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Otoscopic appearances and tympanometric changes in *narghile* smokers

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Abstract
Narghile (water-pipe) smoking requires the generation of significant negative intrapharyngeal pressure, which may be transmitted to the middle ear through the Eustachian tube. A total of 80 ears from regular *narghile* smokers were examined otoscopically and by tympanometry. Seventy ears from heavy cigarette smokers were similarly examined and served as a control group. There was a highly significant increase in the prevalence of attic retractions ($P < 0.01$) in the *narghile* smokers. The tympanometric changes were not significantly different between the two groups ($P > 0.05$).

Key words: Smoking; Ear, Middle; Eustachian Tube

Introduction

There are several documented situations in which significant negative pharyngeal pressures are transmitted to the middle ear through the Eustachian tube. The high negative middle ear pressure caused by sniffing creates retraction of the tympanic membrane, which can be visualized otoscopically.[1,2] Retraction of the tympanic membrane may eventually result in various middle ear disorders, such as retraction pockets, atelectatic ears, otitis media with effusion and even cholesteatomas.[3] The transmission of the negative pressure from the nasopharynx to the middle ear requires an abnormally patent Eustachian tube. Negative middle ear pressures as great as –1000 mm water have been recorded during sniffing.[4] During the Toynbee manoeuvre (i.e. swallowing while the nose is closed), negative nasopharyngeal pressure as low as –300 mm water and negative middle ear pressure (measured by tympanometry) as low as –200 mm water have been recorded.[5] In Muller's manoeuvre, the subject attempts to breathe in as hard as possible while the nose is pinched closed and the mouth is closed.[6] The airway pressure in Muller's manoeuvre may be as low as –1000 mm water.[7]

Narghile smoking is very common in the Middle East and Asia. The *narghile* (water-pipe) is an oriental form of tobacco pipe in which the smoke is drawn through a bowl filled with water before passing into the mouth through a long flexible tube (see Figure 1). The incidence of *narghile* smoking has increased greatly in Egypt over the last decade and has attracted much attention in the public media because of its ill-effects on various body systems. *Narghile* smoking requires the generation of significant negative intrapharyngeal pressure to draw the smoke. This negative pressure may be substantial owing to the partial blockage of the tube system by deposited tobacco.

This study aimed to assess otoscopic and tympanometric changes in persons who had habitually smoked *narghile* for significant periods. Persons who had smoked cigarettes

FIG. 1
Narghile smoking. (Reproduced with permission of the subject.)

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TABLE I

PREVALENCE OF TYMPANIC MEMBRANE PATHOLOGY

	Narghile smokers		Cigarette smokers	
Pathology	Right ear *n* (%)	Left ear *n* (%)	Right ear *n* (%)	Left ear *n* (%)
Pars flaccida only	17 (42.5)	17 (42.5)	6 (17.1)	7 (20.0)
Pars tensa only	1 (2.5)	0 (0.0)	2 (5.7)	2 (5.7)
Pars flaccida and pars tensa	14 (35.0)	15 (37.5)	6 (17.1)	6 (17.1)
Total pathology	32 (80.0)	32 (80.0)	14 (40.0)	15 (42.9)
Normal tympanic membrane	8 (20.0)	8 (20.0)	21 (60.0)	20 (57.1)
Total	40 (100)	40 (100)	35 (100)	35 (100)

in significant amounts for a similar period served as controls. A control group was felt necessary as the inflammatory effect of smoke[8] and the effect of postnasal airflow turbulence on the Eustachian tube[9] are similar in both types of smoking. However, cigarette smoking does not require generation of significant negative intrapharyngeal pressure.

Subjects and methods

Forty men who had been smoking *narghile* for at least five years, for more than 1 hr a day, were examined with a pneumatic otoscope with halogen illumination. The 80 ears were examined by otoscopy for changes in the tympanic membrane and by tympanometry using an automatic tympanometer (range +200 daPa to –300 daPa: 1 daPa = 1.02 mm water). Tympanometry was performed after the subjects attempted several swallowings. The control group comprised 35 men who had smoked more than 20 cigarettes a day for at least the past five years. The 70 ears were examined by otoscopy and by tympanometry.

The otoscopic appearance was noted for any abnormality in the pars tensa or pars flaccida of the tympanic membrane. Pars tensa retraction was graded according to Sade *et al*.[10] into: grade 1, slight retraction of the tympanic membrane towards the promontory; grade 2, tympanic membrane touches the incus or stapes; grade 3, tympanic membrane touches the promontory; and grade 4, tympanic membrane adherent to the promontory. The degree of pars flaccida retraction was graded according to Sade *et al*.[11] into: grade 1, slight retraction of the pars flaccida not touching the neck of the malleus; grade 2, pars flaccida reclining on the neck of the malleus; grade 3, as in grade 2 accompanied by partial destruction of the scutum; and grade 4, attic cholesteatoma. Tympanograms were classified as: type A, peak > –100 daPa; type Ad, very high peaked curve, off the graph; type B, flat; and type C, peak < –100 daPa.[12] The results were analysed statistically by means of the Chi^2 test.

Results

The study group comprised 40 men who were regular *narghile* smokers. Their age range was 20–60 years (mean 38 years). The 80 ears were evaluated by pneumatic otoscopy and by tympanometry. The control group comprised 35 men who were regular cigarette smokers. Their age range was 19–64 years (mean 39 years). The 70 ears were similarly evaluated by otoscopy and by tympanometry.

Otoscopic appearances

Table I shows the prevalence of tympanic membrane changes in both groups. There were no significant differences in the otoscopic findings between the right and left ears in either group. Normal tympanic membranes were found in only 20 per cent of the total tympanic membranes examined in the *narghile* smokers. This was significantly less than in the cigarette smokers, in whom normal tympanic membranes were observed in 58.6 per cent of the total tympanic membranes examined ($p < 0.01$)

Table II reports the detailed otoscopic appearances of the pars flaccida and the pars tensa. Whereas differences in the pars tensa between the two groups of smokers were not statistically significant ($p > 0.05$), the pars flaccida retractions were much more common in the *narghile* smokers than in the cigarette smokers ($p < 0.01$).

TABLE II

OTOSCOPIC APPEARANCES

	Narghile smokers		Cigarette smokers	
Otoscopic appearance	Right ear *n* (%)	Left ear *n* (%)	Right ear *n* (%)	Left ear *n* (%)
Pars flaccida				
Normal	8 (20.0)	9 (22.5)	22 (62.9)	23 (65.7)
Grade 1 retraction	15 (37.5)	15 (37.5)	9 (25.7)	9 (25.7)
Grade 2 retraction	14 (35.0)	15 (37.5)	4 (11.4)	3 (8.6)
Grade 3 retraction	2 (5.0)	1 (2.5)	0 (0.0)	0 (0.0)
Grade 4 retraction	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Radical mastoidectomy	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)
Total	40 (100)	40 (100)	35 (100)	35 (100)
Pars tensa				
Normal	25 (62.5)	25 (62.5)	28 (80.0)	26 (74.3)
Grade 1 retraction	9 (22.5)	10 (25.0)	4 (11.4)	5 (14.3)
Grade 2 retraction	1 (2.5)	2 (5.0)	1 (2.9)	0 (0.0)
Grade 3 retraction	1 (2.5)	1 (2.5)	0 (0.0)	1 (2.9)
Grade 4 retraction	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Atrophy & tympanosclerosis	2 (5.0)	2 (5.0)	1 (2.9)	2 (5.7)
Perforation	1 (2.5)	0 (0.0)	1 (2.9)	1 (2.9)
Radical mastoidectomy	1 (2.5)	0 (0.0)	0 (0.0)	0 (0.0)
Total	40 (100)	40 (100)	35 (100)	35 (100)

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TABLE III
TYMPANOMETRY RESULTS

Tympanogram	*Narghile* smokers		Cigarette smokers	
	Right ear *n* (%)	Left ear *n* (%)	Right ear *n* (%)	Left ear *n* (%)
Type A	30 (75.0)	32 (80.0)	30 (85.7)	29 (82.9)
Type Ad	4 (10.0)	3 (7.5)	2 (5.7)	2 (5.7)
Type C	2 (5.0)	3 (7.5)	1 (2.9)	1 (2.9)
Type B	2 (5.0)	2 (5.0)	1 (2.9)	2 (5.7)
No seal*	2 (5.0)	0 (0.0)	1 (2.9)	1 (2.9)
Total	40 (100)	40 (100)	35 (100)	35 (100)

*Perforation or mastoidectomy.

It must be noted that tympanic membrane pathologies include minor retractions of the pars flaccida, which may be considered harmless.[13]

Tympanometry results

Table III reveals the various tympanometric profiles in both groups. A type A tympanogram was obtained in 77.5 per cent of the *narghile* smokers' ears. The corresponding figure for cigarette smokers was 84.3 per cent. The difference is not statistically significant ($p > 0.05$).

Discussion

In order for the middle ear to function as an auditory organ, it is important that atmospheric pressure be always maintained via normal ventilation.[14] This is done by gas exchange through the Eustachian tube[15] as well as by gas exchange through the middle ear and mastoid mucosa.[16,17] In case of a low pressure relative to the atmosphere, i.e. negative middle ear pressure, reduction of the middle ear space restores the pressure back to atmospheric or near-atmospheric values.[18] Retraction of the pars flaccida or the pars tensa of the tympanic membrane reduces the middle ear space, which would be expected to increase the pressure in the middle ear.[19] Damage to the pars tensa collagenous layer, e.g. by prior inflammation or persistent negative middle ear pressure, may be so severe that the pars tensa becomes even weaker than the pars flaccida. This may explain why pars tensa retractions occasionally occur in the absence of pars flaccida retractions.[20] Atelectatic tympanic membranes and retraction pockets of the pars tensa or pars flaccida often possess a dynamic character; they may worsen, and may occasionally become non-self-cleansing and develop into cholesteatomas.[10,21] Another important consideration in retractions of the tympanic membranes is their relation to hearing loss.[22]

Conventionally, it has been understood that the Eustachian tube is closed by luminal and extraluminal forces and opened only during actions such as swallowing and yawning. Most investigators have treated the parameters of the tubal function tests as static properties of the system, able to be modified only during development or by an acute illness. However, a more dynamic view of tubal function has been suggested.[23] The aeration of the middle ear may be finely modulated by neurogenous reflexes.[24,25] An intermittent ability to induce negative middle ear pressure by rapid sniffing has been documented in a large number of subjects.[26] One explanation for the intermittency of the phenomenon is that the passive closure of the Eustachian tube varies with time, allowing middle ear gas to be aspirated into the nasopharynx when these forces are minimal.

During tympanometry, the tympanic membrane (and ossicular chain) compliance changes as air pressure in the external auditory canal is varied.[27] The peak of maximum compliance indicates the middle ear pressure, and a type A curve with the peak between +100 and –100 mm water is considered normal.[28] Middle ear pressures in ears with atelectasis of the tympanic membrane have been recorded by Buckingham and Ferrer[29] and found to be only –7 mm water on average. These authors reasoned that retraction of the tympanic membrane results in reduction of the volume of the middle ear cavity and negation of the negative pressure in the ear as it develops.

- **Study assessing the effects on the middle ear of smoking through a water pipe (*narghile*), which generates a negative middle ear pressure**
- **Effects were compared with conventional smoking**
- **Although the tympanometric changes were not significantly different, *narghile* smoking was associated with a higher prevalence of attic retraction**

Passive smoking in children causes decreased middle ear ciliary beat frequency and has been associated with otitis media with effusion.[30] However, there is no indication that adult cigarette smokers have a higher incidence of middle ear disease compared with non-smokers.[31] Moreover, cigarette smoking was found to have no significant effect on the admittance characteristics at the plane of the tympanic membrane.[32] On the other hand, *narghile* smoking requires the generation of significant negative pharyngeal pressures, which can be transmitted to the middle ear, causing retraction of the tympanic membrane.[33]

It should be noted that the author was not blinded to the patients' smoking habits, as *narghile* smokers were seen at social clubs. A literature search did not reveal any information concerning the effect of *narghile* smoking on the ears of smokers.

Conclusion

This study found a significant increase in the prevalence of attic retraction in the ears of regular *narghile* smokers. Further studies may be required to obtain more information about development of negative middle ear pressures in these individuals, and to gain more insight into Eustachian tube function.

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