the other two groups (allergic and control groups respectively), but not between Groups 2 (allergic rhinitis) and group 3 (control).

This study showed that there was a statistically significant difference between groups according to compliance of middle ear, a smaller value of ME compliance was found in the polyposis cases in comparison with group (2) and healthy controls (Group 3), with p-value <0.01 S as shown in (table 7).

Rajati et al. [8] agree with this study which found that ET functional studies showed a decreased TM compliance among the polyposis cases in comparison with the healthy controls (Group 3).

In the current study, we found in the group (1) with sino nasal polyposis according to the polyp grading system (18) patients with grade II& (11) patients with grade III and (1) patient with grade IV on the right side while in the left side we found (9) patients with grade II&(18) patients with grade III and (3)patients with grade IV, as shown in (Table 8)

While according to CT staging system in the same group (1) we found that the degree of opacity of sinuses range from (11-22) according to median 17&Lund-Mackay sinus CT grading system as shown in (Table 9).

This means most patients in group (1) have less up to full opacity of sinus that mean extension of polyp to most of sinus.

In this study, we found that there was no statistically significant difference in group (1) between Endoscopic examination (polyp grading system) and type of Tympanogram (type C) and ET functions in the (right &left ear), with p-value >0.05 NS, as shown in (Table 10&11).

Also in this study, we found that there was no statistically significant difference in the group (1) between CT staging system and type of Tympanogram (type C) and ET functions in the (right & left ear) ear, with p-value >0.05 NS, as shown in (Table 12&13).

This demonstrated that the ET dysfunction and abnormal type of tympanogram in cases of nasal polyposis may be due to the inflammation and infection associated with polyposis not due to the obstructive nature of the diseases.

## 5. Conclusion

The ET functions (Tympanometry, Swallowing step and Toynbee test) in the polyposis patients and allergic patients without polyposis seem to be disturbed. This is probably due to the inflammation and infection associated with polyposis and allergy.

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