



Comparison of Fluoridated Miswak and Toothbrushing with Fluoridated Toothpaste on Plaque Removal and Fluoride Release

¹Hosam Baeshen, ²Sabin Salahuddin, ³Robel Dam, ⁴Khalid H Zawawi, ⁵Dowen Birkhed

ABSTRACT

Introduction: Dental caries and periodontal diseases are all induced by oral biofilm (dental plaque). This study was conducted to evaluate if fluoride-impregnated miswak is as effective in plaque removal and fluoride release as toothbrushing with fluoride toothpaste.

Materials and methods: This single-blind, randomized, cross-over study was conducted at the Department of Cariology, University of Gothenburg, Gothenburg, Sweden, from February 2010 to January 2011. Fifteen healthy subjects participated in this study. The participants were instructed to use the following: (1) 0.5% NaF-impregnated miswak, (2) nonfluoridated miswak, (3) toothbrush with nonfluoride toothpaste, and (4) toothbrush with 1450 ppm fluoride toothpaste. Each method was used twice a day for 1 week after which plaque amount and fluoride concentration in resting saliva were measured. There was a 1-week washout period between each method.

Results: No significant difference between miswak and toothbrushing was found regarding plaque removal on buccal and lingual surfaces. A somewhat higher fluoride concentration in resting saliva was found after using impregnated miswak when compared with toothbrushing with fluoride toothpaste ($p < 0.05$).

Conclusion: Miswak and toothbrushing showed the same plaque removing effect on buccal and lingual surfaces. Miswak impregnated with 0.5% NaF resulted in a higher concentration

of fluoride in saliva than brushing with 1450 ppm fluoride toothpaste.

Clinical significance: Miswak impregnated with 0.5% NaF and toothbrushing results in comparable plaque removal and about the same fluoride concentration in saliva even it was somewhat higher for impregnated miswak.

Keywords: Fluoride, Miswak, Toothbrushing.

How to cite this article: Baeshen H, Salahuddin S, Dam R, Zawawi KH, Birkhed D. Comparison of Fluoridated Miswak and Toothbrushing with Fluoridated Toothpaste on Plaque Removal and Fluoride Release. J Contemp Dent Pract 2017;18(4):300-306.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Miswak, also known as the chewing stick, is harvested from the roots, stems, twigs, or bark of the plant "*Salvadora persica*". It is available as a long stick with a diameter of 1 to 1.5 cm. Miswak was first used by the Babylonians and followed by the Greeks, Romans, Jews, Egyptians, and Muslims. It has been used for thousands of years as an oral hygiene tool and is still used in many parts of the Middle East, Asia, and Africa. It has a greater foothold in Muslim countries due to religious reasons as the last messenger of Islam used it frequently (up to five times a day, before each prayer), and many of his followers want to emulate his way of life.¹ Many of the previous studies performed have been based on populations where the use of miswak is common, i.e., Sudan, Nigeria, Namibia, Kingdom of Saudi Arabia, and Yemen.²

Dental caries and periodontal diseases are all induced by oral biofilm (dental plaque). One of the essential steps in the prevention of such diseases is removal of the oral biofilm. It has been demonstrated in clinical settings that patients undergoing orthodontic treatment are more

¹Department of Orthodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia; Department of Orthodontics, Alfarabi College for Dentistry and Nursing, Jeddah Kingdom of Saudi Arabia

^{2,3,5}Former: Department of Cariology, Institute of Odontology Sahlgrenska Academy, University of Gothenburg, Gothenburg Sweden

⁴Department of Orthodontics, Faculty of Dentistry, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia

Corresponding Author: Hosam Baeshen, Department of Orthodontics, Faculty of Dentistry, King Abdulaziz University Jeddah, Kingdom of Saudi Arabia; Alfarabi College for Dentistry and Nursing, Jeddah, Kingdom of Saudi Arabia, e-mail: habaeshen@kau.edu.sa

susceptible for having the enamel white spot formation. Therefore, the need to address questions regarding micro-organism adherence and biofilm development is crucial.^{3,4}

A previous study has shown miswak to be similar or even more effective than toothbrushing in plaque removal.^{5,6} In addition, miswak has been shown to exhibit a higher reduction in gingivitis provided that professional instructions have been given. However, many of the current studies lack details relating to the time, frequency, and duration of miswak usage. This makes it difficult to compare the efficacy of miswak among different studies.^{5,6}

Miswak can also increase salivary flow and elevate the pH in plaque. Most saliva constituents are influenced by the salivary flow rate. However, fluoride concentration in saliva is the exception. Fluoride concentration in the oral cavity is dependent on the fluoride present in the oral environment. One of the major fluoride sources is drinking water. As fluoride concentration in drinking water increases, the prevalence of caries decreases. At the same time, however, the risk for systemic fluorosis increases. Another major source of fluoride is the use of fluoridated toothpaste. While using dentifrices containing fluoride, some of it is inevitably swallowed. Still, since the volume of saliva present in the mouth is small, even a small amount of fluoride will result in a high fluoride concentration, i.e., spread throughout the mouth. However, the concentration of fluoride decreases rapidly because of oral clearance. This shows the importance of locally applied fluoride for caries control. Currently, the approach to caries control is about fluoride being present in the oral fluid close to the site of action.⁷

Miswak can be compared with a toothbrush in that it has bristles, which remove plaque mechanically. However, unlike the toothbrush, its bristles are parallel to the handle, which makes it more difficult to brush on buccal and occlusal surfaces, particularly in the posterior part of the dentition.⁸ Previous studies have shown that both miswak and toothbrushes do not effectively remove plaque in approximal areas, hence, the recommendation to use different approximal tools.⁸ Before cleaning teeth with miswak, it is chewed on briefly to fray the fibers. Then, it is used until it loses its taste and odor.³⁻⁵ Gentle, circular movements should be used to massage the gingiva and to avoid any damage and possible gingival recession.^{4,5} On completion of tooth cleaning, the used bristles are trimmed away and new ones are prepared by further chewing. If the miswak is dry, the end should be soaked in water for 24 hours. However, soaking for more than 24 hours causes loss of active components but without any loss of mechanical properties.^{3,4}

In addition to its mechanical properties, miswak possess a certain antimicrobial effect on gingivitis and

caries. It also has a minor effect on the salivary and sub-lingual microbiota. Mutans streptococci are more susceptible to miswak antimicrobial activity than lactobacilli.⁹

There are two basic grips to hold miswak to ensure controlled and reproducible movements. In the five-finger grip, the four hand fingers are curled lightly around the stick, with the finger nearest the end to be chewed. The pulp of the thumb rests firmly on the opposite side of the stick to the index finger. In the three-finger grip, the miswak is placed between the index and the third finger. The fourth and the fifth fingers are kept clenched on the palm and the thumb rests on the side opposite to the third finger.^{3,4}

Considering previously mentioned properties of miswak and the fact that it is readily available and cheap in countries where it is routinely used, it seems like a suitable alternative to toothbrushing with toothpaste. In 1987, the World Health Organization recommended the use of miswak to achieve good oral hygiene.⁷ However, the current studies state that further research is needed to evaluate the effects of miswak.

Fluoride has been proven to be the most effective anti-cariogenic agent. The daily use of fluoridated toothpaste is well known to be the main contributor to the prevention and decline of dental caries.^{2,8} Miswak contains natural traces of fluoride, but the amount is negligible in preventing dental caries.⁵ When soaked in distilled water, the amount of fluoride released from a miswak has been measured to be less than 0.07 µg/mL F.⁵ The idea of impregnating miswak originated from earlier studies on wooden toothpicks. Recent procedures at our laboratory have been developed to impregnate miswak with fluoride.¹⁰ These *in vitro* and *in vivo* studies show that fluoride can be released effectively and rapidly from miswak. In addition, the spongy consistency of miswak (porous pulp) enables it to absorb high concentrations of fluoride even through its outer layer (bark).¹⁰ Since a large surface area of the chewing stick comes into contact with the dentition, released fluoride can be swallowed. From a toxicological point of view, the maximum fluoride concentration for miswak impregnation should be 0.5% NaF.¹¹ The possibility of impregnating miswak with fluoride makes it suitable for caries prevention when used twice a day or more frequently.

Based on our knowledge, only one study has compared fluoride-impregnated miswak with fluoridated homecare products.¹¹ Our hypothesis was that miswak is comparable to toothbrushing with fluoride toothpaste regarding plaque removal and release of fluoride. Thus, the aim of this study was to compare fluoride-impregnated miswak and toothbrushing with fluoride toothpaste in terms of plaque removal and fluoride release into saliva, when using them twice daily.

MATERIALS AND METHODS

Study Design and Participants

The study was conducted over 9 weeks and was single-blind and randomized with a cross-over design. Fifteen healthy people (6 men and 9 women; mean age 28.8 ± 4.7 years) were recruited from a pool of volunteers of university students. It was assured that all subjects could follow the instructions. Subjects with orthodontic appliances, hyposalivation, (<0.1 mL/min) or systemic diseases that could affect salivary flow were excluded from the study. The participants used four methods: (1) 0.5% NaF impregnated miswak, (2) nonfluoridated miswak, (3) toothbrush with nonfluoride toothpaste, and (4) toothbrush with 1450 ppm F-toothpaste. The participants were instructed to refrain from using supplementary oral hygiene products (fluoride mouth rinses and interproximal cleaning tools) and fluoride-containing chewing gum other than the assigned methods. The details of the study duration and cross-over design are shown in Figure 1.

Ethical Considerations

The study protocol was approved by the Ethics Committee at the University of Gothenburg, Sweden. Prior to the study, informed consent was obtained from all participants.

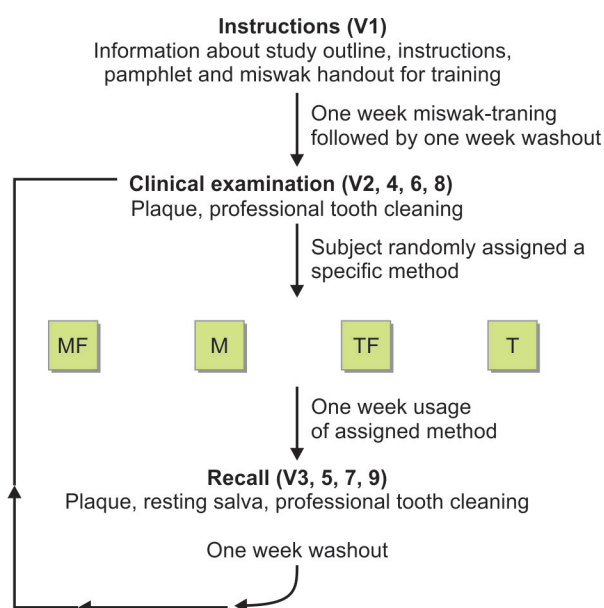


Fig. 1: Study design. During their first visit (V1), the subjects were informed and given instructions and miswak to train with. During their second visit (V2), plaque was measured, followed by professional tooth cleaning and assignment of a random method: MF: Fluoride-impregnated miswak; M: Nonfluoridated miswak; TF: Toothbrush with fluoride toothpaste; T: Toothbrush with toothpaste. One week later they were recalled for the third visit (V3) and the method was evaluated by recording plaque and collecting resting saliva. After the completion of a method, the participants started over again (V4, 6, 8)

Miswak

Miswak (from *S. persica*) was imported from the Kingdom of Saudi Arabia to Sweden and kept frozen. Before the start of the study, they were thawed and soaked in distilled water to remove dirt, and then, cut into 6-cm-long pieces. Half of the chewing sticks were dried in an oven overnight at 40°C and the other half impregnated in a 0.5% NaF solution for 24 hours and left for drying. Finally, all the sticks were sealed in clear plastic nylon bags and coded by a third party into impregnated and nonimpregnated miswak unknown to the examiners.

Toothbrush and Toothpaste

A regular toothbrush (TePe) with soft bristles was used together with fluoride toothpaste (1450 ppm F-toothpaste, 50 RDA) or nonfluoridated toothpaste (45 RDA). When using the toothpaste, the participants were instructed to follow the “modified toothpaste technique” according to Sjögren et al.¹²

Instructions

On the first visit (Fig. 1, V1), all participants attended a meeting, in which the study outline and detailed oral hygiene instructions were given. An illustrative educational pamphlet was handed to the participants. It included instructions on when to brush (morning and night), miswak use according to Almas and Al-Lafi,¹³ and toothbrushing according to Sjögren et al.¹² In addition, they received miswak to practice with at home for a week. Previous studies have shown that it generally takes a longer time to brush teeth with miswak, thus the duration of brushing was dependent on the method used, i.e., 5 minutes for miswak and 2 minutes for toothbrush.¹⁴

Examination

Plaque deposits were recorded according to O’Leary’s Plaque Index.¹⁵ The sites recorded were the buccal, lingual, distal, and mesial surfaces. Third molars were excluded from the study. To register salivary fluoride concentration, resting saliva was collected at 0, 1, 3, 5, 10, 15, 20, and 30 minutes in small beakers, which were kept frozen until analyzed.

On the second visit (V2), baseline levels of plaque were recorded, after which the participants underwent professional tooth cleaning and were assigned an oral hygiene method in a sealed package with the content unknown to the examiners. After using the method for a week, the participants were recalled and the same clinical parameters were registered in addition to collection of resting saliva (V3). Finally, professional tooth cleaning was carried out and the subjects entered a washout week

where they returned to their regular oral hygiene habits. In the following visits (V4, 6, 8), a new oral hygiene method was commenced, after which they would be recalled (V5, 7, 9) and evaluated.

Analysis of Fluoride

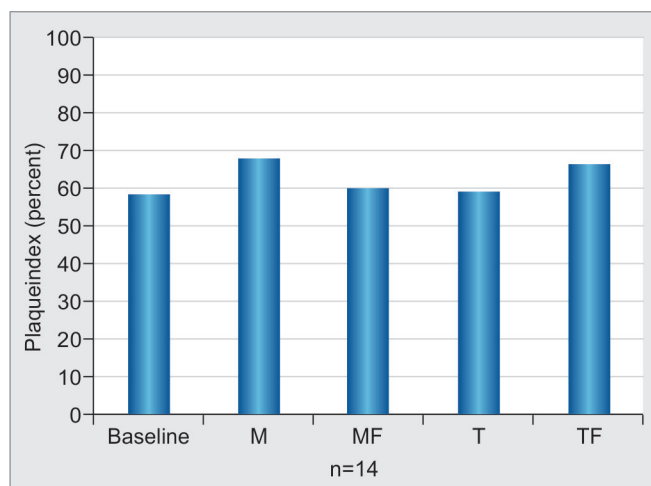
The saliva samples were analyzed using a fluoride-sensitive electrode connected to an ion analyzer (Orion Research), and the ionic strength was stabilized by adding total ionic strength adjustment buffer III in a ratio of 1:10 according to the manufacturer's instructions. The electrode was calibrated against three standard solutions from 0.526 μM (0.01 ppm) to 5.26 mM (100 ppm) of F-toothpaste. The detection limit was about 0.5 μM .

Statistical Methods

The plaque scores for the four methods were analyzed as two groups (miswak and toothbrush). A paired t test was used to compare miswak and toothbrush. A p-value <0.05 was considered to be statistically significant. The statistical analysis was made using Statistical Package for the Social Sciences (IBM) version 20.0. A p-value <0.05 was considered to be statistically significant while comparing the saliva samples.

RESULTS

The general plaque scores compared with baseline following toothbrushing and miswak usage for all participants combined are presented in Graph 1. All surfaces were analyzed while plaque scores were recorded. An increase in plaque in all groups was seen when compared with baseline. The increase was shown not to be statistically significant.



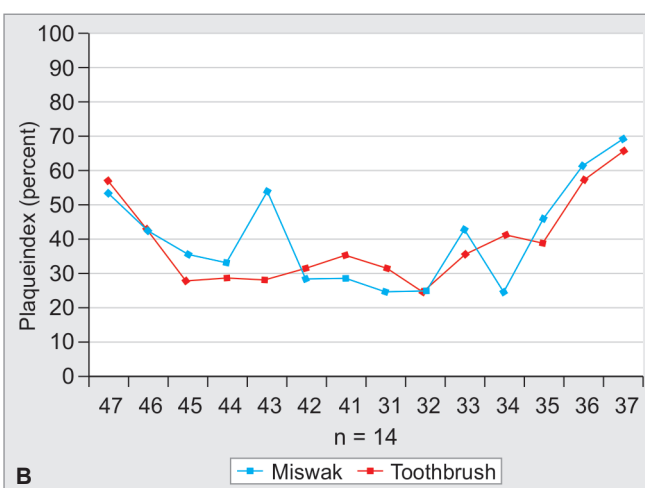
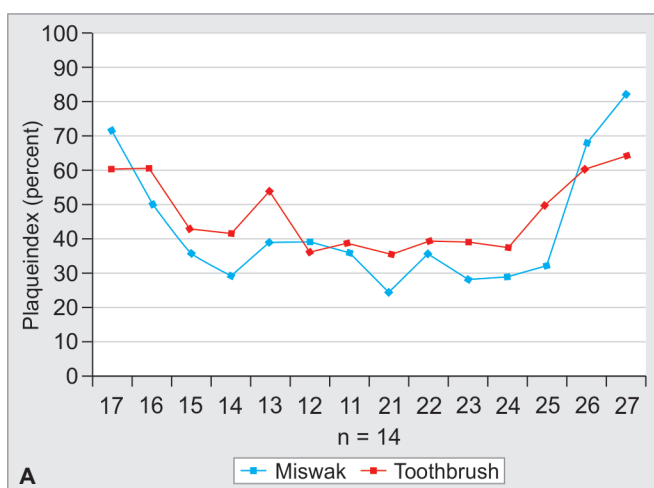
Graph 1: General plaque scores. No significant difference was found on plaque removal when comparing miswak and toothbrush with baseline

The plaque scores on the buccal and lingual surfaces are shown in Graphs 2A, B and 3A, B respectively. The differences between the general plaque scores found buccally and lingually after cleaning with miswak when compared with toothbrushing. However, none of these were statistically significant when analyzed using a paired t test.

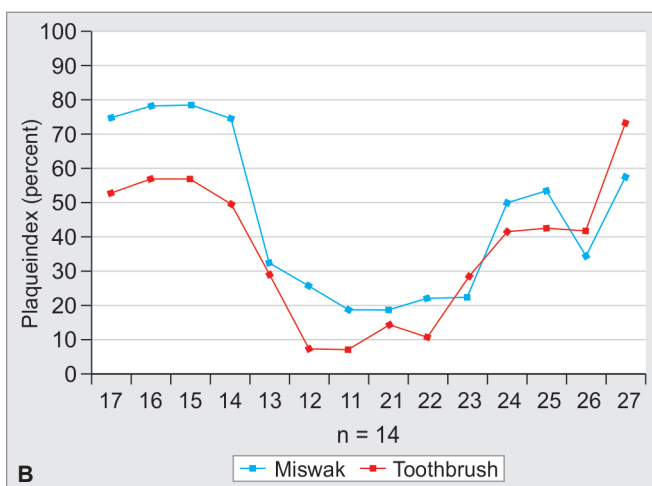
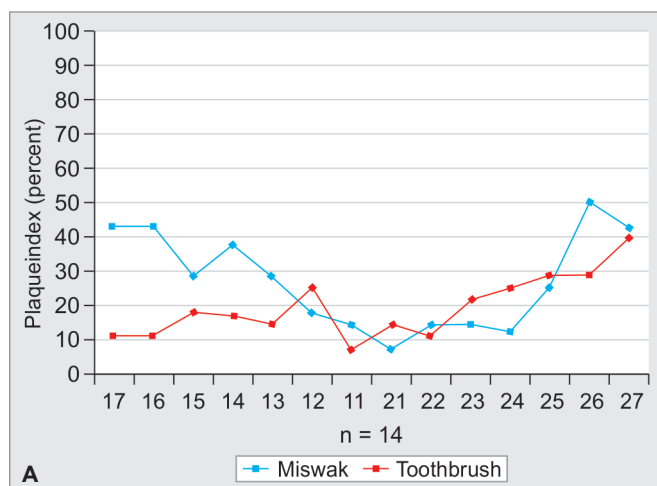
The results of the fluoride analysis are shown in Graph 4. A somewhat higher fluoride concentration was found for impregnated miswak compared with toothbrushing with fluoridated toothpaste. The difference was statistically significant only at 1 minute. As expected, no fluoride was found in saliva samples from a toothpaste without fluoride and nonimpregnated miswak.

Side Effects

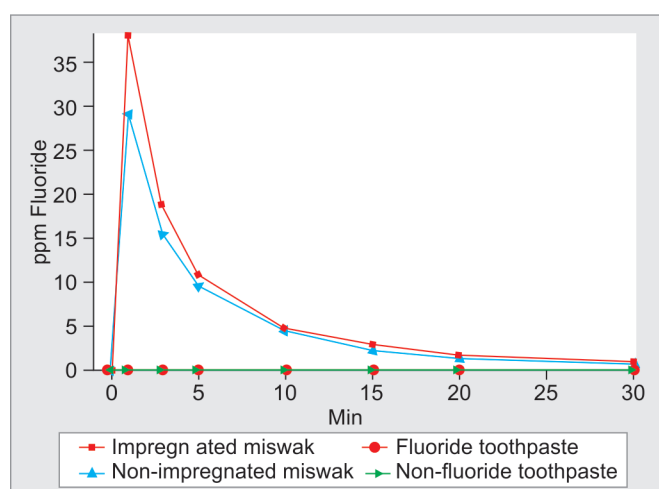
During the study, it was observed that 12 out of 15 subjects developed lesions in areas that were in contact with



Graphs 2A and B: Buccal plaque scores on the upper and lower jaw. After cleaning with miswak, less plaque was recorded buccally in the upper jaw except for molar teeth. In the lower jaw, there were less plaque on incisors and the first left premolar after miswak usage. The differences seen on both the lower and upper jaw were not significant when analyzed statistically



Graphs 3A and B: Lingual plaque scores on the upper and lower jaw. Less plaque was recorded in the upper jaw on the left premolars. In the lower jaw, a higher plaque score for miswak was recorded. The difference seen on both the lower and upper jaw was, however, not significant when analyzed statistically



Graph 4: Fluoride concentration in resting saliva over time. Brushing with impregnated miswak gave a higher fluoride release into saliva than brushing with 1,450 ppm fluoridated toothpaste. As expected, no fluoride release was registered in saliva samples from nonimpregnated miswak and brushing with nonfluoride toothpaste

the miswak. Common places were the gingiva, angles of the mouth, and fingers. Some of these lesions are shown in Figures 2A to C. One participant dropped out before completing the study due to the development of rashes

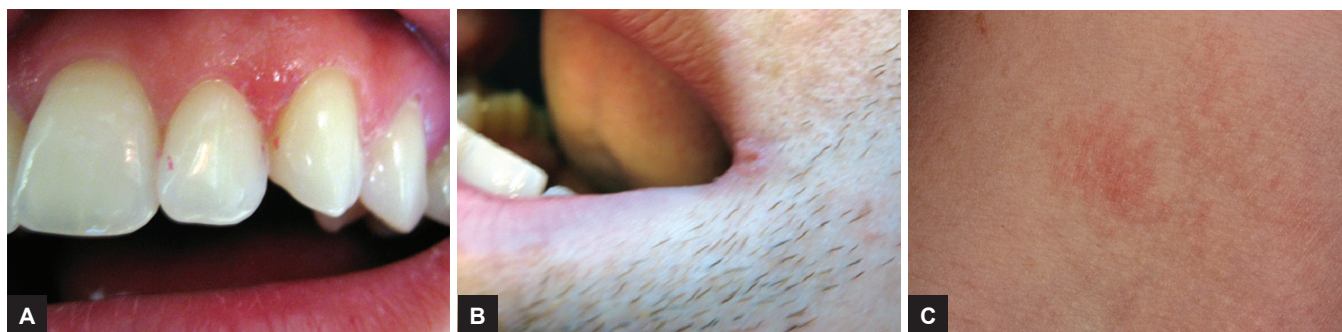
on the hands where the chewing stick was held. The data from that participant were excluded from the study.

DISCUSSION

The findings of this study support the hypothesis that there is no difference between miswak and toothbrushing in the aspect of plaque removal. However, this is the first study that has evaluated miswak with individuals unfamiliar with its use, and it shows that the use of miswak twice daily is equivalent to toothbrushing twice a day. Prior studies have made the comparison when miswak has been used five times a day.

In Graph 1, an increase in plaque scores was recorded for all methods when compared with baseline. This was, however, not shown to be statistically significant. The increase can be explained by the fact that the participants were not allowed to use interproximal cleaning tools during the study.

The findings in Graphs 2A, B and 3A, B, though not statistically significant, could be caused by which hand the miswak was held and based on whether the person was right or left-handed. As stated, the bristles



Figs 2A to C: Many subjects developed lesions in areas in contact with miswak: (A) Common places were the gingiva; (B) angles of the mouth; and (C) fingers

in a miswak are parallel to its handle, possibly explaining some of the differences seen on plaque levels of the posterior teeth. Although the differences were not significant, the outcome could have been different if the study sample was further increased.

Plaque scores for the four methods were analyzed as two groups: Miswak and toothbrush. No consideration was given whether the method contained fluoride. The analysis was done considering fluoride has no significant impact on plaque formation and since it gave an opportunity for a larger study sample.

Using saliva as a diagnostic tool for fluoride analysis is due to saliva being a reflection of the whole oral environment. Compared with measuring fluoride in plaque, which would be a local sample, measuring fluoride concentration in saliva is simpler. Furthermore, no significant difference has been shown between the two methods.

No significant differences between miswak and toothbrushing were found in relation to the plaque. This is in line with a previous study, in which miswak usage resulted in plaque removal equivalent to that of toothbrushing.⁵ On the contrary, the results of this study are in a disagreement with a recent study which showed that miswak effectively prevented dental caries in high school students.¹⁴

A somewhat higher fluoride concentration in resting saliva was found following the use of fluoride-impregnated miswak, which is concomitant with a previous study.¹⁰ The miswak was impregnated in a higher fluoride concentration compared with the fluoride toothpaste, and as expected the fluoridated miswak resulted in a higher fluoride concentration in resting saliva. This is in accordance with earlier studies.¹⁰ One of the limitations of the study is that there was no control over the efficiency of miswak. Regarding compliance, it was considered high in this study since the participants were highly motivated and reinforcement of oral hygiene was done regularly. The use of miswak is technique-sensitive as it takes a longer duration to clean the dentition compared with toothbrushing. In addition, studies on miswak have shown that improved results are reached when professional instructions are given.⁵ Another issue is related to the fact that frozen chewing sticks were used rather than freshly bought ones. This could have made the sticks drier, and coupled with improper use might have led to increased gingival trauma. Freezing and thawing of the miswak could also have damaged the cells, thus releasing substances that might have had an irritating effect on oral mucosa and the skin. The oral lesions observed in the participants could also possibly reflect an improper use of miswak (either excessive pressure or inaccurate angulation of the miswak). Another reason might be that certain constituents of the chewing stick

triggered a sensitivity reaction. When it became apparent that many of the participants developed lesions, they were offered to drop out of the study. However, only one subject chose to discontinue. If any further studies are to be done on nonhabitual users of miswak or with frozen miswak, information must be given concerning the risks of developing lesions.

The ability to generalize the findings of this study is limited by the low number of study participants. To give a general recommendation as an alternative to toothbrushing, future extended and large-scale studies, especially, in developed countries are needed to assess the efficacy of miswak usage. This is due to the fact that miswak is foreign to these societies and religiously linked to Islam in the other countries where it is a common practice. Moreover, it is economically affordable and thus more often used in poor countries for people with limited access to toothbrushes and toothpaste.¹³

CONCLUSION

Miswak and toothbrushing result in comparable plaque removal. Twice a day usage of 0.5% NaF impregnated-miswak results in a salivary fluoride concentration somewhat higher than toothbrushing with 1450 ppm F-toothpaste.

ACKNOWLEDGMENTS

The authors would like to thank the following people at Sahlgrenska Academy, University of Gothenburg, for their invaluable help. Torgny Alstad at the Department of Prosthodontics for assistance with statistical analysis. Sara Rangmar at the Department of Cariology for her support and encouragement. Ann-Britt Lundberg at the Department of Cariology for practical and laboratory assistance.

REFERENCES

1. Niazi F, Naseem M, Khurshid Z, Zafar MS, Almas K. Role of *Salvadora persica* chewing stick (miswak): a natural toothbrush for holistic oral health. *Eur J Dent* 2016 Apr-Jun;10(2): 301-308.
2. Baeshen HA, Lingström P, Birkhed D. Effect of fluoridated chewing sticks (Miswaks) on white spot lesions in post-orthodontic patients. *Am J Orthod Dentofacial Orthop* 2011 Sep;140(3):291-297.
3. Haque MM, Alsareii SA. A review of the therapeutic effects of using miswak (*Salvadora persica*) on oral health. *Saudi Med J* 2015 May;36(5):530-543.
4. Halawany HS. A review on miswak (*Salvadora persica*) and its effect on various aspects of oral health. *Saudi Dent J* 2012 Apr;24(2):63-69.
5. Al-Otaibi M. The miswak (chewing stick) and oral health. Studies on oral hygiene practices of urban Saudi Arabians. *Swed Dent J Suppl* 2004 Jun;167:2-75.

6. Batwa M, Bergström J, Batwa S, Al-Otaibi M. The effectiveness of chewing sticks miswak on plaque removal. *Saudi Dent J* 2006 Sep-Dec;18(3):125-133.
7. Sofrata A, Lingström P, Baljoon M, Gustafsson A. The effect of miswak extract on plaque pH. An *in vivo* study. *Caries Res* 2007 Sep;41(6):451-454.
8. Al-Dabbagh SA, Qasim HJ, Al-Derzi NA. Efficacy of miswak toothpaste and mouthwash on cariogenic bacteria. *Saudi Med J* 2016 Sep;37(9):1009-1014.
9. Almas K, Al-Zeid Z. The immediate antimicrobial effect of a toothbrush and miswak on cariogenic bacteria: a clinical study. *J Contemp Dent Pract* 2004 Feb;5(1):105-114.
10. Baeshen HA, Kjellberg H, Lingström P, Birkhed D. Uptake and release of fluoride from fluoride-impregnated chewing sticks (miswaks) *in vitro* and *in vivo*. *Caries Res* 2008 Aug;42(5): 363-368.
11. Baeshen H, Birkhed D. Release of fluoride from fresh and old NaF-impregnated chewing sticks (Miswaks) *in vitro* and oral retention *in vivo*. *Oral Health Prev Dent* 2010 Jan;8(1): 93-99.
12. Sjögren K, Birkhed D, Rangmar B. Effect of a modified tooth-paste technique on approximal caries in preschool children. *Caries Res* 1995 Apr;29(6):435-441.
13. Almas K, Al-Lafi TR. The miswak (chewing stick) and oral health part-II uses, effect on periodontium and preparation. *Pak Oral Dent Jr* 1997;17:29-36.
14. Mustafa M, AlJeaidi Z, AlAajam WH, Dafaalla Mohammed KA. Study of caries prevalence among miswak and non-miswak users: a prospective study. *J Contemp Dent Pract* 2016 Nov;17(11):926-929.
15. O'Leary TJ, Drake RB, Naylor JE. The plaque control record. *J Periodontol.* 1972 Jan;43(1):38.