

The effectiveness of chewing stick miswak on plaque removal

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هدفت الدراسة إلى تقصي كفاءة السواك على إزالة طبقة اللويحة بالمقارنة مع فرشاة الأسنان من خلال التجربة والواقع العملي. شمل الجزء التجريبي عينة تكونت من ١٥ رجلاً صحيحاً منطوعاً شاركوا في تنظيف الفم بطريقة عشوائية وبأسلوب الفم المجرأ. تراوحت أعمارهم من (٢٠ - ٥٠) سنة، وقد امتنعوا عن استخدام وسائل العناية الفموية لمدة أسبوع للسماح لطبقة اللويحة بالتشكل. تم، بعد أسبوع، تصوير طبقة اللويحة على السطوح الخارجية للأسنان الأمامية والخلفية في الفك العلوي قبل التنظيف وبعد التنظيف بثلاثين و ٦٠ و ١٢٠ ثانية باستخدام كلا من السواك و الفرشاة. أما الجزء السريري فشمّل عينة تكونت من ٥٦ شخصاً تراوحت أعمارهم من (٢٠ - ٦٠) سنة من مستخدمي الفرشاة أو السواك ١٧ مستخدماً للسواك و ٢٩ للفرشاة. وتم استبعاد ١٠ من مستخدمي السواك و الفرشاة بأن واحد. تم تصوير اللويحة على السطوح الخارجية للأسنان الأمامية. دلت النتائج على وجود فرق إحصائي واضح في انخفاض معدل كمية اللويحة الجرثومية خلال الفترات الثلاثة ($p < 0.001$). لكن لم يلاحظ أي فرق إحصائي في انخفاض معدل كمية طبقة اللويحة بين السواك مقارنة بالفرشاة في نفس تلك الأوقات. أما بالنسبة للجزء السريري فلم يلاحظ وجود أي فرق إحصائي في كمية طبقة اللويحة بين مستخدمي السواك و الفرشاة. يمكن الاستنتاج على أن للسواك نفس فعالية الفرشاة في إزالة طبقة اللويحة من على السطوح الخارجية للأسنان وذلك تجريبياً وعملياً.

AIM: The aim of the study was to investigate the effect of chewing stick miswak in comparison with toothbrush on plaque removal during experimental conditions and real life use conditions. **MATERIAL and METHODS:** *Experimental Part:* A sample of 15 healthy male volunteers aged 20 to 50 years (mean and SD 35.2±8.6) 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 denovo plaque formation. A week later, 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 56 subjects (18 females and 38 males) age ranging from 20 to 60 years were included. Seventeen subjects were miswak users and 29 subjects were toothbrush users. Ten subjects who used both methods were excluded. Photographs of plaque distribution of the labial surfaces of anterior teeth were taken. **RESULTS:** The experimental part showed that all three cleaning periods, with miswak as well as with toothbrush, reduced the remaining plaque covered area at the anterior and posterior regions ($P < 0.001$). However, no significant difference was observed between the two methods in any period. The clinical part showed no significant difference in mean plaque level between miswak users and toothbrush users. **CONCLUSION:** It was concluded that miswak was as effective as a toothbrush for reducing plaque on buccal teeth surfaces both experimentally and clinically.

INTRODUCTION

Removal of dental plaque is effective in treating gingivitis, preventing periodontal disease and dental caries. Toothbrushing

is the most common method used to remove plaque.¹ However, toothbrushes are rare in many third-world countries, where locally available chewing sticks are commonly used.²

The most common type of chewing stick, miswak, is derived from Arak tree (*Salvadora persica*) that grows mainly in Saudi Arabia but also in other parts of the Middle East. Miswak is a chewing stick used by many people in different cultures and in many developing countries as a

Received 15 March 2006; Accepted 3 July 2006

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traditional toothbrush for oral hygiene.³ The religious and spiritual impact of miswak probably is the principal reason for using it in Islamic countries.³

It has also been shown that the chewing stick remove plaque from interproximal sites to virtually the same extent as from other more accessible sites.⁴ 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.⁵

It has been demonstrated in vitro that the aqueous extracts of miswak have growth inhibitory effects on several oral microorganisms.⁵⁻⁷ Darout et al. reported 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 is comparable or slightly better than toothbrush.⁸ However, some studies found that there were more plaque formation and gingival bleeding in individuals who used chewing sticks in comparison with toothbrush users.^{9,10} According to the consensus statement on oral hygiene,¹¹ evaluation of the effectiveness of chewing sticks warrants further research.

The aims of this study were first to investigate experimentally the effects of chewing stick miswak in comparison with toothbrush on plaque removal after selected periods of brushing. Second aim was to clinically evaluate the plaque levels in subjects who used chewing sticks in comparison with those who used toothbrush.

MATERIALS AND METHODS

The study was divided into two parts: experimental and clinical as summarized in Figure 1.

Experimental Part

Subjects

A total of 15 male subjects aged 20-50 years (mean and SD 35.2±8.6) volunteered to participate in this study. They were informed about the aims of the study and informed consent was obtained. All participants were interviewed regarding their oral hygiene habits and the use of miswak. They were immigrants in Sweden and culturally very well familiar with the use of miswak. The inclusion criteria were subjects having more than 24 teeth with the presence

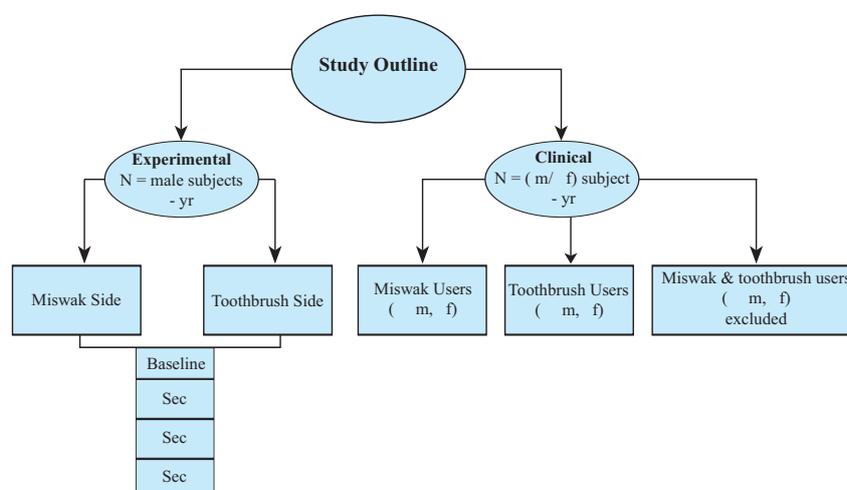


Fig.1. Study design

of maxillary canine, premolars and, 1st and 2nd molars, of healthy condition and were diagnosed without any disease. 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

The study was performed according to a single blind randomized split mouth design. One week before the start of the study during the first visit, intraoral examination and scaling plus professional tooth cleaning was performed. Oral hygiene habits were recorded by a structured interview based on a prepared questionnaire. The questionnaire included education level, smoking habit, dental visit, usage of miswak and/or toothbrush and its frequency. 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, during the 2nd visit, subjects were instructed on a model to use either miswak or toothbrush (without toothpaste). Each subject was given a fresh stick of miswak and a new toothbrush (15 cm in length and 7 mm in width) and (regular, straight handled Oral-B® toothbrush), respectively. The assignment of the right, left side of the dentition and the cleaning method were done in a randomized way using bowl technique. After photographing both sides of the mouth of the subjects, 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

A computerized image analysis system was used.

Photographic recording on the buccal teeth surfaces for documentation of the area covered by plaque was performed after staining with erythrosine. The mirror images of the anterior and posterior regions were photographed approximately at perpendicular angles between the camera and mirror, i.e., 90 degrees.

The teeth selected for examination were the canines, premolars, first and second molars of maxillary left and right quadrants. One week after professional tooth cleaning (second visit) 16 projections were taken before (zero as base line) and after 30, 60, 120 seconds of cleaning, using a stopwatch alarm, as shown in Figures 2a-d. This was done after the use of each device. Subjects were not allowed to use a mirror during brushing as a guide.

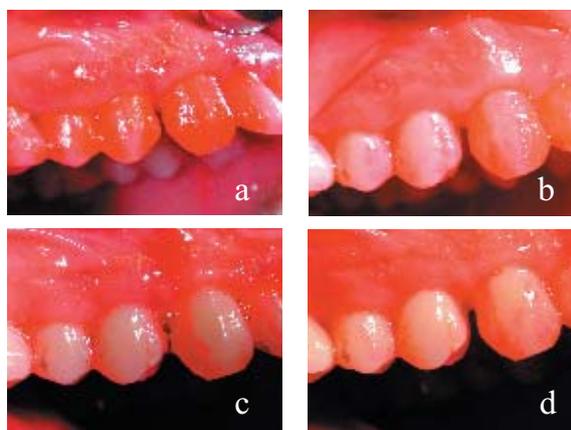


Fig. 2. Digital photographs of plaque distribution before cleaning (a) and after cleaning (b) 30 seconds, (c) 60 seconds, (d) 120 seconds.

A computerized image analysis system (UTHSCSA Image Tool) was used for the evaluation of the photographs. The total buccal teeth surfaces and the area covered by plaque were directly counted in pixels. The plaque area was then calculated in percentage of the total

buccal teeth surfaces. 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 devices and time intervals were opened. The plaque area as a percentage for the anterior and posterior regions was measured at each time point. The mean of anterior and posterior regions were calculated for 15 subjects for the two devices and each time point.

Intraexaminer Reliability

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

$$s = \sqrt{\sum d^2 / 2n},$$

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

The error related to a single determination was $S_s = 3.14$, and the error related to the mean of 15 determinations, $S_m = 0.81$. The error related to the difference between two means was, $S_d = 1.14$. It can be concluded that the error of measurement does not influence the value of the study.

Clinical Part

Subjects

A total of 56 subjects (18 females and 38 males), ranging in age from 20 to 60 years voluntarily participated in this

part of the study. They were outpatients visiting the Dental Department at King Faisal Hospital at Makkah City in Saudi Arabia. All patients were interviewed regarding their oral hygiene habits and use of miswak. The inclusion criteria were the same as in the experimental part of the study. Seventeen subjects (2 females and 15 males) were miswak users and 29 subjects (12 females and 17 males) were conventional toothbrush users whereas 10 subjects (4 females and 6 males) who used both miswak and toothbrush were excluded.

The mean age of miswak group and toothbrush group was 37 and 31 years, respectively. The sex distribution was significantly different in brush method groups ($P < 0.05$) with majority of males in the miswak group.

Examination of Plaque

Photographic examination of the area covered by plaque was performed in the labial tooth surfaces after staining with erythrosine. The teeth selected for examinations were the maxillary and mandibular incisors and canines. Two projections were taken of each individual. The same image analysis program (UTHSCSA Image Tool) and evaluation procedure as described above was used.

Statistical Analysis

In the experimental part of the study, the differences between means of miswak use and toothbrush use 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. In the clinical part of the study, the differences between the means of miswak and toothbrush groups were assessed by unpaired t-test. Statistical significance was accepted at $P < 0.05$. The STATISTICA 6.1 software

program (Stat Soft Scandinavian AB Sweden) was used for calculation.

RESULTS

Experimental Part

None of the participants complained of discomfort or showed any signs of gingival inflammation following one week of withdrawal of oral hygiene procedures.

The overall means and 95% CI of plaque level of the maxillary anterior and posterior regions of the dentition from the start of the experiment and after 30, 60 and 120 seconds of brushing with miswak and toothbrush are shown in the Table 1.

Table 1. Plaque level (%) after brushing with miswak and toothbrush. Mean and 95% CI according to brushing time and maxillary combined regions.

Location	Brushing time	Miwak		Toothbrush		t	P
		Mean %	95% CI	Mean %	95% CI		
Maxillary anterior	0 sec.	53.4	(40.9; 65.8)	53.9	(41.0; 66.7)	-0.1	0.95
	30 sec.	22.5	(13.0; 32.0)	24.3	(15.0; 34.4)	-0.3	0.73
	60 sec.	13.1	(7.4; 18.7)	14.5	(8.2; 20.7)	-0.4	0.72
	120 sec.	6.9	(4.2; 9.6)	6.6	(3.3; 9.8)	0.2	0.87
Maxillary posterior	0 sec.	55.4	(42.4; 68.3)	64.6	(53.8; 75.4)	-1.1	0.25
	30 sec.	20.7	(15.2; 26.3)	25.0	(16.5; 33.5)	-0.8	0.37
	60 sec.	12.2	(7.9; 16.5)	13.4	(8.8; 18.0)	-0.4	0.67
	120 sec.	6.5	(4.2; 8.8)	8.6	(4.7; 12.5)	-0.9	0.32

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

The mean plaque level of anterior region before brushing at start (zero seconds) was 53.4% with miswak and 53.9% with toothbrush. The difference was not statistically significant ($F = 1.0, P = 0.72$). The mean plaque levels after brushing 30 seconds with miswak and toothbrush were 22.5% and 24.3%, respectively. The mean plaque levels after brushing 60 and

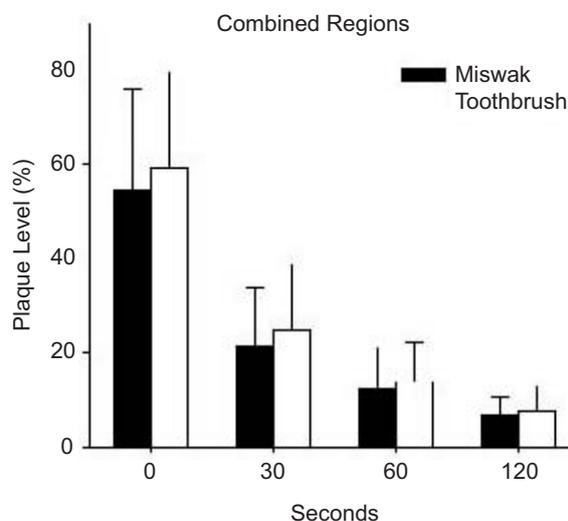


Fig. 3. Plaque levels of maxillary anterior & posterior teeth (miswak versus toothbrush). Each column represents mean percentage and standard deviation at each of examination intervals i.e. 0, 30, 60, 120 seconds.

120 seconds with miswak were 13.1% and 14.5% respectively, and with toothbrush, 6.9% and 6.6% respectively. The overall differences were not statistically significant.

The mean plaque level of the posterior region before the start of brushing (zero seconds) was 55.4% with miswak and 64.6% with toothbrush. The difference was not statistically significant. The mean plaque levels after brushing 30 seconds with miswak and toothbrush were 20.7% and 25.0%, respectively. The difference was not statistically significant. The mean plaque levels after brushing 60 and 120 seconds with miswak were 12.2% and 13.4% respectively, and with toothbrush, 6.5% and 8.6% respectively. These differences were not statistically significant.

Statistical analysis of the changes of the mean plaque levels after brushing with miswak and toothbrush overtime are presented in Tables 2 and 3, respectively. The change of the mean plaque level with miswak after 30 seconds of brushing compared to baseline, at start of the experiment, was statistically significant ($t = 8.8, P < 0.001$). The change of the

Table 2. The time-related change of the mean plaque level with miswak in combined anterior and posterior regions.

Difference of brushing time (secs)	Mean %	SD	t	P
0-30	32.7	14.4	8.8	0.000
30-60	9.0	5.5	6.3	0.000
60-120	5.9	5.4	4.2	0.001

Table 3. The time-related change of the mean plaque level with toothbrush in combined anterior and posterior regions.

Difference of brushing time (secs)	Mean %	SD	t	P
0-30	34.4	14.1	9.4	0.000
30-60	10.9	8.9	4.8	0.000
60-120	6.4	5.1	4.8	0.000

mean plaque level with miswak after 60 seconds compared to 30 seconds was statistically significant ($t = 6.2$, $P < 0.001$). 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 ($t = 9.5$, $P < 0.001$). The change of the mean plaque level with toothbrush after 60 seconds compared to 30 seconds was statistically significant ($t = 4.8$, $P < 0.001$). The change of the mean plaque level with toothbrush after 120 seconds compared to 60 seconds was statistically significant ($t = 4.8$, $P < 0.001$).

The analysis of variance of the total plaque reduction over time of the anterior and posterior regions for each cleaning method indicated a strong and statistically significant plaque reduction ($F=146.8$, $F=111.8$, respectively with $P < 0.001$). The results were shown in Figures 4 and 5.

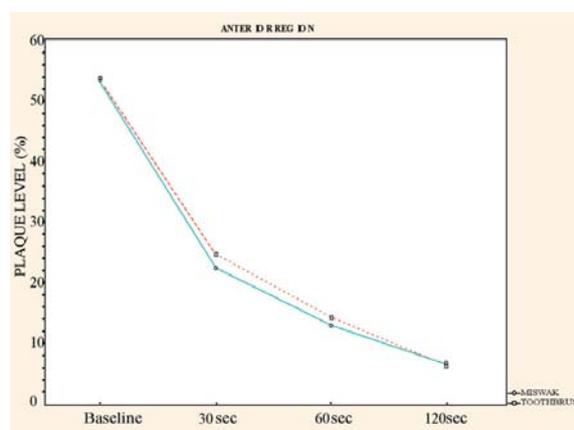


Fig. 4. Reduction in plaque level of maxillary anterior region of both miswak and toothbrush. Differences between all time points were statistically significant.

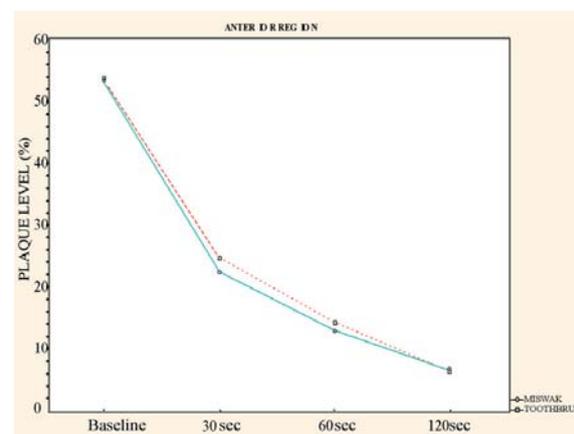


Fig. 5. Reduction in plaque level of maxillary posterior region of both miswak and toothbrush. Differences between all time points were statistically significant.

There were no significant differences of the anterior, posterior and combined regions in plaque reduction between the two cleaning procedures during all time intervals.

Clinical Part

The overall means and 95% CI of plaque level (%) of the anterior labial region for miswak users and toothbrush users were 31.2% (25.5; 36.9) and 27.4% (23.8; 31.0), respectively. The difference in plaque level was not statistically significant ($P > 0.05$).

DISCUSSION

Current dental literature describes several indices and methods for measuring plaque, both quantitatively and qualitatively. The indices used to measure the accumulation of dental plaque, are usually based on subjective estimations of the plaque-covered areas of the tooth surface.¹²⁻¹⁴ However, these indices on an ordinal scale are visual determinations resulting in data of less sensitivity.¹⁵⁻¹⁷ Photogrammetric techniques giving measurements in an interval scale have therefore been used to obtain more accurate measurements of the plaque area.¹⁸⁻²⁰

The results of the experimental part of the study disclosed a significant reduction in plaque after use of either toothbrush or miswak. 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. The clinical part also confirmed the experimental finding that brush method was equally effective. This agreed with earlier reports that compared chewing sticks with toothbrushes in children and adults.^{21, 22} In contrast, others found that chewing sticks were effective in reducing plaque and gingival inflammation. When properly used, miswak had been reported to be as effective as tooth brushing.^{2,8,23-25}

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.²⁶ Miswak was generally used for longer periods than the toothbrush.²⁷ The frequency and duration of miswak use may additionally explain its efficacy. The experimental design was developed to minimize the effects of other variables which could 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.

The experimental trial condition was standardized by instructing all subjects on how to use the identical conventional toothbrushes and chewing sticks under direct supervision. Furthermore, all participants were issued with identical conventional toothbrushes and fresh chewing sticks of fairly uniform length and width obtained from Saudi Arabia and kept frozen for this purpose.

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.

When plaque accumulations of seven days were analyzed, it was evident that plaque accumulation was uniform throughout the buccal surfaces of the mouth. The photographic and image analysis method used in the present study is a more precise and accurate tool for plaque measurement than clinical scoring. Assessment of examiner reliability indicated "acceptable" intra-examiner reliability of the image analysis. However, the study had some limitations. The number of the participants was small and an increase in the number of the individuals might reveal smaller differences between the two methods. In our study, the participants were all males (experimental part). It has been shown that gender did not have a significant difference in the subgingival microbiota between males and females from different ethnic groups.²⁸

The subjects of the clinical part of the study lived mainly in the city of Makkah and were classified as an urban population. We found that 48% of the subjects were using miswak either

exclusively or some times, while 52% used the toothbrush alone. In a study of the use of chewing sticks in rural and urban areas in Pakistan, Asadi and Asadi²⁹ found that more than 50% of the rural population as against only 25% of the urban population used miswak. Al-Otaibi et al.³⁰ found that 73% used a toothbrush daily, while a miswak was used daily by 65% in an urban area in Saudi Arabia. These differences may be due to socioeconomic levels. Gazi et al.²⁵ found that plaque and gingivitis were significantly reduced when miswak was used 5 times a day compared with conventional toothbrush. In Saudi Arabia, the preference for using the miswak may be attributed to religious and cultural influence.

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

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