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The Acute Effects of Water-pipe Smoking on Ankle Brachial Index: A Cross-sectional Study

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Abstract

Introduction: Numerous studies have shown that waterpipe smokers as well as cigarette smokers are at increased risk of cardiovascular diseases. In this study we sought to evaluate the acute effects of waterpipe smoking (WPS) on ankle brachial index (ABI), an indicator of atherosclerosis and an independent predictor of mortality.

Methods: This prospective cross-sectional study was conducted in October 2017. Twenty nine healthy male volunteers who had a history of WPS were enrolled. Demographic data and cigarette and WPS status were recorded via self-reporting questionnaire. Resting heart rate and brachial systolic and diastolic blood pressures of participants were recorded first and ABI measurements were done. Then subjects smoked waterpipe for about 20 minutes and ABI was measured immediately after WPS.

Results: A total of 29 male adults with a mean age of 32 ± 9 years were included. The right-sided ABI was 1.05 ± 0.11 before WPS and significantly decreased to 0.98 ± 0.13 after WPS (P value = 0.006). The left-sided ABI before and after WPS were 1.09 ± 0.20 and 0.95 ± 0.18 respectively and the decrease was statistically significant (P value = 0.037). Vital signs before and after one session of WPS showed significant changes in heart rate (P < 0.001) and no significant changes in systolic and diastolic blood pressures (P = 0.09, and P = 0.14, respectively).

Conclusion: WPS has an acute effect on ABI as well as heart rate so it should be considered as a potential risk factor for cardiovascular diseases.

INTRODUCTION

Waterpipe smoking (WPS), also known as hookah, shisha, narghile, and hubble-bubble is a form of tobacco use that has been practiced for more than four centuries in Asia and Africa [1]. In waterpipes charcoal burns in a container which is separated from tobacco by an aluminum foil. The heated air passes through the foil and tobacco, producing smoke. The smoke bubbles through the water and then the smoker inhales it through a mouthpiece [2]. The myth that waterpipes are not as harmful as smoking, as well as the social nature of its consumption has led to increased popularity of waterpipe, especially among the youth [3]. Also immigration of people from Middle East to the Western countries has contributed to the global epidemic of WPS [4]. Each session of WPS usually lasts 20 to 80 minutes and the smoker may take 50 to 200 puffs [5], so it is estimated that during each session the waterpipe smoker

may inhale as much smoke as consumption of 100 or more cigarettes [6].

Numerous studies have shown that waterpipe smokers are at increased risk of diseases similar to cigarette smokers, including malignancies, obstetric and perinatal complications, osteoporosis, periodontal and oral diseases, and respiratory and cardiovascular diseases [4]. The acute effects of waterpipe on cardiovascular system have been studied in several studies. These studies demonstrated that waterpipe acutely increases heart rate and blood pressure in consumers [7]. Chronically WPS is shown to be associated with coronary artery disease [8, 9].

The ankle brachial index (ABI) is the ratio of the systolic blood pressure (SBP) measured at the ankle to the brachial artery. It is a noninvasive test to diagnose peripheral artery disease. It is also considered an indicator of atherosclerosis and an independent predictor of mortality [10, 11]. It is also known that cigarette smoking is associated with progression of peripheral artery disease and chronic smokers have impaired peripheral circulation [12, 13]. Acute effect of cigarette smoking on ABI in chronic smokers has been evaluated previously [14]. However, to our knowledge, the acute effect of WPS on ABI has never been studied before. In this study we sought to evaluate the acute effects of WPS on ankle brachial index

METHODS

Study Design

This study is a before-after, descriptive cross-sectional study to assess the acute effect of WPS on ankle brachial index among participants. In October 2017, twenty nine healthy male volunteers participated. They had no underlying medical conditions and comprehensive physical examination was normal. All participants had prior experience of WPS. After explaining the aim of the study and potential side effects of WPS, a written informed consent was obtained from the participants. Demographic data and cigarette and WPS status were recorded via self-reporting questionnaire. Current smokers are defined as an adult who has smoked 100 cigarettes in his lifetime and who currently smokes cigarettes. Waterpipe experience is defined as waterpipe use daily, weekly, monthly or occasionally. This study is conducted by Tobacco Prevention and Control Research Center with collaboration of Cardiology Department of Masih Daneshvari Hospital, Tehran, Iran. The study protocol was approved by ethic committee of National Research Institute Tuberculosis and Lung Diseases, Masih Daneshvari Hospital, Tehran, Iran.

Measurement of ABI

The participants were instructed to refrain from tobacco, alcohol and caffeinated beverages for at least 12 hours prior to the test. Resting heart rate and brachial systolic and diastolic blood pressures (DBP) were recorded first. Then ABI measurements were done by a physician**.** After ten minutes of rest in the supine position, ABI was measured using the vascular explorer device (Enverdis Company, Germany). The occlusion pressure in the arteries of the arm and ankle was measured at the same time on each side of the body using plethysmography. Both cuffs were applied simultaneously and a sensor was attached to a finger and a toe. The cuffs were inflated with a computer and special windows software, which contained the subjects' medical information as well as the evaluation results and diagnoses. Examination results were automatically converted in to an ABI value, and displayed in a graphic format. After ABI measurement, subjects smoked waterpipe for about 20 minutes. They were asked to use waterpipe similar to their usual pattern of use (considering number and depth of puffs). 10 grams of the same brand of flavored tobacco was used by all participants. ABI was measured immediately after WPS exactly in the same way mentioned above.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 20 (IBM, Armonk, NY, USA). The Kolmogorov-Smirnov test was used to assess the normality of distribution of all variables. Qualitative variables were presented as numbers and percentages, and quantitative data were expressed as mean ± standard deviation (SD). The paired Student's t-test was used for parametric comparisons before and after water pipe smoking. For nonparametric comparisons Wilcoxon test was used. All reported values were 2-tailed and a p-value of < 0.05 was considered statistically significant.

Table 1. Baseline Characteristics

Characteristic	Value
Age (years)	32 ± 9
Education	
Lower than High school	12 (41.4)
High school graduate	10 (34.5)
Bachelor's degree or higher	7 (24.1)
Marital status	
Single	9 (31)
Married	20 (69)
Current smoker*	
Yes	15 (51.7)
No	14 (48.3)
Daily cigarette smoking	
Yes	11 (37.9)
No	18 (62.1)
Pattern of waterpipe Smoking	
Daily	2 (6.9)
Weekly	4 (13.8)
Monthly	2 (6.9)
Occasionally	21 (72.4)

Data are shown as mean ± SD or number (%).

* Current smoker is defined as an adult who has smoked 100 cigarettes in his lifetime and currently smokes.

RESULTS

A total of 29 male adults with a mean age of 32 ± 9 years were included. Baseline characteristics of participants

are summarized in Table 1. Vital signs before and after one session of WPS is shown in Table 2. No significant changes were seen in systolic and diastolic blood pressures (P = 0.09, and P = 0.1, respectively) while heart rate significantly increased (P < 0.001).

The right-sided ABI was 1.05 ± 0.11 before WPS and significantly decreased to 0.98 ± 0.13 after WPS (P-value = 0.006). The left-sided ABI before and after WPS were 1.09 ± 0.20 and 0.95 ± 0.18 respectively and the decrease was statistically significant (P-value = 0.03). The smoker and non-smoker groups had statistically comparable changes in both right- and left-sided ABIs after WPS (P = 0.4 and 0.9; respectively) (Figure 1).

Table 2. Vital signs before and after WPS

Characteristic	Before WPS	After WPS	P value
Heart rate (beats/min)	72.82 ± 12.39	83.34 ± 12.75	< 0.001
Systolic blood pressure (mmHg)	126.92 ± 14.34	130.68 ± 15.97	0.09
Diastolic blood pressure (mmHg)	73.56 ± 9.10	76.16 ± 10.05	0.1

Data are shown as mean ± SD

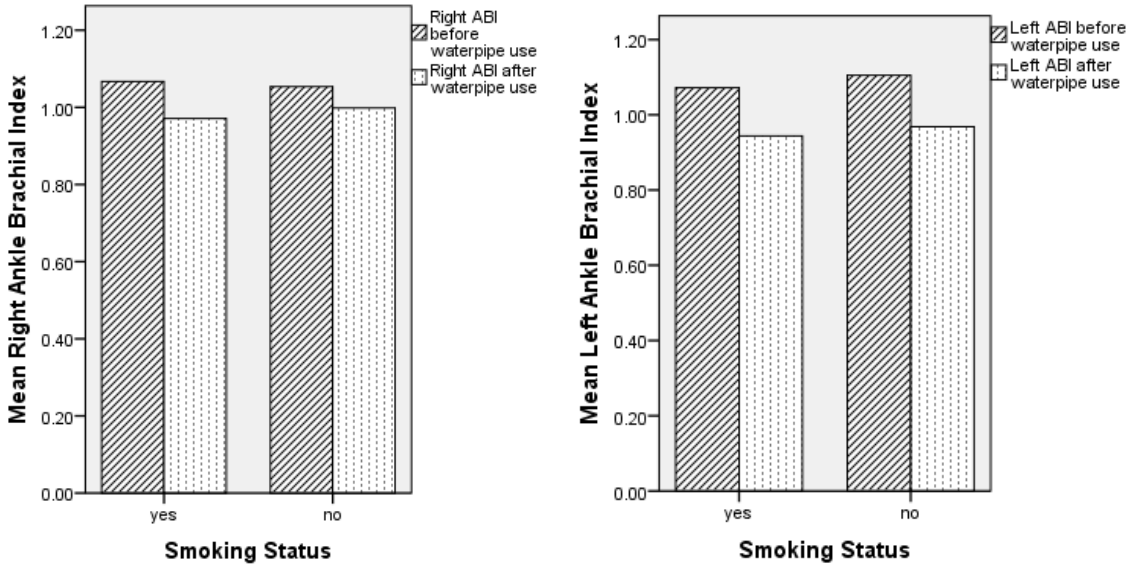

Figure 1. Right-sided and left-sided ABI before and after waterpipe smoking in smoker and non-smoker participants.ABI: Ankle Brachial Indices

DISCUSSION

To the best of our knowledge, this is the first study evaluating the acute effect of WPS on ABI. This study evaluated the acute effects of a single session of WPS on Ankle brachial index, SBP, DBP and heart rate. The principle finding of our study was that one session of WPS significantly decreased ABI in healthy young male subjects. The results also demonstrated statistically significant increase in heart rates after one session of WPS. However, there were no significant changes in SBP and DBP after WPS. These finding were similar in chronic cigarette smokers compared to nonsmokers. Because only two of the participants were smoking waterpipe daily, we could not evaluate differences between chronic waterpipe smokers and Non- or occasional waterpipe smokers.

The observed changes in ABI were similar to a study done by Gardner et al to investigate the acute effects of cigarette smoking on ABI and peripheral circulation in older chronic smokers with established peripheral arterial occlusive disease [15]. They recruited ten chronic smokers with peripheral arterial disease and assign them to two days of smoking and nonsmoking conditions and measured ABI in the subjects on each day. They showed that the resting ABI was 17 % lower on the smoking day. This study was the first study demonstrating an acute reduction in ABI with cigarette smoking. So, our findings suggest that the acute effect of WPS on ABI is similar to cigarette smoking. Even in cases with no history of PAD.

The increased heart rate after WPS has also been observed in previous studies [2, 3]. Shaikh et al. evaluated acute effects of WPS on cardiovascular and respiratory systems. 30 minutes after WPS in a sample of 202 male participants, they reported a statistically significant increase in the mean heart rate of 6.30+/- 0.60 bpm [16].

In previous studies, acute cigarette smoking and WPS have been shown to increase SBP and DBP [1-3, 17]. But our study failed to demonstrate such relationship. It may be explained by our small sample size and the situation surrounding the session. About 40% of our participants were chronic cigarette smokers and we

advised them to refrain from smoking for 12 hours. Although they all reported complete abstinence from smoking prior to the test, we did not objectively measure nicotine and tobacco products in the blood or urine of our participants. So non-adherence to the study protocol may have occurred and is responsible for the incongruent results obtained in our study.

Potential limitations may have affected the observed results in our study. The main limitation of our study was our relative small sample size. This study was a cross-sectional study, so no causal relationship can be established between WPS and decreased ABI. Moreover, we didn't follow up the participants, so we did not measure duration of these effects. Taha et al. evaluated acute effects of cigarette smoking SBP, DBP and heart rate in healthy chronic smokers. They found that acute increases in these parameters returned to baseline values 5-15 minutes after smoking [1]. It should be noted that our study only included young healthy males, so our results may not be generalizable to females and other populations. So further studies must be performed to verify these results and evaluate acute and chronic effects of WPS on ABI.

CONCLUSIONS

In conclusion, our study suggests that WPS has an acute impact on ABI, a known marker of atherosclerosis, increased cardiovascular events and mortality. Therefore, waterpipes should be considered as a potential risk factor for cardiovascular diseases. Also our study showed that WPS has an acute effect on heart rate.

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Conflict of Interest

There is no conflict of interest for this study.

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