

The Effects of Obesity on the Eustachian Tube Function in Saudi Adults (A Cross-Sectional Study)



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Abstract

Eustachian tube dysfunction is estimated to occur as a chronic condition in approximately 4% of adults worldwide. Several studies have suggested that obesity (defined by WHO as a body mass index of 30 or more) [1] can predispose to Eustachian tube dysfunction because fatty deposits may accumulate around the Eustachian tube [2-6]. Alternatively, other studies have found that acute weight loss was associated with Patulous Eustachian tube, probably due to loss of peri-tubal fat [7-9]. Tympanometry is one known method of diagnosing Eustachian tube dysfunction [10]. Our aim from this study is to determine the effects of obesity on Eustachian tube function using tympanometry. This study was done in a tertiary care hospital in Riyadh, Saudi Arabia. We included 82 Saudi adult patients. In our population, we found no statistically significant difference in the Eustachian tube function between obese and non obese patients. Further studies with a larger sample size and different methods of Eustachian tube function assessment might be needed for better understanding of the relationship between obesity and Eustachian tube function.

Introduction

Eustachian tube dysfunction is estimated to occur in approximately 4% of adults worldwide as a chronic condition, however, it can present as an intermittent problem in an unknown but higher percentage. It is believed that Obesity (defined by WHO as body mass index of 30 or more) [1] can increase the risk of Eustachian tube dysfunction because of fatty deposits accumulation around the Eustachian tube [2]. Several studies have suggested a relationship between pediatric obesity and otitis media with effusion because of fat accumulation around the Eustachian tube [3-6]. On the other hand, other studies have found that acute weight loss following bariatric surgery (probably due to loss of peritubal fat) was found to be associated with Patulous Eustachian tube [7-9]. Tympanometry is a test that is used for indirect measurement of the compliance (mobility) and the impedance of the tympanic membrane together with the condition of the ossicles of the middle ear, which was found to be helpful in the diagnosis of Eustachian tube dysfunction along with other middle ear conditions [10]. Valsalva and Toynbee maneuvers can alter the pressure of the middle ear and thus the position tympanic membrane [11]. Kumazawa et al. [12]

described Eustachian tube function testing using tympanometry measurements before and after Valsalva and Toynbee maneuvers. Based on the results they categorized Eustachian tube function into normal, dysfunctional and Patulous Eustachian tube. Our aim from this study is to use the same method that was used by Kumazawa et al. [12] to study the Eustachian tube status in adults, and compare the results between obese and non obese individuals, which to our knowledge has not been done before in Saudi Arabia.

Methodology

Objectives of the study

Aim of the study: To study the relationship between obesity and Eustachian tube dysfunction.

Secondary objectives:

- i. To compare tympanometric measurements between obese and non obese.
- ii. To compare the effects of Valsalva maneuver on Eustachian tube function between obese and non obese patients.

iii. To assess if the effects of Valsalva maneuver would last for 10 minutes in the two groups.

iv. To compare the effects of Toynbee maneuver on Eustachian tube function between obese and non-obese patients.

Materials and Methods

This study is a cross-sectional study which was done in a tertiary hospital in Riyadh, Saudi Arabia in the outpatient department of otolaryngology and head & neck surgery, specifically in the otology outpatient department. It was done by performing serial tympanograms and comparing the results between obese and non-obese patients.

Study subjects

Inclusion criteria:

- Every third adult patient that presented to the otology clinic.
- Male and female patients.
- Patients that presented to the clinic from first of October 2016 to end of March 2017.
- Patients with tympanogram type A and C.

Exclusion criteria:

- Pediatric Patients.
- Patients with tympanogram type B.
- Any patient with craniofacial anomalies.

Study design

The study design we used for this study is a cross-sectional study design.

a. Sample size: The sample size of this study is 82 patients (141 ears) who fulfilled our inclusion and exclusion criteria.

b. Sampling technique: The sampling technique we used is systemic randomization. We included every third adult patient that presented to the otology clinic.

c. Data collection methods, instruments used, and measurements:

i) Instruments Used:

A. GSI Tympanometer Version 1 Middle-Ear Analyzer:

a. It is a computer-based admittance instrument designed to be used in clinical or research settings. The Tympanometer is based on the sophistication, functionality and flexibility of the GSI 33, offering unparalleled testing capabilities.

b. In this study:

a) Admittance (Y) was measured with a probe tone frequency of 226 Hz in a Screening tympanometry mode (Automatic).

b) P-RANGE daPa: Normal.

c) START daPa: +200.

d) Gradient: Tympanometric Width daPa.

e) P-RATE daPa/s: 600/200.

B. Diagnostic Criteria:

a. Tympanometry Normative Data

b. Based on the British Society Of Audiology:

a) Tympanic peak pressure and middle ear pressure:

Under carefully controlled conditions the 95 % range in normal subjects is -20 to +20 daPa, though pressures from -50 to +50 daPa can be considered normal in adults; pressures down to -100 daPa may be of a little clinical significance in isolation.

i. Admittance or compliance: Compliance is normally in the range 0.3 to 1.6 cm³ in adults; 0.2 cm³ is acceptable as the lower limit in children aged less than 6 years but over 6 months.

ii. Ear-canal volume: Typical values for ear-canal volume (ECV) are between 0.6–1.5 cm³ for adults.

b) Based on studies reviewed in Hunter and Shahnaz (2013).

c) All Patients underwent 4 tympanograms:

a. Tympanogram I: patients underwent a baseline tympanogram.

b. Tympanogram II: patients were asked to perform Valsalva maneuver, then immediately underwent a second tympanogram.

c. Tympanogram III: patients were asked to take a 10 minutes break, then underwent a third tympanogram.

d. Tympanogram IV: Patients were asked to perform Toynbee maneuver, then underwent a fourth tympanogram.

C. Data management and analysis:

The data was analyzed using SPSS. Tympanogram variables were analyzed which included: external auditory canal volume, pressure, compliance and gradient. The mean, standard deviation, and confidence interval were calculated. We used Levene's Test for Equality of Variances to calculate the significance.

D. Ethical consideration

Confidentiality was maintained. The research was fully explained to all the participants, and an informed consent was obtained from each participant, patients were told that they were free to withdraw from the research whenever they wished.

Results

After running the data in SPSS, we found that among the 82 patients (141 ears): 49 female patients (60.1%) and 33 male

patients (39.9%). Interestingly, there was 49 non obese patients (23 females{47%} and 26 males{52%}) vs 33 obese patients (26 females {78.8%} vs 7 males {21%}). Female obesity was higher than male obesity which might be attributed to social reasons.

Most variables of tympanometry: type, gradient, compliance and volume didn't show changes in response to Valsalva and Toynbee. However, the only variable of tympanometry that showed changes in response to both maneuvers was (middle ear pressure):

- a. In tympanogram I, non obese patients had a mean pressure of -19.2 while obese patients had a mean pressure of -16.6.
- b. In tympanogram II, non obese patients had a mean pressure of -1.2 while obese patients had a mean pressure of 1.9.
- c. In tympanogram III, non obese patients had a mean pressure of -14.7 while obese patients had a mean pressure of -9.9.
- d. In tympanogram IV, non obese patients had a mean pressure of -31.9 while obese patients had a mean pressure of -25.9 (Table 1).

Table 1:

Group Statistics				
	BMI	N	Mean	Std. Error Mean
Prs.-I	Non-Obese	83	-19.2169-	8.97988
	Obese	58	-16.5517-	9.26863
Prs.-II	Non-Obese	83	-1.2048-	8.83560
	Obese	58	1.8966	8.90039
Prs.-III	Non-Obese	83	-14.6988-	7.92882
	Obese	58	-9.9138-	8.94587
Prs.-IV	Non-Obese	83	-31.8675-	7.89044
	Obese	58	-25.8621-	10.54126

The differences between middle ear pressure among different tympanograms in non obese patients are described below:

- a. The difference in mean pressure between tympanometry II and I was +18.01 (standard error of 5.27) with a P-value of 0.001, which means that Valsalva maneuver raised the middle ear pressure significantly in the control group.
- b. The difference in mean pressure between tympanometry III and II was was -15 (standard error of 3.56) with a P-value of 0.001 which means that, The effect of Valsalva lasted LESS than 10 mins and the pressure went back to the negative side afterwards.

c. The difference between tympanometry III and I was +4.5 (standard error of 4.4) with a p value of 0.308. Which indicates that, after the 10 minutes break, the pressure went down close to the baseline. This P-value for the difference in pressure between them is insignificant.

d. The difference between tympanometry IV and II was -30.7, with a P-value of 0.001 which means that Toynbee decreased the pressure in the middle ear significantly.

The differences between middle ear pressures among different tympanograms in obese patients are described below:

- i. The difference in the mean pressure between tympanometry II and I was +18.4 (standard error of 4.77) with a P-value of 0.001, which means that, Valsalva maneuver has a positive effect on the middle ear pressure.
- ii. The difference in the mean pressure between tympanometry III and II was -11 (standard error of 3.9) with a P-value Of 0.004 which means that, also in obese patients, the effect of Valsalva maneuver didn't last for 10 minutes and the pressure went back to the negative side.

iii. Again in obese patients the difference between tympanometry III and I was 6.6 (standard error of 3.6) with a p value of 0.075. Which indicates that, after the 10 minutes break, the pressure went down close to the baseline and again, the P-value for the difference in pressure between them is insignificant.

iv. The difference between the middle ear pressures in tympanometry IV and II was -27.76, with a P-value of 0.0001 which means that Toynbee decreased the pressure in the middle ear significantly among the obese.

The differences in middle ear pressure between the different tympanograms were compared between obese and non obese patients and non of the results showed any significant difference between them (Tables 2 & 3).

Table 2:

Group Statistics				
	BMI	N	Mean	Std. Error Mean
diff_pr_II_I	Non-Obese	83	18.0120	5.27174
	Obese	58	18.4483	4.77441
diff_pr_III_I	Non-Obese	83	4.5181	4.40278
	Obese	58	6.6379	3.67787
diff_pr_III_II	Non-Obese	83	-15.8771-	7.91772
	Obese	58	-11.1000-	8.93368
diff_pr_IV_II	Non-Obese	83	-30.6627-	5.36418
	Obese	58	-27.7586-	6.71921

Table 3:

Independent Samples Test											
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
										Lower	Upper
diff_pr_II_I	Equal variances assumed	.083	.774	-.058-	139	.953	-.43623-	7.46566	-15.19716-	14.32470	
	Equal variances not assumed			-.061-	138.062	.951	-.43623-	7.11240	-14.49955-	13.62709	
diff_pr_III_I	Equal variances assumed	.260	.611	-.347-	139	.729	-2.11986-	6.10107	-14.18276-	9.94304	
	Equal variances not assumed			-.370-	138.999	.712	-2.11986-	5.73683	-13.46259-	9.22287	
diff_pr_III_II	Equal variances assumed	.264	.608	-.396-	139	.693	-4.77711-	12.06253	-28.62688-	19.07266	
	Equal variances not assumed			-.400-	127.172	.690	-4.77711-	11.93738	-28.39872-	18.84450	
diff_pr_IV_II	Equal variances assumed	.033	.855	-.341-	139	.734	-2.90403-	8.52746	-19.76434-	13.95628	
	Equal variances not assumed			-.338-	119.163	.736	-2.90403-	8.59780	-19.92830-	14.12024	

Discussion

World health organization (WHO) defined underweight as a body mass index (BMI) of below 18.5, normal weight as a BMI of 18.5 to 24.9, over weight as a BMI of 25-29.9, and BMI of 30 or more as obesity (3 classes) [1]. Eustachian tube dysfunction is estimated to occur in approximately 4% of adults worldwide as a chronic condition, and it is believed that it might account for an even higher percentage as an intermittent problem. Multiple studies have suggested that obesity in pediatrics can be associated with Eustachian tube dysfunction because of fat deposition around the Eustachian tubes [3-6]. Moreover, acute weight loss following bariatric surgery was found in more than one study to be associated with Patulous Eustachian tube that could be explained by peri-tubal fat loss, which implies that obesity and more peri-tubal fat can be associated with Eustachian tube dysfunction [7-9].

Tympanometry is a test for the indirect measurement of the compliance (mobility) and the impedance of the tympanic

membrane as well as it might give a hint about the condition of the ossicles in middle ear. It is done by applying positive, normal, and negative pressure in the external auditory canal and monitoring the resultant sound energy flow, and it was found to be helpful in the diagnosis of Eustachian tube dysfunction together with other middle ear conditions [10]. Valsalva maneuver is an expiratory effort with the mouth is closed and the nostrils are pinched shut which forces air into the Eustachian tubes thus increases pressure medial to the tympanic membrane pushing it laterally [11]. While, Toynbee is a maneuver in which the patient will be asked to pinch the nostrils and swallow, If the Eustachian tube is patent, the tympanic membrane will retract medially [11].

Using tympanometry to diagnose Eustachian tube dysfunction is not a new thing; Kumazawa took baseline tympanogram measurements for his patients and then asked them to perform Valsalva, and took second measurements, he then asked them to perform Toynbee, and took their measurements one last time. He then categorized the Eustachian

tube function into: normal when the pressure went up after Valsalva then went back to normal after Toynbee, dysfunctional when the pressure went up after Valsalva and didn't go back to normal after Toynbee, and Patulous when the pressure went back to normal immediately after Valsalva without the need to perform Toynbee [12]. In our study, we used the same method that was used by Kumazawa et al. [12] to study the Eustachian tube status in adults, and we compared the results between obese and non obese individuals.

In tympanogram I, both obese and non obese patients had a baseline mean pressure which was within normal (normal is from -50 up to 50). In tympanogram II, after performing Valsalva, both groups' mean pressures raised significantly and proportionally (non obese patients' mean pressures increased from -19.2 to -1.2 and obese patients' mean pressure raised from -16.6 to 1.9) and the new readings were still within the normal limits. This significant raise in pressure proves that Valsalva is effective in raising middle ear pressure in both groups in a similar fashion. In tympanogram III, both groups' mean pressure declined proportionally (non obese: 14.7, obese: 9.9), but didn't go back to the baseline, this declination suggests that the effect of Valsalva doesn't last for a long time. In tympanogram IV, after performing Toynbee, both groups' mean pressures declined significantly and proportionally (non obese: -31.9, obese: -25.9) and the new readings were still within the normal limits. This significant declination proves that Toynbee is effective in decreasing middle ear pressure in both groups in a similar fashion.

From the above comparison, we can conclude that, using our method, there was no difference in the Eustachian tube function between obese and non obese patients nor there any significant difference in the effects and the duration of the effects of Valsalva and Toynbee between the two groups (Tables 2 & 3).

Conclusion

Using our method, we can conclude that Valsalva and Toynbee maneuvers have significant effects on in the middle ear

pressure in both adult obese and non obese patients. Valsalva maneuver increases the middle ear pressure significantly but temporarily with an effect that lasts less than 10 minutes. There is no significant difference between adult obese and non obese patients in middle ear baseline pressure, effects of Valsalva and Toynbee maneuvers, or the duration of the effects. Further studies with larger sample size and different methods of Eustachian tube function assessment are needed for better understanding of the link between obesity and Eustachian tube function.

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