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Siwak as a oral hygiene aid in patients with fixed orthodontic appliances

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Abstract: *Objectives:* The aims of this study were to compare the mechanical efficacy of Siwak in plaque control and gingival health conditions in subjects wearing fixed orthodontic appliances compared with standard and orthodontic toothbrushes. *Methods:* Forty male patients with a mean age of 17.20 ± 4.01 years, wearing fixed orthodontic appliances were included in this study. Following a session of scaling and polishing, which established a situation with minimal gingival inflammation and close to zero amounts of dental plaque, all patients were instructed to use a standard soft toothbrush for 1 week after which they were randomly and equally allocated to one of four groups: (i) a manual toothbrush group; (ii) an orthodontic toothbrush group; (iii) a Siwak group; and (iv) a combination of Siwak and an orthodontic toothbrush group. All patients were instructed to brush their teeth three times a day. All patients were scored for plaque and gingivitis 1 week after scaling and polishing and 2 weeks following group assignment. *Results:* A similar effect of Siwak to that of soft and orthodontic toothbrushes with respect to plaque control in patients with fixed orthodontic appliances was found. It was the combined use of Siwak and orthodontic toothbrush that provided the best plaque control in such patients. Gingival condition was better in the Siwak groups whether used solely or in combination with an orthodontic toothbrush. *Conclusion:* The use of Siwak promotes gingival health in patients with orthodontic appliances.

Key words: hygiene; orthodontic; Siwak

Introduction

Clinical and microbiological studies have proven that microbial dental plaque has an aetiological importance in the initiation and progression of periodontal diseases (1). This has lead to the notion that plaque removal and control are a primary goal of dental care in general and periodontal therapy in particular.

Many oral hygiene aids are currently available. Mouthrinses, toothpicks, toothbrushes, dental floss and chewing sticks are among those available. The most used chewing stick in the Middle East is the Siwak from the *Salvadora persica* tree. The roots, stem, twigs and bark of *S. persica* provide the Siwak (Fig. 1). A diameter of 1 cm is believed sufficient enough for suppleness and firmness, while a length of 20 and 15 cm is generally acceptable for adults and children, respectively (2). Soaking the Siwak for few hours softens the natural fibres, facilitating teeth brushing, fibre crushing and release of constituents (3).

The value of the Siwak and other plant species used as chewing sticks throughout the world was originally believed to rest solely on their mechanical cleansing action. However, studies suggest several additional properties of chewing sticks including haemostatic, analgesic, anti-inflammatory, antimicrobial and anticaries effects (4–8).

An adequate level of oral hygiene is required to maintain dental health in patients undergoing fixed orthodontic appliance therapy because the wires, brackets and bands act as a barrier to the toothbrush bristles, while at the same time enhancing the accumulation of plaque and debris predisposing the patient to gingival and periodontal diseases (9).

Clinical and microbiological studies have undoubtedly proven that microbial dental plaque has an aetiological importance in the initiation and progression of the most common oral diseases – dental caries and periodontal diseases (1, 10, 11). This has led to the notion that plaque removal and control (on both professional and personal bases) are the primary goals of periodontal therapy and dental preventive programmes.

Several cross-sectional and clinical trials on the Siwak chewing stick conducted in patients without orthodontic appliances have led to the conclusion that Siwak is an efficient tool for plaque debridement and oral hygiene (12), with some indicating its superiority to the use of a toothbrush (12–14). Darout *et al.* (15) assessed and compared the periodontal status of adult Sudanese habitual Siwak and toothbrush users (those using the specific oral hygiene method at least once a day for the past year) and reported that the periodontal status of Sudanese Siwak users is better than that of toothbrush users. Additional studies support the fact that the use of chewing sticks yields results comparable with those of a conventional toothbrush as regards plaque control. Olsson (16), in a 3-month clinical trial on Ethiopian schoolchildren, reported that Mefaka (a chewing stick used in Ethiopia) was as effective as toothbrush in removing oral deposits. A cross-sectional survey among female Ghanians by Norton and Addy (17), demonstrated the lack of difference between toothbrush and chewing stick users for plaque and gingivitis scores. Nörmark and Mosha (18), in their observational study on rural Tanzanian children, stated that whether plastic toothbrushes or local Siwak were used for oral cleaning made no difference in plaque deposits, gingivitis and caries.

Fig 1. The Miswak.

Notwithstanding the relative abundance of literature on the clinical benefits of Siwak use, information on their effect is probably non-existent in the specific case of fixed orthodontic appliance therapy. This clinical trial was conducted to test the hypothesis that Siwak is an efficient oral hygiene device in patients with fixed orthodontic appliances.

Materials and methods

Forty medically and periodontally healthy male subjects wearing fixed orthodontic appliances for at least 6 months were recruited for this randomized clinical trial from the pool of patients attending the orthodontic clinic at the Jordan University of Science and Technology Dental Teaching Center. A checklist of male patients with fixed orthodontic appliances attending the orthodontic clinic was obtained. Patients were telephoned and those interested in participation were appointed for a clinical screening visit. The first 40 volunteers complying with the inclusion criteria were selected for the study after their approval. A written consent was obtained from the patients or patients' parents. Ethical approval for this research was obtained from the local research committee and Research on Human Committee.

Subjects were randomly assigned to four groups of treatment by drawing a paper from a basket with folded paper tags. These groups of 10 subjects each were: (i) manual toothbrush group; (ii) orthodontic brush group; (iii) Siwak brush group; and (iv) Siwak with an orthodontic brush group. Age of

subjects in the different groups is shown in Table 1. None of the subjects had previous experience in Siwak use.

The three types of brushes that were used in this study were: (i) classic soft supple toothbrush; (ii) orthodontic brush; (iii) Siwak sticks from *S. persica* tree. All of the used Siwak sticks in the study were of approximately uniform length and diameter. At day 0, a session of scaling and polishing using piezoelectric ultrasonic scaler and a polishing cup was performed by the first examiner for all participants. So all subjects were returned to no-plaque state after enrollment. All participants were handed a new classic soft toothbrush and a fluoride-containing toothpaste. Participants were asked to brush their teeth three times daily and to refrain from using any plaque control methods other than the items they were or will be given for the entire trial period.

Seven days later, gingival index proposed by Loe and Silness (19) and plaque index according to the Quingly Hein Index-Modified by Turesky *et al.* (20) were used to evaluate periodontal status for all subjects. No separate bleeding index was used because gingival index contained a bleeding element in it. The classic soft toothbrushes that were used by the subjects from day 0 to day 7 were collected and patients were given according to their group allocation either a new classic soft supple toothbrush, or an orthodontic brush, or a Siwak, or an orthodontic brush with a Siwak. The proper technique of using the designated toothbrush, and or the Siwak was explained by the assistant to each individual according to his group allocation both verbally and visually using models. In addition, all subjects received written instructions with coloured pictures demonstrating the modified bass technique for toothbrushing. Subjects who were supposed to use the Siwak were given a sheet of written instructions demonstrating the proper preparation and preservation techniques of Siwak. All subjects were asked to brush their teeth three times daily with reemphasis on not using any plaque control methods other than the items they were handed.

At day 21, gingival and plaque indices were measured by the same examiner following the same protocol of assessment at day 7 of examination. As the efficacy of Siwak in orthodontic patients was not studied before and strict oral hygiene measures are needed in those patients, this study was conducted in this short duration.

Table 1. **Descriptive statistics of patients' age**

Group	Number of participants	Minimum age	Maximum age	Mean	Standard deviation
Group 1	10	14	26	18.70	3.97
Group 2	10	13	27	17.70	4.88
Group 3	10	13	22	16.30	3.30
Group 4	10	13	24	16.10	3.78
Total subjects	40	13	27	17.20	4.01

Statistical analysis

Data analysis was carried out using the Statistical Package for Social Sciences (SPSS®) version 10 (SPSS Inc., Chicago, IL, USA). Mean and standard deviations of plaque and gingival index scores in each group at day 7 and day 21 of examination were calculated. The gingival index values measured at three sites facially and at three sites palatally/lingually or each examined tooth were averaged into one facial and one palatal/lingual mean gingival index.

Paired *t*-test was used to identify intra-group differences in the changes of plaque and gingival indices between baseline and consecutive visit of examination. Analysis of variance (ANOVA) was used to determine whether significant differences existed between the studied groups. LSD multiple comparison test was applied to identify which of the groups were different.

Method error

Before the initiation of the study, the reliability of the examiner was tested. Plaque and gingival index scores were recorded and later reexamined for selected teeth in the upper and lower segments in 10 randomly assigned subjects. Kappa statistics (21) were used to evaluate the errors in readings. Results of the Kappa values were above 80%, which indicates substantial agreement between readings (22).

Results

Changes in plaque and gingival indices between the two examinations

Tables 2–5 show mean, standard deviations, mean difference and *P*-value of plaque and gingival indices between the first and second examination.

Group 1 (soft standard toothbrush)

Plaque index changes

Full mouth plaque index was increased from day 7 to day 21 ($P < 0.001$). Plaque index increased significantly at the facial and palatal surfaces of the upper teeth ($P < 0.001$) and at the lingual surfaces of the lower teeth ($P < 0.001$). Collectively, a significant increase in plaque index occurred in the upper arch and lower ($P < 0.001$ and $P < 0.01$ respectively).

Table 2. **Mean values, standard deviations, mean differences and *P*-values of plaque and gingival indices between the two examinations in group 1**

	Plaque index				Gingival index			
	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value
Upper								
Facial surfaces	1.21 ± 0.71	2.11 ± 1.14	0.90	0.001***	0.90 ± 0.45	1.35 ± 0.33	0.45	0.023*
Palatal surfaces	1.11 ± 0.71	2.06 ± 0.81	0.95	0.001***	0.96 ± 0.41	1.47 ± 0.40	0.51	0.005**
Total	1.16 ± 0.67	2.10 ± 0.84	0.94	0.000***	0.93 ± 0.40	1.41 ± 0.35	0.48	0.008**
Lower								
Facial surfaces	1.27 ± 0.82	2.01 ± 0.98	0.74	0.053	0.86 ± 0.41	1.34 ± 0.35	0.48	0.021*
Lingual surfaces	1.19 ± 0.70	2.28 ± 0.93	1.08	0.001***	0.96 ± 0.45	1.57 ± 0.39	0.61	0.001***
Total	1.23 ± 0.71	2.14 ± 0.80	0.91	0.003**	0.91 ± 0.40	1.45 ± 0.34	0.54	0.004**
Full mouth	1.20 ± 0.66	2.12 ± 0.75	0.92	0.000***	0.92 ± 0.38	1.43 ± 0.32	0.51	0.005**

*$P < 0.05$, **$P \leq 0.01$, ***$P \leq 0.001$.

Table 3. **Mean values, standard deviations, mean differences and *P*-values of plaque and gingival indices between the two examinations in group 2**

	Gingival index				Plaque index			
	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value
Upper								
Facial surfaces	0.91 ± 0.26	1.17 ± 0.31	0.26	0.030*	1.13 ± 0.48	1.77 ± 0.99	0.64	0.110
Palatal surfaces	0.73 ± 0.44	1.20 ± 0.32	0.47	0.002**	1.00 ± 0.67	1.76 ± 0.59	0.76	0.033*
Total	0.80 ± 0.22	1.18 ± 0.27	0.38	0.002**	1.05 ± 0.54	1.69 ± 0.65	0.64	0.046*
Lower								
Facial surfaces	0.79 ± 0.29	1.10 ± 0.26	0.31	0.026*	1.11 ± 0.61	1.72 ± 0.93	0.61	0.084
Lingual surfaces	1.00 ± 0.44	1.38 ± 0.37	0.38	0.055	1.25 ± 0.75	2.01 ± 0.63	0.76	0.005**
Total	0.89 ± 0.33	1.24 ± 0.29±	0.35	0.030*	1.18 ± 0.66	1.87 ± 0.74	0.69	0.021*
Full mouth	0.84 ± 0.26	1.21 ± 0.26	0.37	0.005**	1.11 ± 0.59	1.78 ± 0.67	0.66	0.030*

*$P < 0.05$, **$P \leq 0.01$.

Table 4. **Mean values, standard deviations, mean differences and *P*-values of plaque and gingival indices between the two examinations in group 3**

	Gingival index				Plaque index			
	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value
Upper								
Facial surfaces	1.05 ± 0.40	1.10 ± 0.20	0.05	0.709	1.64 ± 0.90	2.36 ± 1.36	0.72	0.156
Palatal surfaces	1.04 ± 0.56	1.08 ± 0.26	0.04	0.839	1.61 ± 0.70	2.25 ± 0.97	0.64	0.104
Total	1.04 ± 0.42	1.09 ± 0.17	0.05	0.772	1.63 ± 0.65	2.26 ± 0.92	0.63	0.070
Lower								
Facial surfaces	0.96 ± 0.29	1.06 ± 0.25	0.10	0.417	1.00 ± 0.67	2.53 ± 1.18	1.53	0.005**
Lingual surfaces	1.23 ± 0.46	1.27 ± 0.36	0.04	0.827	1.33 ± 0.97	2.93 ± 1.15	1.60	0.001***
Total	1.09 ± 0.30	1.17 ± 0.26	0.08	0.632	1.17 ± 0.80	2.73 ± 1.02	1.56	0.001***
Full mouth	1.08 ± 0.30	1.12 ± 0.19	0.04	0.744	1.45 ± 0.72	2.43 ± 0.97	0.98	0.013*

*$P < 0.05$, **$P \leq 0.01$, ***$P \leq 0.001$.

Gingival index changes

Full mouth gingival index was found to be increased between the two examinations ($P < 0.01$). Gingival index increased significantly at the facial surfaces of upper and lower teeth ($P < 0.05$) and at the palatal surfaces of the upper and lower teeth ($P < 0.01$ and $P < 0.001$ respectively). Collectively, a significant increase in gingival index occurred in the upper and lower arches ($P < 0.01$).

Table 5. **Mean values, standard deviations, mean differences and *P*-values of plaque and gingival indices between the two examinations in group 4**

	Gingival index				Plaque index			
	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value	Day 7 (mean ± SD)	Day 21 (mean ± SD)	Mean difference	*P*-value
Upper								
Facial surfaces	0.90 ± 0.38	0.98 ± 0.25	0.08	0.308	1.51 ± 0.87	2.07 ± 1.32	0.56	0.264
Palatal surfaces	0.65 ± 0.31	0.91 ± 0.21	0.26	0.029*	1.07 ± 1.03	1.87 ± 0.93	0.80	0.129
Total	0.78 ± 0.28	0.95 ± 0.18	0.17	0.010**	1.29 ± 0.83	1.80 ± 0.89	0.51	0.209
Lower								
Facial surfaces	0.84 ± 0.48	0.97 ± 0.14	0.13	0.286	1.29 ± 0.75	2.32 ± 1.39	1.03	0.042*
Lingual surfaces	0.99 ± 0.39	0.99 ± 0.34	0.00	0.956	1.32 ± 0.63	1.84 ± 0.69	0.52	0.079
Total	0.91 ± 0.42	0.98 ± 0.19	0.07	0.439	1.31 ± 0.66	2.08 ± 0.95	0.77	0.045*
Full mouth	0.85 ± 0.32	0.97 ± 0.16	0.12	0.071	1.30 ± 0.70	1.95 ± 0.87	0.65	0.088

*$P < 0.05$, **$P \leq 0.01$.

Group 2 (orthodontic toothbrush)

Plaque index changes

Full mouth plaque index was found to be increased between the two examinations ($P < 0.05$). Plaque index increased on the palatal surfaces of upper arch ($P < 0.05$) and lingual surfaces of lower teeth ($P < 0.01$). However, this increase was not significant at the facial surfaces of the upper and lower arches ($P = 0.110$ and $P = 0.084$ respectively). Collectively, a significant increase in plaque index occurred in the upper arch and lower ($P < 0.05$).

Gingival index changes

Full mouth gingival index was found to be increased between the two examinations ($P < 0.01$). Gingival index was increased at the facial ($P < 0.05$) and palatal ($P < 0.01$) surfaces of the upper arch and at facial surfaces of the lower arch ($P < 0.05$). The increase on the facial surfaces of lower teeth did not reach significance ($P = 0.055$). Collectively, a significant increase in gingival index occurred in the upper ($P < 0.01$) and lower arches ($P < 0.05$).

Group 3 (Siwak)

Plaque index changes

Full mouth plaque index was found to be increased ($P < 0.05$). The increased plaque index reached statistical significance in the lower arch only ($P < 0.001$) both at the facial ($P < 0.01$) and lingual ($P < 0.001$) surfaces.

Gingival index changes

Although gingival index increased between the two examinations, the increases did not reach statistical significance.

Group 4 (Siwak and orthodontic toothbrush)

Plaque index changes

An increase in the plaque index was found at all examined sites. The increased plaque index reached significance in lower arch only ($P < 0.05$) at the facial surfaces ($P < 0.05$).

Gingival index changes

An insignificant reduction was observed at all sites. It reached significance in the upper arch only ($P < 0.01$) at the palatal surfaces ($P < 0.05$).

Effects of each method of brushing on different tooth surfaces

Effects on the plaque index

Table 6 describes the effects of each method of brushing on the plaque index levels on different tooth surfaces. Differences in plaque index between facial and lingual tooth surfaces were not significant in any of the four groups. However, the differences in plaque index between upper and lower jaws reached statistical significance in the Siwak group only ($P < 0.01$).

Table 6. **The effects on the plaque index by each technique on different tooth surfaces**

Groups	Variables	Plaque index			Gingival index		
		Mean difference	Standard error of the mean differences	*P*-value	Mean difference	Standard error of the mean differences	*P*-value
Group 1	Upper facial versus palatal	0.048	0.192	0.807	0.064	0.104	0.552
	Lower facial versus lingual	0.346	0.320	0.308	0.126	0.105	0.262
	Upper versus lower	0.024	0.220	0.913	0.066	0.054	0.248
Group 2	Upper facial versus palatal	0.120	0.125	0.363	0.202	0.131	0.158
	Lower facial versus lingual	0.160	0.196	0.434	0.075	0.121	0.551
	Upper versus lower	0.047	0.097	0.636	0.027	0.106	0.804
Group 3	Upper facial versus palatal	0.076	0.328	0.820	0.007	0.137	0.958
	Lower facial versus lingual	0.061	0.355	0.866	0.053	0.113	0.646
	Upper versus lower	0.778	0.180	0.002**	0.020	0.123	0.869
Group 4	Upper facial versus palatal	0.230	0.244	0.371	0.184	0.140	0.221
	Lower facial versus lingual	0.510	0.274	0.095	0.137	0.104	0.219
	Upper versus lower	0.259	0.230	0.289	0.095	0.090	0.321

**Statistically significant at $P \leq 0.01$.

Effects on the gingival index

Table 6 describes the effects of each method of brushing on the gingival index levels on different tooth surfaces. Differences in gingival index between facial and lingual surfaces in both arches and between upper and lower arches were not significant in any of the groups studied.

Comparison of the changes in the total plaque and gingival indices between different groups

Plaque index changes

Table 7 describes the differences among groups in the overall upper and lower jaws' plaque index values and full mouth plaque index values. Although some differences in plaque indices among groups were detected, these did not however lead to significantly different values among groups in the overall upper and lower jaws' plaque index values and accordingly full mouth plaque index values.

Gingival index changes

Table 8 describes the differences among groups in the overall upper and lower jaws' gingival index values and full mouth gingival index values. Significant differences were noticed between group 1 (standard toothbrush group) and group 3 (Siwak group) in the upper and lower arches ($P < 0.05$) and in full mouth gingival index ($P < 0.01$); between group 1 (standard toothbrush group) and group 4 (Siwak and orthodontic brush group) in the lower arch and in the full mouth gingival index ($P < 0.05$) and between group 2 (orthodontic toothbrush group) and group 3 (Siwak group) in the upper arch and in the full mouth gingival index values ($P < 0.05$).

Discussion

Although it has been shown that mechanical tooth brushing is an effective method of removing plaque and promotion of oral health, the use of chewing sticks for such purpose is still a much debatable issue. In this study, the effects of Siwak use in

Table 7. **Differences among groups in the overall, upper and lower jaws' plaque index values and full mouth plaque index values**

	Group 1 versus group 2		Group 1 versus group 3		Group 1 versus group 4		Group 2 versus group 3		Group 2 versus group 4		Group 3 versus group 4	
	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value
Upper jaw	0.297	0.472	0.305	0.462	0.421	0.311	0.007	0.986	0.123	0.765	0.116	0.778
Lower jaw	0.225	0.577	0.497	0.222	0.137	0.734	0.723	0.079	0.088	0.826	0.634	0.122
Full mouth	0.261	0.508	0.054	0.891	0.277	0.484	0.316	0.425	0.015	0.969	0.331	0.403

Table 8. **Differences among groups in the overall, upper and lower jaws' gingival index values and full mouth gingival index values**

	Group 1 versus group 2		Group 1 versus group 3		Group 1 versus group 4		Group 2 versus group 3		Group 2 versus group 4		Group 3 versus group 4	
	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value	Mean difference	*P*-value
Upper jaw	0.102	0.531	0.434	0.011*	0.310	0.063	0.332	0.047*	0.208	0.206	0.124	0.449
Lower jaw	0.196	0.278	0.480	0.011*	0.473	0.012*	0.284	0.119	0.276	0.129	0.007	0.967
Full mouth differences	0.146	0.355	0.469	0.005**	0.392	0.017*	0.323	0.046*	0.246	0.125	0.077	0.625

*$P < 0.05$; **$P < 0.01$.

patients with fixed orthodontic appliances were assessed by comparing two periodontal parameters in Siwak and toothbrush users.

The results of this study indicated that an increase in the overall mouth plaque index occurred during the 3-week trial period in all studied groups. However, this increase was statistically insignificant in subjects adopting the combined use of Siwak and an orthodontic brush. Subjects using the soft toothbrush demonstrated the greatest significant increase in the overall mouth plaque index, followed by those using the Siwak and those using the orthodontic toothbrush.

The increase in the plaque index was an expected finding that coincides with the fact that fixed orthodontic appliances introduce new stagnant areas available for colonization and retention of substrates. Despite the fact that some studies found an increase in the plaque index of subjects following fixed orthodontic appliance insertion (9, 23), others stated that it is the behavioural and health awareness factors, rather than the orthodontic treatment itself that were responsible for the gingival health in patients with orthodontic appliances (24).

The fact that the combined use of Siwak and an orthodontic brush provided the best plaque control, may be primarily explained by the superior anti-plaque mechanical performance of the orthodontic brush, and secondarily by the ability of Siwak's fine bristles to engage the wires, brackets and the tooth surface with a better combined net outcome.

In this study, no significant inter-group differences in the plaque index changes were observed between days 7 and 21 of examination. This is in agreement with the findings of Nörmark and Mosha (18) who reported no difference in plaque deposits whether plastic toothbrushes or local Siwak were used for oral cleaning. Further support was provided by Eid *et al.* (12) who suggested that the mean plaque scores in the Siwak, toothbrush and combined Siwak/toothbrush users were statistically insignificant. The short duration of the trial may have well contributed to the insignificant observations among the studied groups.

When the changes in the plaque index of the facial surfaces of the upper and lower jaws were compared with their lingual counterparts, and when the upper and lower jaws' values of these variables were compared in each group, no significant intra-group differences were observed. The only exception was seen in the Siwak group, which demonstrated a better plaque control in the upper jaw than in the lower jaw. Contrary to these findings were those by Thienpont *et al.* (25) who indicated that the plaque index scores in patients with orthodontic appliances were better in the lower jaw than in the upper.

The overall mouth gingival index was increased in all studied groups. These data support other studies which reported that regardless of the quality of plaque control, most subjects undergoing fixed orthodontic treatment develop generalized gingivitis within a short time (26). On the other hand, other studies concluded that it is the behavioural aspects rather than the mere presence of the orthodontic appliance that is responsible for the gingival condition of the orthodontic patients (24).

It must however be underlined that the increase in the overall mouth gingival index was significant for those subjects using the soft toothbrush and the orthodontic toothbrush only. Subjects using the Siwak either solely or in combination with the orthodontic brush demonstrated an insignificant increase in the overall mouth gingival index, with the former group being more insignificant. These observed better ginigival health in Siwak groups could be explained by the reported antimicrobial effects of Siwak (4–8).

Contrary to the insignificant inter-group differences in the overall mouth plaque index changes observed in this study, the overall mouth gingival index changes between the two examinations revealed significant differences between different groups. The greatest differences were observed between subjects using the soft toothbrush and those using the Siwak, with significantly better gingival health in the latter group. These results are in agreement with some other studies performed in patients without orthodontic appliances (13) but contrary to

other studies who reported no differences with regards to bleeding scores (gingivitis) were observed in subjects using either the Siwak or a toothbrush (12, 18).

In the present study, data showed that significant better differences in the overall mouth gingival index existed in subjects using the Siwak than in those using the soft toothbrush over the facial and palatal/lingual surfaces of both the upper and lower jaws. These findings are somehow contradictory to those by Al-Otaibi *et al.* (14) who stated that lingual surfaces of subjects using the Siwak demonstrated worse gingival conditions than the facial surfaces in comparison to toothbrushing and in partial agreement with Gazi *et al.* (13) who stated that patients who followed the regimen of Siwak brushing showed a significant reduction in gingivitis compared with a toothbrush on the buccal side, whereas on the lingual side the difference was insignificant.

Findings also demonstrated that despite the fact that no significant differences in the overall mouth gingival index changes were found between the soft toothbrush users and those using an orthodontic brush, significant differences were however identified between soft toothbrush users and those using the combination of Siwak and orthodontic brush as a tool for plaque debridement and oral hygiene. The evidence at hand makes it justifiable to suggest that the addition of Siwak use to that of orthodontic brush use was responsible for the observed differences.

The limitations of this study include its short duration and the limited number of participants per group. In addition, lack of females among the subjects may limit its findings to males. Further prospective clinical trials with longer duration and larger sample sizes are needed to evaluate the benefits of Siwak use for orthodontic patients. The finding that gingival index remained low despite increased plaque index among the Siwak subjects is interesting and worth further follow-up.

Conclusions

1 Siwak effectiveness in plaque control in patients with fixed orthodontic appliances was comparable with that of orthodontic and soft brushes after 21 days of use.

2 The combined daily use of Siwak and orthodontic brush provided superior performance and better values of plaque and gingival index than using either alone.

3 Siwak may reduce the incidence of gingivitis and promote gingival health in patients with fixed orthodontic appliances. However, long-term studies are required to test this hypothesis.

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