The effectiveness of miswak chewing stick on plaque removal

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Abstract

The aims of this study were to investigate the effect of chewing stick miswak in comparison with toothbrush on plaque removal during experimental conditions and real life use conditions.

Experimental part: A sample of 15 healthy male volunteers aged 20 to 50 years participated in a single blind randomized split mouth design study. Subjects were instructed to refrain from using any oral hygiene for one week to allow plaque formation. One week later digital photographs of plaque distribution of the buccal tooth areas of maxillary anterior and posterior regions were taken, before cleaning and after 30, 60, 120 seconds of cleaning with either miswak or toothbrush.

Clinical part: A total of 42 subjects 17 females and 25 males, ranging in age from 20 to 50 years were included. 8 subjects were miswak users and 20 subjects were toothbrush users. 14 subjects who used both methods were excluded. Digital photographs of plaque distribution of the labial surfaces of anterior teeth were taken. Oral hygiene habits were recorded by interview.

The results showed a highly significant reduction in mean plaque levels of both miswak and toothbrush during all time intervals. There were no significant differences in plaque reduction between the two methods during all time intervals. The clinical part showed no significant difference in mean plaque level between miswak users and toothbrush users. It is concluded
that miswak is as effective as a toothbrush for reducing plaque both experimentally and clinically.

*Keywords:* Chewing stick; Miswak; Toothbrush; Plaque
**Introduction**

Removal of dental plaque is effective in treating gingivitis and preventing periodontal disease and dental caries. Toothbrushing is the most common method used to remove plaque (Hawkins et al. 1986). However, toothbrushes are rare in many third-world countries, where locally available chewing sticks are commonly used (Elvin-Lewis, 1982). Mechanical toothbrushing has been shown to be an effective method of removing plaque (Frandsen, 1986). However, chewing sticks have been traditionally used by many people in different cultures around the world for the promotion of oral hygiene. According to the consensus statement on oral hygiene (2000), evaluation of the effectiveness of chewing sticks warrants further research. The World Health Organization has also recommended and encouraged the use of these sticks as tool for oral hygiene in areas where their use is customary (WHO, 1987).

The most common type of chewing stick, miswak, is derived from *Salvadora persica*, a small tree or shrub with a spongy stem and roots, which are easy to crush between the teeth. Pieces of the root usually swell and become soft when soaked in water.

Miswak is a chewing stick used in many developing countries as a traditional toothbrush for oral hygiene.
In a recent study in Saudi Arabia, large differences were found in the oral hygiene habits, mainly related to age and socio-economic level (Al-Otaibi et al. 2003). It was found that among 50-60 year old individuals, toothbrush was never used by 44% of those with lower education while all were regular miswak users (Al-Otaibi et al. 2003).

It was found that the chewing stick removed plaque from interproximal sites to virtually the same extent as from other more accessible sites (Danielsen et al. 1989). The conventional toothbrushing has been reported to be relatively ineffective for the removal of interproximal plaque (Hawkins et al. 1986).

Contradictory data have been reported on the oral health of miswak users. Several reports have claimed that chewing sticks are effective in reducing plaque and gingival inflammation. When properly used, miswak has been reported to be as effective as tooth brushing (Olsson 1978, Elvin-Lewis 1982, Gazi et al. 1990, Darout et al. 2000, Al-Otaibi et al. 2003).

Periodontal treatment need was found to be low in habitual miswak users in two Saudi Arabian cities, when compared with data from many other countries (Al-Khateeb et al. 1991). The addition of toothpaste to brushing with chewing stick did not improve removal of plaque (Danielsen et al. 1989).

Some very recent studies concluded that the periodontal status of miswak users in a Sudanese population was better than that of toothbrush users,
suggesting that the efficiency of miswak use for oral hygiene in this group is comparable or slightly better than toothbrush (Darout et al. 2000).

However, some studies found that there were more plaque formation and gingival bleeding in individuals who used chewing sticks in comparison with toothbrush users (Norton and Addy 1989, Eid et al. 1990, Mengel et al. 1996). In a study performed in Yemen it was found that the toothbrush was more efficient an oral hygiene aid than the miswak (Mengel et al. 1996).

The value of chewing sticks is believed to be in their mechanical cleansing action. However, the use of miswak has also been reported to inhibit the formation of dental plaque chemically, and exert antimicrobial effect against many oral bacteria (Al-Lafi and Ababneh 1995).

It has been demonstrated in vitro those aqueous extracts of miswak have growth inhibitory effects on several oral microorganisms (Homer et al. 1992, Al-Lafi & Ababneh 1995, Almas & Al-Bagieh 1999). Using the checkerboard DNA-DNA hybridization method, Darout et al. (2002), stated that miswak may have a selective inhibitory effect on the levels of certain bacteria in saliva, particularly several oral Streptococci species.

Chewing sticks also have fungistatic and antimycotic effects (Lewis 1980; Al-Bagieh et al. 1994).
The first aim of this study was to investigate the effect of chewing stick miswak in comparison with toothbrush on plaque removal during experimental.

The second aim was to clinically evaluate plaque levels in subjects who used chewing sticks in comparison with those of toothbrush users.
Materials and Methods

The study was divided into two parts; experimental and clinical were summarized in fig.1.

Experimental part

Subjects
A total of 15 male subjects aged 20-50 years volunteered to participate in this study. They were all healthy people. The author informed each participant about the aims of the study and informed consent was obtained. All participants were interviewed regarding their oral hygiene habits and use of miswak. They were immigrants to Sweden and culturally well familiar with the use of miswak. The inclusion criteria were subjects having >24 teeth, being healthy (not having any diagnosed disease), smoking <10 cigarettes per day. They were current miswak users or had used miswak earlier, right-handed and without orthodontics appliance.

The study was carried out at the Institute of Odontology, Karolinska Institutet and approved by the local Ethics Committee at Karolinska University Hospital, Sweden.
Design

One week before start of the study (1st visit), intraoral examination and digital photographs of plaque distribution were taken after staining the teeth with erythrosine and scaling plus professional tooth cleaning. Oral hygiene habits were recorded by a structured interview based on a prepared questionnaire. Subjects were then instructed to refrain from using either miswak or toothbrush or any device of oral hygiene for one week to allow de novo plaque formation.

One week later (2nd visit), digital photographs of plaque distribution were taken. Subjects were then instructed to use either miswak or toothbrush (without toothpaste). The cleaning method was randomly selected.

The subjects were instructed to use of either method in the proper way. Each subject was given a fresh stick of miswak and a new toothbrush (15 cm in length, and 7 mm in width) (regular, straight handled Oral-B toothbrush), respectively. They were instructed to crush the head of the miswak between the upper and lower anterior teeth to allow bristles formation. The assignment of the right and left side of the dentition was done in a randomized way. After the completion of the photography of both sides in the subject, professional tooth cleaning was performed. Subjects were then allowed to continue their tooth cleaning habits and oral hygiene routines as normal.
Photographic Procedure and Image Analysis

The study was performed according to a single blind randomized split mouth design. A computerized image analysis system was used.

Photographic recording of the buccal tooth areas for documentation of the area covered by plaque was performed. The teeth selected for examination were the canines, premolars, first and second molars of maxillary left and right quadrants. The buccal tooth surfaces were photographed after staining with erythrosine. 4 projections were taken at the first visit before professional tooth cleaning. One week later (second visit) 16 projections were taken after staining the plaque with erythrosine at the following time points using a stopwatch, (a) before cleaning , (b) after 30 seconds of cleaning , (c) after 60 seconds of cleaning , (d) after 120 seconds of cleaning were shown in fig.2(a-d). This was done after the use of each method. Subjects were not allowed to use a mirror during brushing, so they cannot use erythrosine stain as a guide.

A computerized image analysis system was used for the evaluation of photograph with the aid of UTHSCSA Image Tool (IT) program. The total tooth area and the area covered by plaque were digitized. The plaque area was expressed as a percentage of the total tooth area. The author analyzed the images. All images were coded and the analysis of the images was done in a blinded way. All data were stored in a computer for subsequent statistical analysis. At the completion of the experiment, the codes for the
two different hygiene methods and time intervals were opened. The plaque area as a percentage for anterior and posterior region was recorded at the following time points, (a) before cleaning, (b) after 30 seconds of cleaning, (c) after 60 seconds of cleaning, (d) after 120 seconds of cleaning. The mean of anterior and posterior region were calculated for 15 subjects for the two methods and each time point.

The intraexaminer reliability was assessed during the analysis of the images. Ten photographs including 50 buccal surfaces of the maxillary left and right quadrants were randomly selected. The analysis of the images was repeated within a few days after the first examination. The magnitude of the measurement error (s) was estimated from the difference between two repeated sets of measurements, according to the formula

\[ s = \sqrt{\frac{\sum d^2}{2n}}, \]

Where d = difference between repeats and n= number of repeats.

The error related to a single determination was Ss = 3.14, and the error related to the mean of 15 determinations, Sm = 0.81. The error related to the difference between two means was, Sd =1.14. It can be concluded that the error of measurement does not influence the value obtained in the experimental or clinical portions of the study.
Fig. 1. Summary of the study outline including experimental and clinical parts
Clinical part

Subjects

A total of 42 subjects (17 females and 25 males), ranging in age from 20 to 50 years were participating in this part of the study. They were outpatients visiting the dental department at King Faisal Hospital at Makkah city in Saudi Arabia, who volunteered to participate in the study. They were all
healthy people. The author informed each participant about the aims of the study. All patients were interviewed regarding their oral hygiene habits and use of miswak and conventional toothbrush. The subjects were asked at this visit; to answer a questionnaire about their oral hygiene practices same as in the experimental part of study. The inclusion criteria were subjects having >24 teeth, being healthy (not having any diagnosed disease), right-handed and without orthodontics appliance.

8 male subjects were miswak users and 20 subjects (14 females and 6 males) were conventional toothbrush users. 14 subjects (3 females and 11 males) who used both miswak and toothbrush were excluded.

Clinical Examination

The clinical examination comprised measurement of pocket depth, scoring of the gingival status, recession of the gingival margin, dental calculus, and photographic recording of the labial tooth areas for documentation of the area covered by plaque after staining with erythrosine. The teeth selected for examinations were the maxillary and mandibular anterior teeth (central incisors and canines).

Probing pocket depth (4 aspects per tooth) and recession of the gingival margin were recorded with a manual pressure sensitive probe.
The index used for assessing the status of gingival health or inflammation was the Gingival Index (GI) proposed by Löe and Silness (1963).

The index used for assessing the dental calculus (lingual and labial surfaces of mandibular anterior teeth) was the Simplified Oral Hygiene Index (OHI) proposed by Greene and Vermilion (1964).

*Photographic Procedure and Image Analysis*

The labial tooth surfaces of selected teeth were photographed after staining with erythrosine. Two projections were taken at this visit before scaling and professional tooth cleaning. The same image analysis program UTHSCSA Image Tool (IT) and evaluation procedure as described above was used.

*Statistical Analysis*

In the experimental part of the study, the differences between means of miswak and toothbrush at various time intervals were tested by paired t-test.

The differences between times points within brushing groups were tested by means of repeated measures ANOVA. Statistical significance was accepted at p < 0.05.
In the clinical part of the study, the differences between the means of miswak and toothbrush users were assessed by the Mann-Whitney U test. Statistical significance was accepted at $p < 0.05$.

**Results**

**Experimental part**

The overall means and standard deviations of plaque level of the maxillary anterior, posterior and combined regions of the dentition at start of experiment and after 30, 60 and 120 seconds of brushing with miswak and toothbrush are shown in Figs. 3 - 5.

The change of the mean plaque level with miswak after 30 seconds of brushing compared to baseline (at start of experiment) was statistically significant ($t = 8.8$, $p = 0.000$). The change of the mean plaque level with miswak after 60 seconds compared to 30 seconds was statistically significant ($t = 6.2$, $p = 0.000$). The change of the mean plaque level with miswak after 120 seconds compared to 60 seconds was statistically significant ($t = 4.2$, $p = 0.001$). The change of the mean plaque level with toothbrush after 30 seconds of brushing compared to baseline was statistically significant ($t = 9.5$, $p = 0.000$). The change of the mean plaque level with toothbrush after 60 seconds compared to 30 seconds was
statistically significant ($t = 4.8$, $p = 0.000$). The change of the mean plaque level with toothbrush after 120 seconds compared to 60 seconds was statistically significant ($t = 4.8$, $p = 0.000$).

The analysis of variance of the total plaque reduction over time of anterior and posterior regions for each cleaning method indicated a strong and statistically significant plaque reduction ($F=146.8$, $F=111.8$, respectively, $p=0.000$).

**Clinical part**

The overall medians and quartile ranges of plaque level of the anterior labial region of miswak and toothbrush users are shown in Fig. 6.

The difference in plaque level between miswak and toothbrush users was not statistically significant (Mann-Whitney U test; $z = 0.33$, $p = 0.74$).
Fig. 3. Plaque level of maxillary anterior (miswak versus toothbrush) regarding to time points. Each column represents mean percentage and S.D. at each of examination intervals i.e. 0, 30, 60, 120 seconds.

**Anterior region**
Fig. 4. Plaque level of maxillary posterior (miswak versus toothbrush) regarding to time points. Each column represents mean percentage and S.D. at each of examination intervals i.e. 0, 30, 60, 120 second.

Posterior region
Fig. 5. Plaque reduction level of maxillary anterior & posterior (miswak versus toothbrush) regarding to time points. Each column represents mean percentage and S.D. at each of examination intervals i.e. 0, 30, 60, 120 second.

**Combined region**
Fig. 6. Plaque level (%) of maxillary anterior teeth in miswak and toothbrush users. Median and QR in box plot.
ORAL HYGIENE DEVICE
PLAQUE LEVEL (%)

MISWAK TOOTHBRUSH

ORAL HYGIENE DEVICE
Discussion

Bacterial plaque plays an important role in the etiology of dental caries, gingivitis and periodontitis. The effective removal of dental plaque can result in the prevention or reduction of these diseases. It has been shown that mechanical toothbrushing is an effective method of removing plaque (Frandsen 1986). However, chewing sticks (miswak) also may play a role in the promotion of oral hygiene; and it has been suggested that evaluation of the effectiveness of chewing sticks requires further research (Consensus Statement Oral Hygiene, 2000). World Health Organization has recommended and encouraged the use of chewing sticks as a tool for oral hygiene (WHO, 1987).

The experimental part of the present study compared the effects of the traditional chewing stick (miswak) and a conventional toothbrush on plaque removal over selected brushing durations in a small sample of adult men, familiar with both miswak and toothbrush. The clinical part of the study evaluated the use of chewing sticks in comparison with toothbrush use on plaque removal under real life conditions. The effect was assessed by the reduction of plaque distribution, based on computerized image analysis.

The results disclosed a significant reduction in plaque percentage after use of both toothbrush and miswak. The experimental design was developed to minimize the effects of other variables which would affect plaque control, including type of toothbrush and/or chewing stick (miswak), frequency of
toothbrushing and/or miswak, technique of toothbrushing and/or miswak, and use of other oral hygiene aids.

To standardize the experimental condition, all participants were issued with identical conventional toothbrushes and chewing sticks of fairly uniform length and width. Furthermore they were instructed about the efficient use of both methods under direct supervision. The validity of the results is related to the applied methodology. The study design differentiated between the effects of each method in a controlled way, i.e., the participants were asked to refrain from using either miswak and toothbrush or any device of oral hygiene for one week.

When plaque accumulations of seven days were analyzed, it was evident that plaque accumulation was uniform throughout the buccal surfaces of the mouth. The posterior region (64.6%), (55.4%) had relatively little higher plaque accumulation level when compared to the anterior region (53.9%), (53.4%) for both toothbrush and miswak groups respectively. The natural mechanical cleansing action of the tongue and buccal mucosal surfaces of cheeks and lips may account for this variation in plaque accumulation level. The brushing time periods produced a nearly similar change of the mean plaque level with toothbrush and miswak. Although the 120-second period yielded more significant plaque level than the 30-second period, for each method. These time periods compare closely to an earlier report that estimated brushing time (Hawkins et al., 1986). The photographic and
image analysis method used in the present study is a more precise and accurate tool for plaque measurement than clinical scoring. Examiner consistency was established by calibration of the examiner at several intervals during the study. Assessment of examiner reliability indicated "excellent" intra-examiner reliability of the image analysis. Participation in the study may have resulted in some improvement due to impact of scaling and prophylaxis at the beginning and the end of the experimental period.

However, the study has some limitations. The number of the participants was small and an increase in the number of the individuals might reveal smaller differences between two methods. In our study the participants were all males (experimental part). It has been shown that gender did not have a significant effect on salivary levels of most or all of the species assessed in several studies and no significant differences in the subgingival microbiota between males and females from different ethnic groups (Schenkein et al. 1993, Darout et al. 2002). It was tried to have the photographic angulations perpendicular to the long axis of the buccal tooth surfaces.

The subjects of the clinical part of the study lived mainly in the city of Makkah and were classified as an urban population. In a study of the use of chewing sticks in rural and urban area in Pakistan, Asadi and Asadi (1997) found that more than 50% of rural subjects but only 25% of the urban population used a miswak. Al-Otaibi et al. (2003) found that 73% used a
toothbrush daily, while a miswak was used daily by 65% in an urban area in Saudi Arabia.

The miswak was as effective as the conventional toothbrush in reducing plaque in all time periods, i.e., after 30, 60 and 120 seconds of cleaning. This confirms earlier reports that compared chewing sticks with toothbrushes (Nörmark & Mosha 1989, Sartita & Tuominen 1990). These studies did not find a difference in oral health between users of chewing sticks versus users of toothbrushes in children and adults. In contrast, others found that chewing sticks are effective in reducing plaque and gingival inflammation. When properly used, miswak has been reported to be as effective as tooth brushing (Olsson 1978, Elvin-Lewis 1982, Gazi et al. 1990, Darout et al. 2000, Al-Otaibi et al. 2003).

However, some studies showed that habitual users of chewing stick miswak had significantly higher prevalence of gingivitis than users of toothbrushes (Norton and Addy 1989, Eid et al. 1990). The difference between the two types of toothbrushes in relation to the occurrence of gingivitis persisted even when other factors such as age, sex, education, place of residence and toothbrushing frequency were controlled.

Gazi et al. (1990) found that patients using miswak regularly showed decreased gingival bleeding on probing compared with non-miswak users and also found that plaque and gingivitis were significantly reduced when miswak was used 5 times a day compared with conventional toothbrush.
This reduction in plaque may be attributed to the presence of a variety of substances in miswak.

Various explanations for the cleansing efficacy of the miswak have been offered, including the mechanical effects of its fibers, the release of beneficial chemicals or a combination of both (Hardie & Ahmed, 1995). The miswak is generally used for longer periods of time than the toothbrush, e.g., cleaning usually occurs for 5 to 10 minutes each time (Akhtar and Ajmal 1981), and the plant fibers remove plaque and simultaneously massage the gum.

For summary it can be concluded that miswak was as effective as a toothbrush for reducing plaque both experimentally and clinically.
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References


