Original Article

Breath Carbon Monoxide Levels in Different Forms of Smoking

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ABSTRACT

Background and Objectives. *Bidi*, cigarette, *hookah* and *chillum* are common modes of tobacco smoking in India. Many people consider *hookah* and *chillum* smoking less toxic because smoke is filtered through water or wet cloth. We evaluated the toxicity of tobacco smoking by measuring end-tidal carbon monoxide (eCO) levels after various modes of smoking.

Methods. Eighteen healthy smokers who smoked *bidi*, cigarette, *hookah* and *chillum* on six days were studied. They smoked one *bidi*, one cigarette, five minutes *hookah*, one serve (15 minutes) *hookah*, five minutes *chillum* and one serve (15 minutes) *chillum* on six days randomly. The eCO values were measured before initiation of smoking and for a period of one hour after the smoking session. Increase in eCO values in comparison to baseline after different modes of smoking was compared.

Results. In comparison to baseline, mean eCO levels were raised by 4.94 (0.96) parts per million (ppm) immediately and 4.17 (1.07) ppm 60 minutes after cigarette smoking. *Bidi* smoking caused slightly less increase in mean eCO levels (3.17 [0.82]). One serve of *hookah* and *chillum* smoking caused elevation of mean eCO values by almost eight-folds higher than that of cigarette smoking. Five minutes of smoking with *hookah* (22.18 [5.29]) and one serve of *hookah* (33.0 [8.76]) and *chillum* (40.14 [12.73]) caused significantly higher values of mean increase in eCO in comparison to cigarette smoking ($p<0.001$).

Conclusion. With regard to eCO levels, *hookah* and *chillum* smoking are much more toxic than cigarette smoking.
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Key words: *Hookah*, Tobacco smoking, *Bidi* smoking, *Chillum* smoking, End-tidal carbon monoxide.

INTRODUCTION

Bidi, cigarette, *chillum* and *hookah* are commonly used methods of smoking in India.[1] Amongst them, *bidi* is the most common form of tobacco smoking (50%).[1] Less than 20% smoke cigarettes, whereas, *hookah* smokers are even lesser. A *bidi* is made of a piece of *tendu* (*Diospyros melanoxylon*) leaf in which dried tobacco is rolled. Primarily it is popular in the adults but now flavoured *bidis* (chocolate, mango, cherry) are also in vogue.[2] They are freely available on the net and are a tempting attraction for children.[2] *Chillum* consists of a clay pipe 10cm-15cm long that is held vertically. They are locally made and are inexpensive. The smoke passes through a fold of wet cloth before getting inhaled. *Chillum* has also been used to smoke opium and other narcotic substances. *Hookah* is also called as *water-pipe, narghille and sheesha* in different parts of the world. The tobacco smoke in a *hookah* passes through water before inhalation. *Chillum* and *hookah* are mainly smoked in rural areas. However, now these are becoming popular amongst youngsters in metropolitan cities because of availability of *hookah* joints. *Hookah* is becoming a popular way of smoking tobacco not only in India, but also in many countries in the world. In a recently carried out study in United States of America (USA), it was found that 15% of college students have used *hookah* at least once in life time which was much more than any other substance of abuse.[3]

As the smoke in *hookah* is filtered through water and in *chillum* it passes through a wet cloth, many smokers consider these modes of smoking to be less harmful. Though data are available to show harmful effects of cigarette smoking, more convincing comparative data are needed, especially for less conventional modes of tobacco smoking, such as *bidi*, *hookah* and *chillum*. We planned to study levels of carbon monoxide in exhaled breath after use of *hookah*, *bidi* and *chillum* in comparison to cigarette smoking.

MATERIAL AND METHODS

Eighteen healthy smokers were included in the study after obtaining the informed consent. The study was approved by Institutional Ethics Committee. All subjects were familiar and have been using all the

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four modes of smoking; however, routinely they were using one particular mode of smoking. The subjects reported to the respiratory laboratory after abstaining from any smoking for 24 hours. The eCO levels were measured using a breath analyser (Bedfont UK) at baseline and for one hour after using different modes of smoking on six days. Subjects smoked one *bidi*, one regular cigarette, *hookah* for five minutes, one serve *hookah* (15 minutes), *chillum* for five minutes and one serve of *chillum* (15 minutes) on six days randomly. Usually, a smoker takes five minutes in smoking a cigarette. Therefore, to have comparable data for same duration we also studied *hookah* and *chillum* smoked for five minutes. *Chillum* and *hookah* were used on two days with two types of serving. After obtaining baseline values, eCO levels were determined immediately, 10 minutes, 20 minutes, 30 minutes and 60 minutes after completion of smoking. The same volunteers were evaluated on subsequent days with random allocation of smoking modes.

Increase in end-tidal carbon monoxide values from baseline (ΔeCO) were calculated after different modes of smoking. The mean ΔeCO values among various modalities of smoking were compared by application of analysis of variance.

RESULTS

The mean age of volunteers was 48.0±11.0 years. At baseline eCO levels in different groups, such as *bidi*, cigarette, *hookah* (5 minutes), *hookah* (one serve), *chillum* (5 minutes) and *chillum* (one serve) were 10.2±3.2, 10.4±4.2, 12.1±5.6, 11.7±5.6, 10.7±4.2 and 10.7±4.2 ppm, respectively (Table). The baseline values on different days were comparable (F=0.496, p=0.778). The eCO values were increased from baseline values with different modes of smoking (Figure). It was observed that one serve of *chillum* raised the eCO levels maximally. One serve and five minutes of *hookah* smoking also raised the eCO levels significantly higher in comparison to cigarette smoking (p<0.001). *Bidi* smoking also caused increased levels of eCO and the magnitude of increase was slightly less than that of cigarette but the difference was not significant statistically.

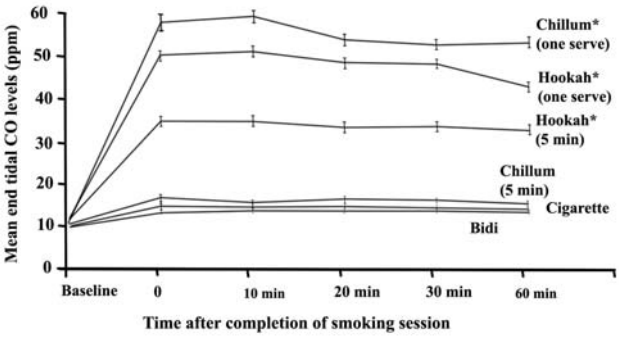

Figure. Mean end-tidal carbon monoxide after various modes of smoking
***= P<0.001**
CO=Carbon monoxide; ppm=Parts per million

DISCUSSION

Cigarette smoke consists of around 2% to 4% carbon monoxide.[4] Our study showed that *bidi* smoke also raised eCO level comparable to cigarette smoking. Both *hookah* and *chillum* raised eCO much higher levels than cigarette smoking. The level of eCO

Table. Pre-smoking mean baseline and post-smoking increase in eCO (Δ) values after various modes of smoking

	Pre-smoking Baseline eCO Values (ppm)+	Post-smoking Increase in eCO from Baseline (ppm)++				
		At the end of smoking	10 min after smoking	20 min after smoking	30 min after smoking	60 min after smoking
Bidi	10.2±3.2	3.00±0.72	3.61±0.84	3.67±0.86	3.61±0.83	3.17±0.82
Cigarette	10.4±4.2	4.94±1.07	4.56±0.91	4.89±1.07	4.67±0.99	4.17±0.96
***Hookah* (5 min)**	12.1±5.6	25.27±6.30*	25.09±6.32*	23.45±5.61*	23.55±5.43*	22.18±5.29*
***Hookah* (One serve)**	11.7±5.6	41.57±11.23*	42.57±10.22*	39.14±9.69*	39.00±10.20*	33.00±8.76*
***Chillum* (5 min)**	10.7±4.2	5.55±0.79	4.64±0.65	5.18±0.66	5.00±0.61	4.27±0.48
***Chillum* (One serve)**	10.7±4.2	45.00±17.04*	46.14±14.41*	41.29±11.72*	39.86±11.82*	40.14±12.73*

One serve is equivalent to 15 minutes of smoking
+=expressed as mean±SD; ++=expressed as mean±(SEM); * P<0.001;
ppm=Parts per million; SD=Standard deviation; SEM=Standard error of mean

remained high for one hour. Clinical significance of such levels of eCO is yet not known but in animal experiments even low levels of CO have been shown harmful.[5]

It has been a popular myth that the water in a *hookah* detoxifies the smoke. Old historical accounts state that the *hookah* was invented by a physician named Hakim Abul Fath during the reign of Emperor Akbar in India.[6] The physician suggested that this form would be less toxic. So this popular belief of *hookah* being safe is as old as the origin of *hookah*. It had been shown in older studies that *hookah* smoking was less toxic as compared to cigarette smoking because in it smoke was passed through water.[7] However, a study done in Pakistan[9] showed that the eCO hazard is similar in *hookah* and cigarette smokers. It was also substantiated in another study carried out by Shafagoj and Mohammed.[10] They documented an increase in end-expiratory increase in eCO, heart rate, systolic, diastolic and mean arterial blood pressure after *hookah* smoking. In this study,[10] it has been suggested that eCO levels were comparable to cigarette smoking. Since they did not measure comparative eCO values after *hookah* and cigarette smoking, objective data were lacking.

Our study showed that eCO levels after *hookah* smoking was much higher than cigarette smoking, therefore, suggesting substantial higher toxicity than cigarette smoking. A newer study[8] has also suggested that *hookah* smoke is more toxic in terms of CO and smoke exposure.[8]

Hookah joints claim that the nicotine content is 0.5% while tar content is 0%.[11] *Hookah* smokers continue smoking till they have enough nicotine to satisfy them. *Hookah* smoke is made less irritating by moisturising it and adding fruity flavours. Thus, *hookah* smokers inhale more smoke and are exposed to higher levels of CO, carcinogens and heavy metals present in *hookah* smoke.[9] This exposes water-pipe smokers to the risk of same kind of diseases as caused by cigarette smoking which includes cancer, heart and respiratory diseases.[12] The concentration of toxins inhaled during *hookah* smoking depends on the frequency, depth of inhalation and total duration of the smoking session.[12]

Bidi is a slim, unfiltered and a more dangerous form of tobacco. Some studies indicate that the amount of nicotine and other toxic substances delivered by a *bidi* is as great as that by an ordinary cigarette.[13,14] In a recent study,[15] the average breath CO levels were equal to or higher for *bidi* smokers than cigarette smokers. However in our study, eCO levels were slightly lower during *bidi* than cigarette smoking. Use of *bidi* is not limited to rural India but even in USA as many as 5% adolescents use *bidi* believing that they are healthy alternatives to traditional cigarettes.[16] The irony of *bidi* smoking is that it is smoked with more intensity and frequency leading to higher nicotine intake[14] and 2-3 times greater tar inhalation than cigarettes.[17]

One serve of *chillum* smoking was found most toxic in increasing eCO levels in the breath. Though *chillum* smoking is not widely practiced in urban areas but many people in rural India still smoke *chillum*. Since smoke through *chillum* passes through wet cloth many people believe it less toxic. Unfortunately, none of the studies in the past evaluated the toxic effects of *chillum*. In view of the results of the present study showing highest eCO levels after *chillum* smoking, there is need to study the effect of this mode of smoking more extensively. Curiously five minutes of *chillum* smoking could increase eCO level much less than five minutes *hookah* and one serve of *chillum* smoking. Probably it may due to the fact that *chillum* takes longer time in ignition and smoke generation.

CONCLUSIONS

Bidi, the most commonly used mode of smoking, is as toxic as a regular cigarette in terms of end-tidal CO levels. *Hookah* and *chillum* use commonly considered harmless were associated with almost eight-fold higher rise in breath CO levels in comparison to cigarette smoking, indicating substantially higher toxicity. One serve of *chillum* smoking lead to maximal increase in eCO levels indicating the possibility of *chillum* being the most dangerous mode of smoking.

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