Comparative Effect of Chewing Sticks and Toothbrushing on Plaque Removal and Gingival Health

Meshari Al-Otaibi[a]/Mohammed Al-Harthy[b]/Birgitta Söder[c]/
Anders Gustafsson[d]/Birgit Angmar-Månsson[a]

Purpose: The aim of the study was to compare the effect of the chewing stick (miswak), and toothbrushing on plaque removal and gingival health.

Materials and Methods: The participants comprised 15 healthy Saudi Arabian male volunteers aged 21 to 36 years, attending the Dental Center at Al-Noor Specialist Hospital in Makkah City in Saudi Arabia. The study was designed as a single, blind, randomized crossover study. The Turesky modified Quigley-Hein plaque and Löe-Silness gingival indices and digital photographs of plaque distribution were recorded at baseline, one week after professional tooth cleaning, and again following three weeks use of either the miswak or toothbrush. Professional tooth cleaning was repeated, and after a further three weeks use of either the miswak or toothbrush (using the alternative method to that used in the first experimental period), plaque and gingival indices, and digital photographs of plaque distribution were recorded anew.

Results: Compared to toothbrushing, the use of the miswak resulted in significant reductions in plaque ($p < 0.001$) and gingival ($p < 0.01$) indices. Image analysis of the plaque distribution showed a significant difference in reduction of plaque between the miswak and toothbrush periods ($p < 0.05$).

Conclusion: It is concluded that the miswak is more effective than toothbrushing for reducing plaque and gingivitis, when preceded by professional instruction in its correct application. The miswak appeared to be more effective than toothbrushing for removing plaque from the embrasures, thus enhancing interproximal health.

Key words: chewing stick, miswak, oral hygiene, plaque, salvadora persica

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[a] *Department of Cariology and Endodontology, Institute of Odontology, Karolinska Institutet, Huddinge, Sweden.*

[b] *Dental Center, Al-Noor Specialist Hospital, Makkah City, Saudi Arabia.*

[c] *Division of Dental Hygiene, Institute of Odontology, Karolinska Institutet, Huddinge, Sweden.*

[d] *Department of Periodontology, Institute of Odontology, Karolinska Institutet, Huddinge, Sweden.*

Reprint requests: *Dr. Meshari Al-Otaibi, Institute of Odontology, Department of Cariology and Endodontology, Karolinska Institutet, P.O. Box 4064, SE-141 04 Huddinge, Sweden. Tel: +46 8 728 81 88. Fax: +46 8 711 83 43. E-mail: moshari.alotaibi@ofa.ki.se*

In most industrialized countries, oral hygiene is based on the use of the toothbrush. However, toothbrushes are rare in many third-world countries, where locally available chewing sticks are commonly used (Elvin-Lewis, 1982; Lewis, 1980). The influence of Islam on the widespread adoption of this means of tooth cleaning has been significant (Khoory, 1983). The material used in the most common chewing stick (miswak) is *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 tend to swell and soften when soaked in water.

The subgingival microbial flora is highly organized into biofilms. The bacteria are largely protected from host defenses and are highly resistant to chemotherapeutic agents. By physically disrupting the biofilm thorough scaling, root planing and proper oral hygiene measures, it is possible to prevent further periodontal attachment loss in most individuals (Dahlén et al, 1992; McNabb et al, 1992). Bacterial plaque plays an important role in the etiology of dental caries, gingivitis and periodontitis. The effective removal of dental plaque can result in disease prevention or reduction. Mechanical toothbrushing has been shown to be an effective method of removing plaque (Frandsen, 1986). However, chewing sticks may play a role in the promotion of oral hygiene, and, 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 an effective tool for oral hygiene (WHO, 1987) in areas where their use is customary.

A recent study in Saudi Arabia disclosed major variations in oral hygiene habits among people from different age and socio-economic levels (Al-Otaibi et al, 2003). Among 50–60 year olds, 44% of those with lower education never used a toothbrush, but all were regular miswak users.

Reports on the oral health of miswak users are contradictory; several claiming that chewing sticks are effective in reducing plaque and gingival inflammation. When used properly, the miswak is reported to be as effective as a toothbrush (Manley et al, 1975; Olsson, 1978a & b; Elvin-Lewis et al, 1980; Nörmark and Mosha, 1989; Gazi et al, 1990; Darout et al, 2000a). Periodontal treatment needs were found to be low for 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). The chewing stick was almost as effective in removing plaque from interproximal sites as from other more accessible sites (Danielsen et al, 1989), whereas the conventional toothbrush is reported to be relatively ineffective in removing interproximal plaque (Hawkins et al, 1986). However, some recent studies have reported more plaque formation and gingival bleeding in individuals who used chewing sticks and who were not toothbrush users (Norton and Addy, 1989; Eid et al, 1990; Mumghamba et al, 1995; Mengel et al, 1996).

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

The aim of this study was to compare the effects of the use of the miswak and toothbrush in respect of: 1) mechanical plaque removal, and 2) gingival health, in a sample of adult Saudi Arabian dental patients familiar with both methods of oral hygiene.

MATERIALS AND METHODS

Experimental Design

The study was approved by the Ethics Committee at Huddinge University Hospital, Sweden, and by the General Medical Affair Administration at Makkah City. The study was performed according to a single, blind, randomized crossover design. During the miswak period, participants were instructed to use the miswak before prayers (in accordance with the religious custom) 5 times a day, and to refrain from toothbrushing. During the toothbrush period, they were instructed to brush their teeth twice a day without toothpaste, in the morning and in the evening, at bedtime, and to refrain from using a miswak during this period.

1. One week before the start of the study, participants received an intraoral examination and scaling, plus professional tooth cleaning. Participants were informed about the study and informed consent was obtained. Oral hygiene habits were recorded. The participants were then instructed to continue their usual oral hygiene routines during the following week.
2. One week later, the participants underwent registration of gingival inflammation and plaque deposits and digital photographs of plaque distribution. The participants were then instructed to use either the miswak or toothbrush (without toothpaste) for the following three weeks. In respect of the order of use of miswak and toothbrush, the participants were assigned even or odd numbers by the random binary outcome of the toss of a dice.
3. The participants were instructed in the use of either the miswak or the toothbrush by the assistant dentist, who also recorded the order of use.

The examining dentist (M.A-H) did not participate in these procedures (single blind). Each subject was issued with a new, conventional toothbrush (regular, straight-handled Oral-B). They were also issued with 4 fresh sticks of miswak (20 cm in length, and 7 mm in width) and instructed to store unused sticks in a refrigerator.

4. Three weeks later, the participants underwent registration of gingival inflammation and plaque deposits and digital photographs of plaque distribution, followed by professional tooth cleaning. The participants were then instructed to follow their habitual oral hygiene routines for the following week.
5. One week later, the participants again underwent registration of gingival inflammation and plaque deposits and digital photographs of plaque distribution. No professional tooth cleaning was performed at this visit. The participants were instructed to use either toothbrush or miswak (the alternative method to that used in the first experimental period) for the following three weeks.
6. Three weeks later, the participants underwent registration of gingival inflammation and plaque deposits and digital photographs of plaque distribution.

Participants

The participants comprised 15 male volunteers, aged 21–36 years, who were regular dental patients at the Dental Center at Al-Noor Specialist Hospital at Makkah City, Saudi Arabia. One of the authors (M. A-H) informed each participant about the aims of the study. All patients were interviewed in respect of their oral hygiene habits and their use of the miswak.

The inclusion criteria were: participants with or without evidence of periodontitis, dentate (≥ 24 teeth), healthy (no diagnosed disease), non-smoking or smoking ≤ 10 cigarettes per day or ≤ 2 water pipes per day. Participants were current miswak users or had used the miswak previously, were right-handed and without orthodontic appliances.

Clinical Examination

The clinical examination comprised registration of plaque deposits and gingival inflammation status, and digital photographs of the buccal tooth surfaces, to record the area covered by plaque. The gingival and plaque indices were based on assessment of the maxillary left and mandibular right quadrants. Before the start of the study, one of the authors (M. A-H) undertook special training in scoring gingival and plaque indices at the Dental School, Karolinska Institutet, Sweden. Intraexaminer reliability was assessed by repeated scorings at an interval of a few hours: evaluation by the Mann-Whitney U test disclosed no significant differences between the two measurement sessions.

Plaque was stained with erythrosine and scored according to the Turesky modified Quigley-Hein Plaque Index (Q-H Index) (Quigley and Hein, 1962; Turesky et al, 1970). The mesial, buccal, distal and lingual aspects of the teeth were recorded and a separate index calculated for each of these aspects.

The status of gingival health, or the presence of inflammation, was assessed in accordance with the Gingival Index (GI) proposed by Löe and Silness (1963), but with bleeding provoked following probing to the bottom of the sulcus (Löe, 1967).

After staining with erythrosine, the labial surfaces of the upper incisor teeth were photographed. Image analysis was used to determine the proportion of tooth area covered with plaque. With the aid of the image processing and analysis program UTHSCSA ImageTool (IT), the tooth area and the area covered by plaque in the color slides were digitized and plaque distribution was expressed as a percentage of the tooth area (Söder et al, 1993). Intraexaminer reliability of the analyzer (M.A-O) was also assessed during the image analysis. Ten photographs showing about 40 buccal surfaces, randomly selected from the 15 participants, were re-scored within a few days of the initial assessment. There were no significant differences between the two measurements.

Statistical Analysis

Data were stored in a computer for subsequent statistical analysis. At the completion of the experiment, the codes for the two different hygiene methods were deleted. Plaque and gingival scores were recorded, and the means were calculated of the scores of the 420 cases (28 teeth each per 15 participants) for each of the 4 surfaces after the two different oral hygiene periods. The scores of the mesial, buccal, distal, and lingual surfaces were calculated independently following the two periods

Table 1 The overall means and standard errors of plaque scores (according to Q-H Index) of the different tooth surfaces at baseline and after 3 weeks of brushing with either miswak or toothbrush

	Mean (Standard Error)			
Measurement	Buccal	Lingual	Mesial	Distal
Baseline				
Miswak	2.89 (0.06)	3.17 (0.06)	4.84 (0.02)	4.72 (0.03)
Toothbrush	2.78 (0.06)	3.09 (0.05)	4.76 (0.03)	4.68 (0.04)
After 3 weeks				
Miswak	2.55 (0.05)	2.98 (0.06)	4.64 (0.05)	4.5 (0.05)
Toothbrush	2.78 (0.05)	3.15 (0.05)	4.75 (0.03)	4.66 (0.03)

Table 2 The overall means and standard errors of scores of gingival indices at baseline and after 3 weeks of brushing with either miswak or toothbrush

	Mean (Standard Error)			
Measurement	Buccal	Lingual	Mesial	Distal
Baseline				
Miswak	1.07 (0.02)	1.10 (0.02)	1.16 (0.02)	1.18 (0.02)
Toothbrush	0.96 (0.02)	1.00 (0.02)	1.01 (0.02)	1.06 (0.02)
After 3 weeks				
Miswak	0.99 (0.02)	1.03 (0.02)	1.00 (0.02)	1.06 (0.02)
Toothbrush	0.95 (0.02)	0.96 (0.02)	0.98 (0.02)	1.04 (0.02)

of cleaning, and analysis of variance for repeated measures was performed. T-tests of independent samples were used to find the p-values during the two periods of different oral hygiene, after the image analysis had been performed.

RESULTS

The overall means and standard errors of plaque scores of the different tooth surfaces at baseline and after 3 weeks of brushing with either the miswak or toothbrush are shown in Table 1. Table 2 shows the means and standard errors of scores of gingival indices at baseline and after 3 weeks use of the miswak or toothbrush. The analysis of variance of the changes recorded for each tooth-cleaning period is shown in Table 3. On all 4 surfaces of the teeth, the reduction in plaque scores achieved by the miswak was highly significant compared with toothbrushing ($p < 0.001$). The miswak achieved similar significant reductions in gingival inflammation on the buccal, distal and mesial aspects ($p < 0.01$, $p < 0.001$ and $p < 0.001$, respectively). The reduction in gingivitis score on the lingual surfaces was not significant ($p = 0.28$).

Fig 1 illustrates the results of the image analysis of plaque distribution on selected surfaces of all participants after the 2 periods of oral hygiene, showing the means of the percentage of the plaque covered area in box plots at baseline and at the end of each period. The reduction in plaque after the miswak period was significant ($p < 0.05$), but not after the toothbrush period.

Table 3 Changes of the means of plaque and gingival indices of individual tooth surfaces between baseline and after a 3 weeks period of tooth cleaning with miswak (Δ M) and toothbrush (Δ B)

	Miswak (M)	Toothbrush (B)	Δ M versus Δ B
	Δ M	Δ B	p-value*
Plaque index			
Buccal	0.34	0	< 0.00001
Lingual	0.19	– 0.1	< 0.01
Mesial	0.2	0.01	< 0.001
Distal	0.22	0.02	< 0.001
Gingival index			
Buccal	0.08	0.01	< 0.01
Lingual	0.07	0.04	NS
Mesial	0.16	0.03	< 0.001
Distal	0.12	0.02	< 0.00001

* Comparisons for significance between mean changes over time after 3 weeks of tooth cleaning with miswak or toothbrush.
NS= not significant

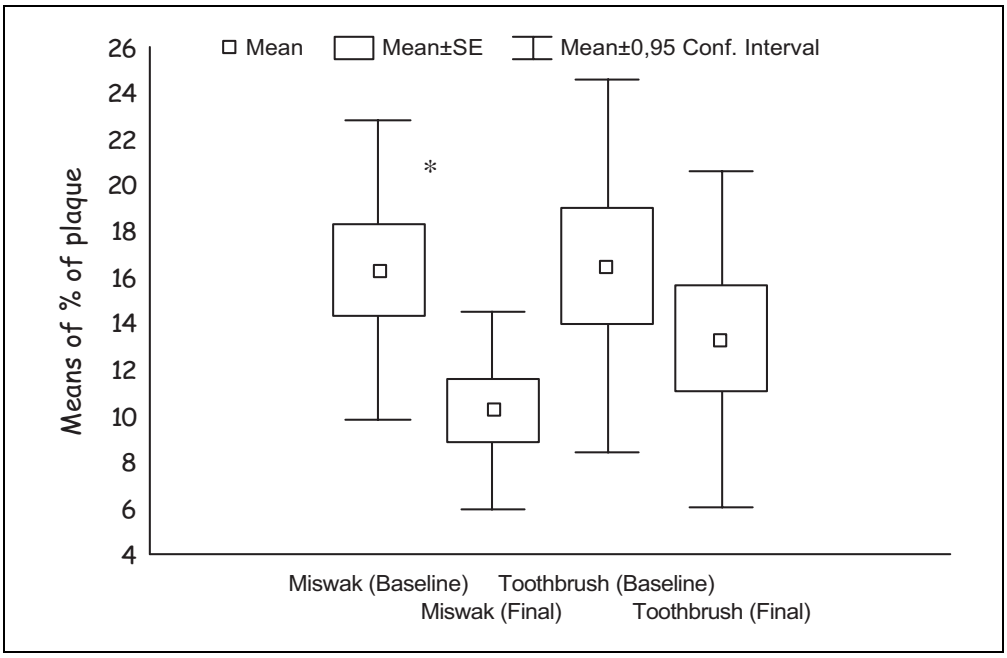

Fig 1 Percentage (mean ± se) of the upper incisor tooth surfaces covered by plaque in all participants at baseline, and after 3 weeks of tooth cleaning by miswak or toothbrush. Data are derived from computerized image analysis. * $p < 0.05$

DISCUSSION

The present study compared the effect of the traditional chewing stick (miswak) and a conventional toothbrush on plaque removal and gingival health in a small sample of Saudi men, accustomed to using both the miswak and the toothbrush. The effects were assessed by the modified Q-H plaque and GI indices and Plaque percentage of plaque distribution, based on computerized image analysis.

The results disclosed a significant reduction in plaque and gingivitis scores after use of both toothbrush and miswak. To standardize the experimental

conditions, all participants were issued with identical conventional toothbrushes and chewing sticks of fairly uniform length and width, and were instructed in the efficient use of both devices. The clinical scorings were expressed in the commonly used indices, slightly modified to suit the purpose of the study.

The validity of the results is related to the applied methodology. The study design differentiated between the effects of each device in a controlled way: i.e. the participants were asked to refrain from toothbrushing during the period of miswak use and vice versa. Participation in the clinical study per se may have resulted in some improvement due to the impact of prophylaxis and oral hygiene instruction at the beginning of each experimental period. A third person randomized the order of experimental periods and this information was not accessible to the specially trained examiner. Individual patients were not informed about the study hypotheses, and were asked not to disclose to the examining dentist which oral hygiene method they had been using.

During each 3-week experimental period the participants used only one device and refrained from using the other, and the wash-out period (7 days) between the experimental crossover periods allowed accumulation of plaque and bacteria. A final factor contributing to the reliability of the results was excellent intraoperator agreement in respect of scoring plaque and gingivitis, and assessing the image analysis of plaque distribution.

However, the study has some limitations. The number of participants was small and a larger sample might have disclosed more significant differences than found in the 15 participants. All the participants were males. It has been shown, however, 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 were found in the subgingival microbiota between males and females from different ethnic groups (Schenkein et al, 1993; Darout et al, 2002).

The miswak was significantly more effective than the conventional toothbrush in reducing plaque and gingivitis. This confirms earlier reports by Gazi et al (1990) that compared with conventional toothbrushing, plaque and gingivitis were significantly reduced when the miswak was used 5 times a day.

However, other studies report no difference in oral health between users of the miswak and toothbrushes (Nörmark and Mosha, 1989), or the higher prevalence of gingivitis among users of chewing sticks (Norton and Addy, 1989; Eid et al, 1990; Mumghamba et al, 1995). These contradictory results might be attributable to differences in socio-economic and/or educational levels and the awareness of oral health.

Various explanations for the cleansing efficacy of the miswak have been advanced: e.g. the mechanical effects of the fibers, the release of beneficial chemicals, or a combination of both (Hardie and 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.

In Saudi Arabia, the preference for using the miswak may be attributed to religious and cultural influences. It is socially acceptable to use the miswak even in public, and Saudi men are accustomed to carrying these sticks in their pockets, and use them frequently during the day: at work, at home, at the mosque or in the street (Al-Otaibi et al, 2003). The frequency and duration of miswak use may explain its relative superiority in the present study.

The following conclusions may be drawn from the study:

- the miswak was more effective than a toothbrush in reducing plaque and gingivitis, when the experimental period was preceded by professional instruction in oral hygiene and the correct application of the miswak.
- the miswak appeared to be more effective than the toothbrush in removing plaque from embrasures, potentially enhancing the condition of the interproximal gingivae.

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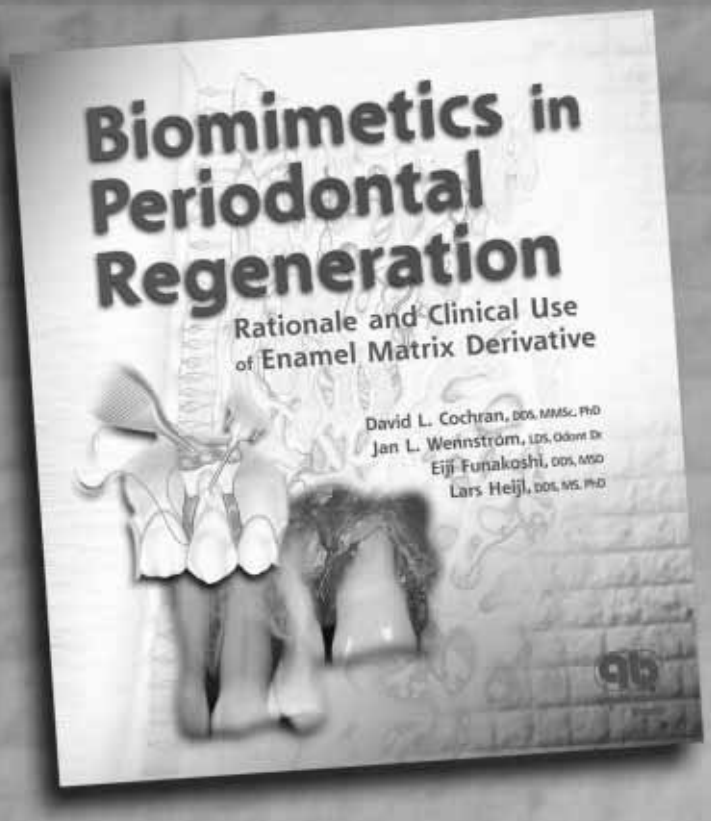

Biomimetics in Periodontal Regeneration

Rationale and Clinical Use of Enamel Matrix Derivative

David L. Cochran, Jan L. Wennström, Eiji Funakoshi, and Lars Heijl

The newest generation in periodontal growth factors, enamel matrix derivative (EMD) promotes complete regeneration of periodontal tissues by mimicking the biologic processes involved in nascent tooth development and shows considerable promise even in the treatment of furcation-involved teeth. This well-illustrated, easy-to-read manual explains the concepts and mechanism of action of this advanced treatment approach and demonstrates the surgical techniques and method of application that will optimize the potential for success. Case presentations provide clinical and radiographic evidence of regeneration of cementum, alveolar bone, and the periodontal ligament. Clinicians experienced with periodontal regenerative techniques and those new to the field will find this a useful guide.

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Contents