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ORIGINAL ARTICLE

Effect of water pipe tobacco smoking on plasma high sensitivity C reactive protein level and endothelial function compared to cigarette smoking

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KEYWORDS

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Abstract *Background:* Cigarette smoking is a well known risk factor for cardiovascular disease, however, little is known regarding water pipe (WP) smoking. High sensitivity C-reactive protein (hs-CRP) and flow mediated dilatation (FMD) are well recognized methods to assess cardiovascular risks.

Objectives: To study the effect of WP smoking on hs-CRP level and endothelial function compared to cigarette smoking.

Methods: The study included 77 male subjects (30 WP smokers, 30 cigarette smokers, and 17 controls). Hs-CRP level was measured using the ELISA technique and the threshold of high risk level was 3 mg/l. FMD was assessed in the brachial artery. Subjects with FMD < 10% were considered to have endothelial dysfunction. The composite of high risk hs-CRP level and endothelial dysfunction was considered as high risk profile.

Results: Hs-CRP level was slightly higher in smokers than controls (2.21 ± 1.6 versus 1.73 ± 1.19 mg/l, $P = 0.25$). FMD was significantly lower in smokers (12 ± 6.66 versus 17.45 ± 11.29%, $P = 0.016$). There were no significant differences between WP smokers and cigarette smokers regarding hs-CRP level ($P = 0.19$) and FMD ($P = 0.91$). In an adjusted regression

Abbreviations: WP, water pipe; FH, family history; CAD, coronary artery disease; BMI, body mass index; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; Hs-CRP, high sensitivity C-reactive protein; D1, basal brachial artery diameter; D2, hyperemic brachial artery diameter; FMD, flow mediated dilatation.

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model, age ($P = 0.002$) and cigarette smoking ($P = 0.046$) were found to be significant predictors for high risk profile, whereas WP smoking did not have a predictive effect ($P = 0.91$).
Conclusions: WP smokers and cigarette smokers had comparable degrees of inflammation and endothelial dysfunction. However, cigarette smoking was a stronger predictor for high risk profile.

1. Introduction

Water pipe (WP) tobacco smoking (other terms are hookah, shisha, nargile, arghile and hubble bubbleis) is gaining wide popularity among young and middle aged males and females. Available evidence suggests that the prevalence of WP smoking ranged from 6% to 34% among Middle Eastern adolescents, 5–17% among American adolescents, and that WP use is increasing globally.[1] Studies on the cardiovascular effects of WP smoking are limited by methodological quality, the novelty of WP epidemic relative to cigarettes, and the highly variable WP tobacco contents.

Inflammation and endothelial dysfunction are integral components for the initiation and progression of atherosclerosis. These components precede the clinical manifestations of atherosclerosis and cardiovascular events. High sensitivity C reactive protein (hs-CRP) has been described as an inflammatory biomarker linked to cardiovascular risk factors and cardiac events.[2,3] An hs-CRP level of >3 mg/l was independently associated with a 60% excess risk of incident coronary artery disease (CAD) as compared with levels <1 mg/l after adjustment for all Framingham risk variables.[4] Flow mediated dilatation (FMD); another predictor of cardiovascular risks, is a measure of nitric oxide (NO) mediated endothelial function that reflects the hyperemic response of the brachial artery to sheer stress.[5,6] Cigarette smoking has been recognized to be associated with inflammation and impaired endothelial function,[7] but little is known regarding WP smoking.

Although several in vitro studies compared WP to cigarette smoke, there are little data regarding the in vivo effect of either type of smoking. Furthermore, WP tobacco is highly variable in content and processing. The apple flavored WP tobacco, despite its popularity, was not well characterized in clinical studies.

2. Methods

The study enrolled 77 apparently healthy males including 60 smokers (duration $\geqslant$ 5 years) and 17 non smokers as a control group. Smokers were divided into 30 WP smokers and 30 cigarette smokers. WP smoking was unified to include only apple flavored WP tobacco. We used the term "water pipe head" (WPH) to describe a single smoking ration (Fig. 1). Several rations may be consumed by WP smoker during a single smoking session.

Exclusion criteria included mixed PW and cigarette smoking, age >60 years, evidence or suspicion of CAD, cerebrovascular or peripheral vascular disease, hypertension (HTN), diabetes mellitus (DM), hypercholesterolemia, acute or chronic inflammatory disease, malignancy, recent surgery, antiinflammatory drug intake, and hs-CRP levels >10 mg/l.

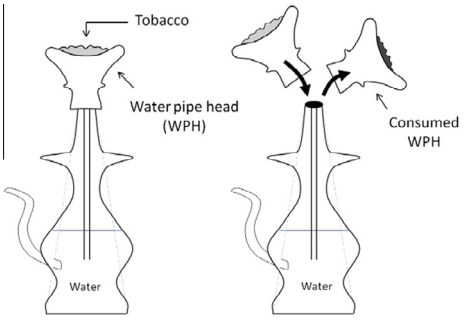

Figure 1 Simple illustration of water pipe showing water pipe head (WPH) containing the tobacco (left) being exchanged when consumed (right).

All subjects were assessed by history and clinical examination, 12-lead surface electrocardiogram (ECG), random blood sugar, total cholesterol, hs-CRP, and FMD. History taking emphasized on smoking duration (years), number of WPHs or cigarettes consumed per day, and number of lifetime totally smoked WPHs or cigarettes calculated as number of WPHs or cigarettes/day multiplied by 365 multiplied by smoking duration (years).

2.1. High sensitivity CRP

It was measured by enzyme linked immunosorbent assay (ELISA). Hs-CRP levels were classified as low risk (<1 mg/l), intermediate risk (1–3 mg/l), and high risk (>3 mg/l).[8,9]

2.2. Flow mediated dilatation

It was measured by a non invasive method to evaluate flow mediated dilatation as an endothelium dependant vasoregulatory function in the brachial artery. Steps of measurement included:[10,11]

2.2.1. Subject preparation

Measurement was done during the fasting state for 8–12 h in a quiet, temperature-controlled room (22–24 °C). All vasoactive medications were withheld for at least four half lives. Subjects avoided exercise and withheld caffeine, high-fat food, vitamin C, and tobacco for at least 4–6 h before the study.

2.2.2. Equipment

Linear array transducer with a minimum frequency of 7 MHz, attached to a high-quality mainframe ultrasound system was used to acquire images with sufficient resolution for subsequent analysis. Image resolution was enhanced with broadband (multiple-frequency: 7–12 MHz) linear array