

Short term effect of hubble-bubble smoking on voice

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Abstract

Objective: To investigate the short term effect of hubble-bubble smoking on voice.

Study design: Prospective study.

Material: Eighteen non-dysphonic subjects (seven men and 11 women) with a history of hubble-bubble smoking and no history of cigarette smoking underwent acoustic analysis and laryngeal video-stroboscopic examination before and 30 minutes after hubble-bubble smoking.

Results: On laryngeal video-stroboscopy, none of the subjects had vocal fold erythema either before or after smoking. Five patients had mild vocal fold oedema both before and after smoking. After smoking, there was a slight increase in the number of subjects with thick mucus between the vocal folds (six, vs four before smoking) and with vocal fold vessel dilation (two, vs one before smoking). Acoustic analysis indicated a drop in habitual pitch, fundamental frequency and voice turbulence index after smoking, and an increase in noise-to-harmonics ratio.

Conclusion: Even 30 minutes of hubble-bubble smoking can cause a drop in vocal pitch and an increase in laryngeal secretions and vocal fold vasodilation.

Key words: Hubble Bubble; Smoking; Voice; Acoustic Analysis; Stroboscopy

Introduction

The global tobacco smoking epidemic has been associated with more than 40 causes of morbidity and mortality, most of which occur in developing countries as well as developed ones.^{1–3} Most health policies and research projects focus on cigarette smoking; however, in the Middle East most young people smoke tobacco using water pipes. Emigration from the Middle East to other parts of the world, together with tourist exposure in coffee shops, have contributed to an expansion of water pipe smoking in Europe and the USA. A comprehensive review regarding glottal water pipe smoking indicated an increase in usage, attributed to a mistaken perception regarding the health effects of this kind of smoking which has facilitated its spread among women and children.⁴ A study conducted at the American University of Beirut assessed knowledge, attitudes and practices regarding Argileh (hubble-bubble) smoking among pregnant Lebanese women; it found that they knew little about the harmful ingredients and effects of hubble-bubble smoking, and that up to 23 per cent had smoked a water pipe during their pregnancy.⁵ Similarly, in a sample of 416 Lebanese university students 43 per

cent were current or previous hubble-bubble smokers, with 28.3 per cent beginning smoking at an average age of 16 years.⁶

Hubble-bubble smoking is a traditional method of smoking tobacco which was originally described nearly 400 years ago in Turkey and India.^{5,6} A dark tobacco paste (tumbak) is placed on a tray on top of a pipe connected to a glass bottle (narghile) half-filled with water. The tobacco is lit by charcoal embers, and the smoke is inhaled through the water via an inhalation tube, after being both diluted by the air above the water and cooled by the water (Figure 1). The size of the narghile influences the concentration of carbon monoxide in the inhaled smoke: the smaller the narghile and its burning bowl, the smaller the air volume above its water base and the shorter the length of the inhalation tube, resulting in a higher concentration of inhaled carbon monoxide.

The composition of tobacco used in hubble-bubble smoking is variable and not well standardised. Analysis of aerosolised hubble-bubble smoke found a high concentration of carbon monoxide, nicotine, ‘tar’ and heavy metals, making the adverse consequences of hubble-bubble smoking similar to those of



FIG. 1
A hubble-bubble (water pipe).

smoking cigarettes. These adverse consequences include increased risk of malignancy, genetic damage, oxidative damage, impaired pulmonary function and low birth weight, in addition to the increased risk of infectious diseases resulting from pipe-sharing and the psychological risks of consuming psychoactive drugs added to the tobacco.⁷ In a comparative analysis of the effects of hubble-bubble and cigarette smoking on respiratory metabolic parameters, chronic respiratory symptoms appeared at an earlier age in hubble-bubble smokers compared with cigarette smokers.⁸

The effect of hubble-bubble smoking on voice has not been investigated, despite the clear association between tobacco use and laryngeal pathology. The purpose of this study was to assess the short term effect of hubble-bubble smoking on the voice, in hubble-bubble smokers with no history of dysphonia.

Materials and methods

Eighteen subjects who were habitual hubble-bubble smokers and who had no history of dysphonia were solicited to participate in the study.

The study was approved by the relevant institution review board, and all subjects were informed of the investigation and agreed to participate.

We excluded from the study any subjects with dysphonia, a history of cigarette smoking, micro-laryngeal

surgery or manipulation, any recent upper respiratory tract infection, or an age below 16 years.

Demographic data were collected, including subject age, gender, number of years of smoking and number of hubble-bubble heads smoked per week.

Subjects underwent laryngeal video-stroboscopy followed by acoustic analysis. Both examinations were then repeated directly after 30 minutes' hubble-bubble smoking. The period of 30 minutes was chosen as this is the shortest average time spent smoking a water pipe in a social setting.

Laryngeal video-stroboscopy was performed using a 70° rigid telescope coupled to a Karl Storz model 8020 laryngostrobe and also to a 30 mm, single chip, colour endoscopic telecamera (Dx pal 202320 20; Karl Storz, Tuttlingen, Germany). The presence or absence of the following was noted: (1) oedema of the true vocal folds; (2) erythema of the true vocal folds; (3) thick mucus between the vocal folds; (4) dilated true vocal fold vessels; (5) benign lesions (e.g. nodule, polyp or cyst); and (6) other lesions (e.g. leukoplakia).

Oedema was classified as follows. Mild (type one) oedema was limited to the upper surface of the vocal fold; the movement of the true vocal fold was intact and the patency of the glottis was preserved. Moderate (type two) oedema extended to the lower surface of the vocal fold, beyond the margin. In severe (type three) oedema, during inhalation open space was limited to the posterior glottis (as per Yonekawa's classification).⁹

Acoustic analysis was performed using a Kay Elemetric Visi Pitch system (model 3300; KayPentax, New Jersey, USA). The patient was seated in a quiet room, and their vocal signal was recorded directly into the system using a condenser microphone placed 15 cm from the mouth. The following acoustic variables were measured: average fundamental frequency, relative average perturbation, shimmer, noise-to-harmonic ratio, voice turbulence index and habitual pitch. Habitual pitch was measured by asking the subject to count to ten in a normal voice. The remaining variables were measured by asking the subject to sustain the vowel /ah/ for 2 seconds, and using the voice quality assessment module of the Visi Pitch system. Acoustic analysis tests were repeated three times before and three times after smoking, in order to generate representative data.

Statistical analysis

Frequencies and means (\pm standard deviation) were used to describe categorical and continuous variables, respectively. The McNemar and Wilcoxon non-parametric tests were used to determine any significant changes in laryngeal stroboscopic data and acoustic parameters, respectively, before and after hubble-bubble smoking. All analyses were conducted using the Statistical Package for the Social Sciences version 15 software package. A one-tailed *p* value of less than 0.05 was considered statistically significant.

Results

Demographic data

Subjects comprised seven men and 11 women, with a male:female ratio of 0.63 and a mean age of 24.3 + 7.8 years. Subjects' duration of smoking ranged from one to 10 years. The majority had one to five years' history of smoking, with only 23.6 per cent exceeding five years. The mean number of hubble-bubble heads smoked was 5.77 per week per subject (see Table I).

Laryngeal video-stroboscopy

None of the subjects had vocal fold erythema either before or after smoking. Five patients had mild oedema of the vocal folds, but there was no change in the incidence after 30 minutes of hubble-bubble smoking. After smoking, there was a slight increase in the number of subjects with thick mucus between the vocal folds (six, *vs* four before smoking) and with dilated true vocal fold blood vessels (two, *vs* one before smoking) (Figure 2) (see Table II).

Acoustic analysis

Following hubble-bubble smoking, acoustic analysis revealed a drop in both habitual pitch and fundamental

Findings	Before HB (n (%))	After HB (n (%))	<i>p</i>
Erythema	0 (0)	0 (0)	1.00
Oedema	5 (27.8)	5 (27.8)	1.00
Thick mucus	4 (22.2)	6 (33.3)	0.25
Dilated vessels	1 (5.6)	2 (11.1)	0.5
Benign lesions	0 (0)	0 (0)	1.00
Other lesions	0 (0)	0 (0)	1.00

HB = hubble-bubble smoking

frequency. There was also an increase in noise-to-harmonic ratio and a statistically significant decrease in voice turbulence index. There was no statistically significant change in relative average perturbation or shimmer.

When results were stratified by gender, we found a significant drop in fundamental frequency ($p = 0.05$) and habitual pitch ($p = 0.049$) in female subjects following smoking. Among male subjects, there was a significant increase in fundamental frequency ($p = 0.04$) and a significant reduction in noise-to-harmonic ratio ($p = 0.008$) following smoking (see Table III).

Discussion

The acute and long term health effects of cigarette smoking have been thoroughly investigated. However, few studies have assessed the effects of hubble-bubble (water pipe) smoking.⁴⁻¹⁰

Shafagoj and Mohammed have investigated the acute effects of hubble-bubble smoking on the cardiovascular system.¹¹ In this prospective study, 45 minutes of hubble-bubble smoking was found to cause a modest increase in heart rate, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure and maximum end-expiratory carbon monoxide. These effects were attributed to the nicotine content of hubble-bubble smoke generated from commonly used tobacco.

Hadidi and Mohammed used gas chromatography to analyse 13 commercial brands of hubble-bubble tobacco, and found that the mean nicotine content was 8.32 mg/g tobacco, with a mean nicotine content of 713 mg/head (i.e. 20 g unflavoured tobacco).¹² The addition of additives such as honey, glycerin or other flavourings lowered the nicotine content. For instance, smoking one head of flavoured tobacco delivered on average one-third of the nicotine present in 20 cigarettes.

From such research, hubble-bubble smoking would seem to have the same physiological effects and health hazards as cigarette smoking. There have been many previous studies assessing the acute and long term effect of tobacco usage on the larynx and voice, but none investigating the effect of hubble-bubble smoking on voice.

Characteristic	Value
Age (mean ± SD; y)	24.3 ± 7.5
Gender (M/F; %)	38.9/61.1
HB smoking history (%)	
<1 y	17.7
1-5 y	58.7
>5 y	23.6
HB heads smoked (mean; n/wk)	5.77

SD = standard deviation; y = years; M = males; F = females; HB = hubble-bubble; wk = week

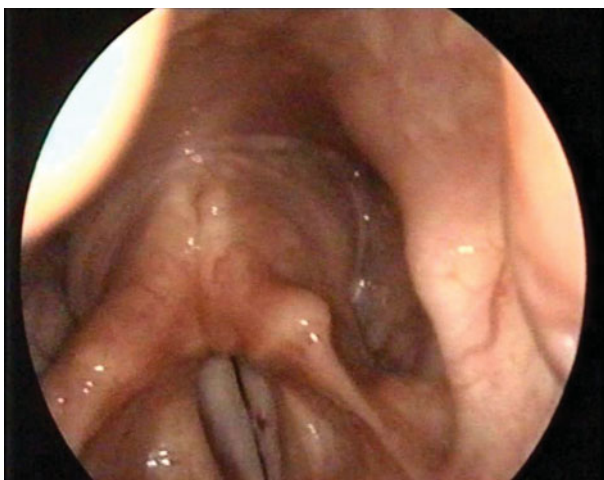


FIG. 2

Endoscopic view showing mild oedema of the right true vocal fold, with a dilated vessel on the upper lip of the left true vocal fold.

TABLE III
ACOUSTIC ANALYSIS

Parameter	Total		Women		Men		p
	Before HB	After HB	Before HB	After HB	Before HB	After HB	
F ₀ (Hz)	184.65 ± 51.1	181.94 ± 47.5	221 ± 19.7	217.4 ± 17.1	127.55 ± 23.2	131.27 ± 22.1	0.04
Jitter	0.763 ± 0.35	0.743 ± 0.45	0.754 ± 0.26	0.854 ± 0.42	0.777 ± 0.48	0.599 ± 0.49	0.18
Shimmer	3.05 ± 0.69	3.08 ± 0.89	3.26 ± 0.67	3.39 ± 0.97	2.73 ± 0.64	2.67 ± 0.62	0.34
NHR	0.134 ± 0.061	0.178 ± 0.171	0.117 ± 0.01	0.229 ± 0.22	0.164 ± 0.09	0.113 ± 0.02	0.008
VTI	0.031 ± 0.006	0.026 ± 0.007	0.033 ± 0.008	0.027 ± 0.005	0.029 ± 0.003	0.025 ± 0.009	0.14
HP (Hz)	180.58 ± 46.7	172.34 ± 45.00	213.53 ± 16.5	207.64 ± 17.6	128.81 ± 24.5	126.96 ± 19.5	0.40

Data represent means ± standard deviations unless specified otherwise. HB = hubble-bubble smoking; F₀ = fundamental frequency; NHR = noise-to-harmonics ratio; VTI = vocal turbulence index; HP = habitual pitch

Vocal disturbances are very often reported by cigarette smokers of both genders and various ages. These vocal changes are more common in women and are usually of many years' duration. Such changes have been attributed to oedematous changes in the vocal fold covering. Smoking is considered the main aetiological factor in the development of Reinke's oedema; other, less common factors include phonotrauma, allergy and respiratory tract infection.¹³ Furthermore, in patients with Reinke's oedema, cigarette consumption and duration of cigarette smoke exposure have been found to correlate with the severity of histological lesions present, with a longer duration of smoke exposure being associated with worse histological damage. Hence, there is a clear relationship between vocal fold epithelial changes and the quantity of tobacco consumed over a lifetime, with progressive epithelial thickening occurring as the duration of smoking increases.¹⁴

These histological changes are reflected in several acoustic parameters, especially a reduced fundamental frequency and an increase in perturbation parameters. Multi-parameter acoustic analysis has been used to assess the effect of cigarette smoking on voice in the early stages (i.e. up to 10 years).¹⁵ The main differences between smokers and non-smokers were seen in frequency perturbation and tremor parameters. These findings suggest a possible neurological effect of nicotine (or other chemical components of tobacco) on the voice.¹⁵ Furthermore, on evaluating the long term results of microlaryngeal surgery in patients with Reinke's oedema, a lower recurrence rate was found in patients who ceased smoking post-operatively.¹⁶ Hence, oedematous vocal fold changes are not an unusual finding in a smoker.

Even smokers with no vocal complaints may benefit from laryngeal examination. There have been reports in the literature of abnormal laryngeal findings and acoustic vocal parameters in smokers with no history of dysphonia. For example, one study investigated the vocal effects of chronic tobacco usage in 20 subjects with no dysphonia at the time of examination. Laryngeal video-stroboscopic findings were similar to those of patients with organic dysphonia, and acoustic analysis revealed a decrease in the fundamental frequency and an increase in cycle-to-cycle variations in frequency.¹⁷ In a similar study, Damborenea Tajada *et al.* investigated non-dysphonic adults of average age 38 years, and found that the fundamental frequency of the sustained vowel /a/ was lower for smokers than non-smokers (being respectively 115 vs 129 Hz for men and 185 vs 201 Hz for women).¹⁸

In our subject group, there was a non-significant, 2.7 Hz decrease in fundamental frequency and a 8 Hz decrease in habitual pitch, following 30 minutes of hubble-bubble smoking. The decrease in the habitual pitch was statistically significant for female subjects. A statistically significant decrease in voice turbulence index was seen for the whole subject group.

In smokers, the observed reduction in fundamental frequency and habitual pitch has long been attributed to vocal fold oedema caused by tobacco, as previously mentioned. Swelling and enlargement of the vocal folds, secondary to Reinke's oedema, result in an increase in mass, which causes the vocal folds to vibrate at a lower frequency (Table IV). In our study, 27.8 per cent of subjects had vocal fold oedema; in addition, 33.3 per cent had thick mucus, which may also affect the rheological properties of the vocal folds.

Amongst our male subjects, there was an increase in the fundamental frequency accompanied by a decrease in noise-to-harmonics ratio.

Other variables that may affect the fundamental frequency include mass, tension, length and airflow. The latter variable may be affected by an individual's stress level, which Guimaraes and Abberton found to be higher in smokers.¹⁹ This theoretical association is currently untested, but could be investigated via analysis of mean flow rate, subglottic pressure and stress parameters in smokers.

Many studies have considered the noise-to-harmonics ratio to represent an objective measure of voice quality. Unfortunately, we did not undertake perceptual evaluation of voice quality before and after hubble-bubble smoking, and thus are unable to confirm or refute this assumption in our subjects. However, many studies have shown that voice quality worsens after cigarette smoking, with an increase in perturbation parameters and turbulence measures. This was indeed the case in our overall subject group, in which the noise-to-harmonics ratio was seen to increase. However, in our male subjects this latter parameter decreased. A larger sample size may have shifted these results towards agreement with previous findings.

- **This study investigated the short term effect of hubble-bubble smoking on voice**
- **Eighteen non-dysphonic hubble-bubble smokers with no history of cigarette smoking underwent acoustic analysis and laryngeal video-stroboscopic examination before and after smoking**
- **Even a short period of hubble-bubble smoking can reduce vocal pitch, increase laryngeal secretions and dilate vocal fold vessels**

There were no major vocal fold changes observed endoscopically after 30 minutes of hubble-bubble smoking. The lack of significant laryngeal stroboscopic findings both before and after smoking may be attributed to the following: (1) our subjects were non-dysphonic when included in the study, (2) our subjects had a relatively short history of hubble-bubble smoking (less than five years for 58 per cent), and (3) a short smoking period was used in the study (30 minutes).

TABLE IV
VOCAL SYMPTOMS AND FINDINGS IN SMOKERS

Vocal symptoms	Vocal fold changes	Acoustic changes
Hoarseness	↑ Mucus	↓ F ₀ & HP
Breathiness	Erythematous changes	↑ Perturbation parameters in Shimmer
Roughness	Vessel dilation	↑ Noise parameters
Deeper voice	Epithelial hyper/dysplasia	
	Atypia	
	Reinke's oedema	
	Carcinoma	

↑ = increased; ↓ = decreased; F₀ = fundamental frequency; HP = habitual pitch; hyper/dysplasia = hyperplasia and dysplasia

Our study is the first to draw attention to the short term effect of hubble-bubble smoking on voice, in subjects from a society with a tradition of this type of smoking in both men and women.

This study had two limitations: the small number of subjects enrolled, and the lack of perceptual evaluation of the voice after smoking.

Conclusion

There has been no previously published investigation of the vocal effects of hubble-bubble smoking in subjects with a history of this type of smoking. In our study, such investigation was achieved by means of objective acoustic analysis (using six specific acoustic parameters) and laryngeal video-stroboscopy. Our results indicate that even a short period of hubble-bubble smoking (30 minutes) can result in a drop in vocal pitch and an increase in laryngeal secretions and vocal fold vessel dilation. A larger study is needed to document the histological changes associated with these vocal disturbances.

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