Does Smoking Affect the Findings of Tympanometry in Healthy Subjects?: A Pilot Study

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Abstract

Study Design

Pilot cross-sectional survey
Methods

100 healthy adult volunteers (50 smokers and 50 non-smokers) were recruited for the study. Exclusion criteria included:
History of ear /sinonasal disease/cleft palate/upper respiratory tract infection at time of examination

Abnormal tympanic membrane
Impacted wax
Significant passive smoking in non-smokers

All subjects included in the study were evaluated as follows:

Detailed smoking history
Otoscopy
Tympanometry

Results

There is a tendency for more negative middle ear pressure in smokers than in non-smokers though this difference may not be clinically significant. There were no significant differences in ear canal volume, middle ear compliance and presence of stapedial reflex in both groups. There was no correlation between middle ear pressure and duration of smoking and number of cigarettes smoked amongst smokers.
Conclusion

A definitive study with a larger sample size is needed to explore the effects of smoking on findings of tympanometry in healthy subjects.

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INTRODUCTION

The relationship between smoking and respiratory tract disease has been extensively investigated. The middle ear cleft is developmentally a part of the upper respiratory tract and anatomically continuous with it. There is conflicting evidence regarding the effect of smoking on hearing loss with one study suggesting that smoking may play a role in age-related hearing loss. [1]

A number of studies have highlighted the occurrence of negative middle ear pressure and of middle ear effusions in

children exposed to passive smoking. [2, 3, 4]

Since its introduction some 30 years ago, tympanometry has been widely used as a diagnostic and screening tool for abnormal middle ear function. Its sensitivity in detection of fluid in the middle ear has been validated by subsequent myringotomy.[5]

The aim of the present study is to determine whether active smoking has any adverse effect on middle ear pressure and compliance in healthy subjects as measured by tympanometry.

MATERIAL AND METHODS

We carried out a pilot cross sectional observational study involving healthy volunteers divided into 2 groups:

STUDY GROUP.

Smoking apparently healthy volunteers

CONTROL GROUP.

Healthy non-smoking volunteers with no significant history of passive smoking.

Healthy volunteers for both groups were recruited from individuals of different age groups in the hospital dining room.

EXCLUSION CRITERIA FOR BOTH GROUPS:

- History of ear surgery
- History of recurrent upper respiratory tract infections
- Acute upper respiratory tract infection at time of examination
- History of cleft palate
- Abnormal appearance of tympanic membrane
- Impacted wax in ear canals

METHODS

The North Wales Local Research Ethics Committee approved the study.

All subjects in both study and control groups were subjected to the following after obtaining a written informed consent:

A) Brief history taking including;

History of smoking, number of cigarettes per day, duration of smoking and presence of passive smoking.

B) Otoscopy; to ascertain the presence of a normal ear canal, tympanic membrane and absence of impacted wax

C) Impedance metry using the GSI 33 autotympanometer to measure:

1. middle ear pressure
2. middle ear compliance
3. volume of ear canal
4. stapedial reflex

STATISTICAL METHODS

All studied variables showed clear evidence of non-normality ($p < .01$); hence non-parametric statistical methods are used throughout. A Mann-Whitney test was used to compare the 50 smokers with the 50 non-smokers for all the variables, except Stapedial Reflex (binary variable). A chi-square test was used to test for differences between smokers and non-smokers on Stapedial Reflex. Spearman's correlation coefficients were calculated to investigate whether, for smokers, there were any correlations between middle ear volume and pressure and age, duration of smoking, number of cigarettes smoked per day or time last smoked (minutes).

RESULTS

100 healthy volunteers took part in the study; 50 smokers and 50 non-smokers. Table 1 shows the distribution of patients by age and sex. Table 2 gives the descriptive statistics (median, range) and p-values. Evidence of differences between smokers and non-smokers were found for middle ear pressure in both right and left ears ($p = .042$ and .010, respectively). Middle ear pressure was higher (i.e. less negative), on average, for non-smokers in both ears. No other differences were found.

Figure 1

Table 1: Distribution of subjects by age and sex

	Smokers	Non-Smokers
Mean Age in Years(range)	38.8 (22-64)	41 (22-57)
Males	12	14
Females	38	36

Figure 2

Table 2: Descriptive statistics and p-values for comparisons of smokers and non-smokers

	Variable	Median (range)		p-value
		Smokers	Non-smokers	
Right ear	ECV(ml)	1.0 (0.6 – 2.2)	0.9 (0.5 – 2.2)	.08
	Middle Ear Volume(ml)	0.55 (0.2 – 2.0)	0.6 (0.1 – 1.8)	.96
	Middle Ear Pressure (dapa)	-.50 (-170 – +50)	0.0 (-180 - +25)	**.042**
Left Ear	ECV(ml)	1.0 (0.2 – 2.4)	0.9 (0.5 –2.5)	.35
	Middle Ear Volume(ml)	0.5 (0.0 – 2.2)	0.5 (0.0 – 2.9)	.75
	Middle Ear Pressure (dapa)	-10 (-205 - +25)	-5 (-200 - +40)	**.010**

Table 3 shows the numbers of patients with and without Right and Left Stapedial Reflex (respectively) in both groups.

Figure 3

Table 3: Incidence of stapedial reflex

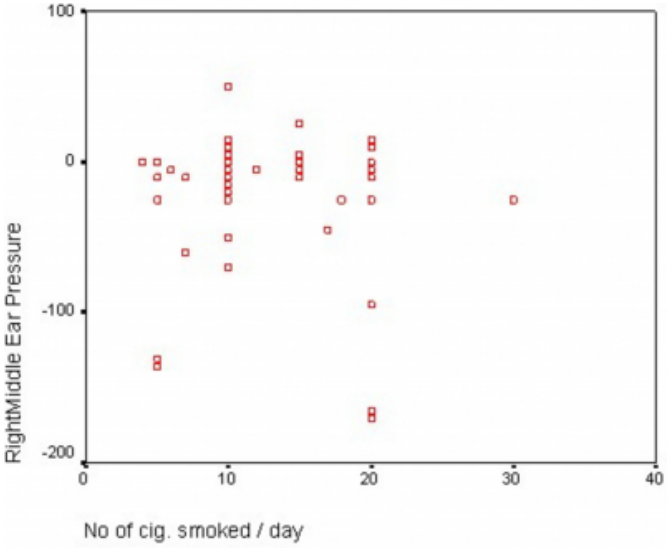
Right Stapedial Reflex	Smokers	Non-smokers	Total
Absent	19 (38%)	15 (30%)	34
Present	31 (62%)	35 (70%)	66
Left Stapedial Reflex	**Smokers**	**Non-smokers**	**Total**
Absent	21 (42%)	20 (40%)	41
Present	29 (58%)	30 (60%)	59

There were no significant differences in the stapedial reflexes between smokers and non-smokers. (Chi-square test; p = .40 and .84 for right and left ears, respectively). Mann-Whitney tests and a Chi-square tests (for Stapedial Reflex) were used to compare males and females. Significant differences were found only for External Canal Volume (ECV) both left and right ears (p = .001). The males had higher ECV's in both ears than females. No other differences were found.

No significant correlations were found between measured variables, smoking habits (Number of cigarettes\smoked/day, duration of smoking in years and time when subject last smoked) and age. Figure 1 is a plot of right middle ear pressure against number of cigarettes smoked per day, illustrating the lack of any clear relationship(r=0.05, p=0.7).

Figure 4

Figure 1: Correlation of right middle ear pressure with number of cigarettes smoked per day.



DISCUSSION

Many studies have demonstrated the harmful effects of smoking on individual smokers, including an increased incidence of arterial disease, lung cancer and respiratory infections. There are a number of ways in which smoking could affect Eustachian tube function and tympanometry findings including a direct effect of irritants in tobacco smoke on the mucosa of the middle ear and Eustachian tube and increased respiratory tract infections. Agius et al, 1995 demonstrated impaired middle ear ciliary function due to tobacco smoke exposure.5 Steiger and Champon, 1997 found that the Valsalva-induced tympanometric peak pressure shifts of young smokers were less than those measured among young non-smokers. They also observed a similar but less compelling finding among elderly subjects. [6]

Antonelli et al, 1994 used a chinchilla model to determine whether tobacco smoke contributes to the pathogenesis of acute otitis media. They found that persistence of middle ear effusion and persistence of non-typable Haemophilus influenzae in the middle ear effusion were not different between the smoke- and sham-exposed groups. This suggests that mainstream smoke exposure does not change the natural course of otitis media in the chinchilla model. [7]

Our study shows a statistically significant association of smoking with negative middle ear pressure in healthy individuals. This effect may not be clinically significant (normal values of up to -150 dapa) in our small sample size of healthy subjects. The question also arises whether smoking may adversely affect middle ear pressure to a greater extent in patients with pre-existing Eustachian tube dysfunction such as patients with upper respiratory tract infections and nasal allergy. The absence of correlation between the number of cigarettes smoked / duration of smoking and middle ear pressure may be due to the small sample size of the healthy smokers. The findings of this pilot study can help in the sample size calculation of a definitive study addressing this issue. The preoperative Eustachian tube function is considered an important predictive factor for the result of Tympanoplasty. [8] Future research is therefore needed to evaluate any potential effect of smoking on Eustachian tube function in patients with chronic ear disease.

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