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Brushing skills and plaque reduction using single- and triple-headed toothbrushes

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Objective: To evaluate the effect of toothbrush design on brushing skills and plaque removal among young healthy adults. **Method and Materials:** A population of 200 healthy young adults was approached. Patients were randomly assigned to one of two research groups: one used a manual single-headed toothbrush, while the other used a manual triple-headed toothbrush. At the start of the study, participants were asked to brush their teeth using the provided toothbrush with no prior guidance or instructions. Plaque Index (PI) was measured. Immediately afterward, participants were personally instructed on how to brush their teeth using the provided toothbrush. Toothbrushing performance skill was evaluated and scored using the toothbrushing performance skill index (TB-PS-I/Ashkenazi index) following the first brushing, as well as on a recall visit 1 week later. **Results:** Following the first, uninstructed brushing, PI values ranged from 0.41 to 1.33, with higher plaque scores for the single-headed toothbrush group. One week after receiving brushing instructions, PI decreased in the both toothbrush groups and ranged between 0.12 and 0.81, with higher PI scores for the single-headed toothbrush group. Following the first, uninstructed brushing, total TB-PS-I scores, as well as component scores ("reaching" and "staying") showed no difference between the two toothbrush groups. One week after receiving brushing instructions, the TB-PS-I in the triple-headed toothbrush group was significantly higher than that in the single-headed toothbrush group. **Conclusion:** The triple-headed toothbrush was found to promote easier toothbrushing and plaque removal both before and after receiving toothbrushing instructions. *(Quintessence Int 2012;43:525–531)*

Key words: gingivitis, manual toothbrush, oral hygiene, periodontitis, plaque, prevention

Meticulous plaque removal on a daily basis is important to prevent caries and and gingival and periodontal disease.[1,2] However, most adults and children brush only the buccal and occlusal surfaces, while the lingual surfaces remain neglected.[3] Moreover, problems with hand-eye coordination, as well as frequency, duration, and consistency of toothbrushing, might interfere in achieving effective plaque control.[4,5] The manual triple-headed toothbrush (Fig 1) was designed to simultaneously clean the lingual, buccal, and occlusal tooth surfaces. Several studies found this toothbrush to be superior to the single-headed toothbrush in reducing Plaque, Gingival, and Bleeding Indices (PI, GI, and BoP) in healthy and handicapped children, ages 4 to 15 years old.[6–8] In another study, results from brushing with the triple-headed toothbrush were similar to those with the single-headed toothbrush.[9]

The frequently used method for evaluating correct and effective toothbrushing is examination of the negative outcome variables of poor performance, such as presence of plaque, caries, and gingival and periodontal disease.[7–12] However, these indices do not elucidate the specific problems involved in toothbrushing, nor do they indicate the best approach for improving outcomes. Accumulation of plaque can result from poor toothbrushing due to a lack of hand-eye coordination, brushing too few tooth segments, not brushing each segment for long enough, or from not brushing teeth at all.[13]

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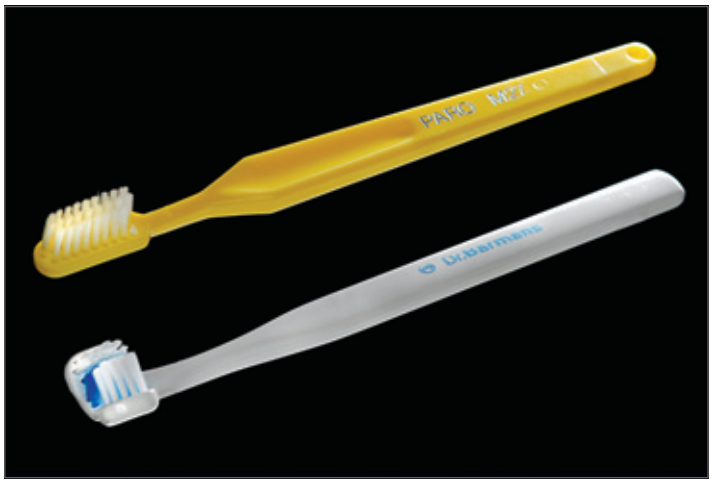


Fig 1 The two types of toothbrushes used in the present study.

Studies evaluating toothbrushing performance usually assess the total duration of toothbrushing[3,14,15] and/or toothbrushing performance in only a few segments of the arch.[14–16] However, detailed evaluation of patients at follow-up appointments is important to highlight specific toothbrushing problems, follow progress, and improve the weak points in their performance. Recently, a new informative index (Ashkenazi index) was introduced and validated for evaluating, by direct observation, toothbrushing performance.[8] This index, the toothbrushing performance skill index (TB-PS-I), evaluates two criteria: correct placement of the toothbrush on each segment (even once) ("reach") and the performance of a sufficient number of horizontal strokes (8 to 10) in each segment ("stay").

The aim of the present study was to evaluate the effect of toothbrush design (single- vs triple-headed toothbrushes) on brushing skills (as measured using the Ashkenazi index) and plaque removal.

METHOD AND MATERIALS

Population

A population of 200 healthy young adults was approached to participate in the present study. All patients were 18 to 21 years of age. Patients were randomly assigned to one of two research groups with the toss of a coin. In one group, patients were provided with a manual single-headed toothbrush (Paro M27, Paro), and in the other group, patients received a manual triple-headed toothbrush (Dr Barman's Superbrush Medium, DENTACO) (see Fig 1). The Ethics Committee of Tel Aviv University, Tel Aviv, Israel, approved the study, and written informed consent was obtained from the participants.

Study design

At the beginning of the study, participants were asked to brush their teeth using the provided toothbrush with no prior guidance or instruction. PI[12] was measured in all first molars and two incisors by one calibrated dentist (Y.M.), with the aid of disclosing solution (RED-COTE, John D. Butler).

The examination was carried out in a lighted room using a dental mirror.

Immediately afterward, participants were personally instructed by the same clinician on how to brush their teeth using the provided toothbrush.

The instruction for toothbrushing included an explanation of the purpose of brushing and a demonstration of the technique on a plastic model and on their teeth. In the single-headed toothbrush group, participants were instructed to brush according to the horizontal scrub technique,[17] (ie, to brush the buccal aspect in each arch in five

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segments [anterior, two canines, and two posterior segments] and the lingual/palatal aspect in three segments [anterior and two posterior segments]), to place the toothbrush partially on the gingiva and partially on the teeth, and to perform 10 back and forth brushing strokes on each segment.

In the triple-headed toothbrush group, participants were instructed to brush each arch in five separate segments (anterior, two canines, and two posterior segments), to place the toothbrush on the occlusal surfaces, and to perform about 10 back and forth brushing strokes on each segment.

Participants who were clinically diagnosed with caries or periodontal disease were referred for dental treatment.

Toothbrushing performance skill was evaluated and scored as detailed below during the first brushing, as well as on a recall visit 1 week later. Further instructions were provided when the technique was not optimal. At the end of the first session, any visible plaque was removed by toothbrushing.

Toothbrushing performance skill index (TB-PS-I/Ashkenazi index)

Participants' toothbrushing performance skill was evaluated by the recently introduced and validated Ashkenazi index[8] according to two criteria: correct placement of the toothbrush on each segment (even once) ("reach" component) and the performance of a sufficient number of horizontal strokes (8 to 10) in each segment ("stay" component).[8]

One point was assigned for each component performed according to instruction in each segment. Therefore, the maximum score for the horizontal scrub technique was 32 points (16 points for reaching the five buccal and three lingual segments in the maxillary and mandibular arches, and 16 points for sufficient strokes in each segment). The maximum score using the triple-headed toothbrush was 20 points (10 points for reaching the five segments [anterior, two canines, and two posterior] in the maxillary and mandibular arches, and 10 points for sufficient strokes in each segment). An overall toothbrushing performance skill index (TB-PS-I) was calculated as the percentage of points achieved of the maximal possible points for the relevant technique.

Statistical analysis

Differences in PI and TB-PS-I between the single- and triple-headed toothbrush groups were analyzed using paired Student *t* test and the general linear model (GLM) for repeated measures, with gain in plaque as an independent variable and age and past treatments as covariates. The chi-square test was used to analyze differences between groups regarding sex, previous oral hygiene instruction, etc. The Pearson correlation was utilized for correlating PI with the TB-PS-I. The level of significance was set at 5%.

RESULTS

Study population

Overall, 190 participants agreed to take part in this study and came back for the follow-up examination (95% compliance rate). Of them, 97 received instruction on the single-headed toothbrush and 93 on the triple-headed toothbrush. The demographic characteristics of participants lost to follow-up (10 participants) were similar to those who remained in the study until its complettion. Participants' mean age was 20.2 ± 3.0 years. The differences in age and sex between the single- and triple-headed toothbrush groups were not statistically significant.

PI

Following the first, uninstructed brushing, PI values ranged from 0.41 to 1.33, with higher plaque scores for the single-headed toothbrush group (Table 1). One week after receiving brushing instructions, the PI decreased in both toothbrush groups (Tables 2 and 3) and ranged between 0.12 and 0.81, again with higher plaque scores for the single-headed toothbrush group (see Table 1). Please note that Table 1 provides the differences between the two study groups in each time point, whereas Tables 2 and 3 provide the difference between time points in each study group.

Sex as well as self-reported previous oral hygiene instruction and dental treatment had no influence on PI or performance skill index.

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Table 1 Mean PI and *P* values following the first, uninstructed brushing and 1 week after receiving brushing instructions

	Tooth no.*	Single-headed (n = 97) (mean ± SD)	Triple-headed (n = 93) (mean ± SD)	*P* value
Uninstructed brushing	26	1.01 ± .621	0.46 ± .700	.000
	11	0.47 ± .542	0.41 ± .647	.449
	16	1.10 ± .586	0.44 ± .683	.000
	36	1.33 ± .625	0.75 ± .702	.000
	31	0.55 ± .629	0.67 ± .889	.285
	46	1.28 ± .657	0.82 ± .675	.000
1 week following brushing instructions	26	0.53 ± .663	0.30 ± .547	.012
	11	0.13 ± .342	0.33 ± .577	.005
	16	0.60 ± .672	0.34 ± .599	.007
	36	0.73 ± .67	0.60 ± .592	.159
	31	0.12 ± .361	0.38 ± .588	.001
	46	0.81 ± .712	0.62 ± .569	.043

*FDI tooth-numbering system. PI, Plaque Index; SD, standard deviation.

Table 2 PI values differences between the first, uninstructed brushing and 1 week after receiving brushing instructions

	Tooth no.*	Uninstructed brushing (mean ± SD)	1 week following brushing instructions (mean ± SD)	*P* value
Single-headed (n = 97)	26	1.01 ± 0.62	0.53 ± 0.66	< .001
	11	0.47 ± 0.54	0.13 ± 0.34	< .001
	16	1.10 ± 0.59	0.60 ± 0.67	< .001
	36	1.33 ± 0.62	0.73 ± 0.67	< .001
	31	0.55 ± 0.63	0.12 ± 0.36	< .001
	46	1.28 ± 0.66	0.81 ± 0.71	< .001
Triple-headed (n = 93)	26	0.46 ± 0.70	0.30 ± 0.55	.155
	11	0.41 ± 0.65	0.33 ± 0.58	.342
	16	0.44 ± 0.68	0.34 ± 0.60	.232
	36	0.75 ± 0.70	0.34 ± 0.60	.027
	31	0.67 ± 0.89	0.38 ± 0.59	.002
	46	0.82 ± 0.67	0.62 ± 0.57	.007

*FDI tooth-numbering system. PI, Plaque Index; SD, standard deviation.

Table 3 Differences in treatment gains between single- and triple-headed brushes

Tooth no.*	*P* value
26	.003
11	.006
16	< .001
36	< .001
31	.231
46	.008

*FDI tooth-numbering system.

Toothbrushing performance skill index

Following the first, uninstructed brushing, total TB-PS-I scores, as well as component scores ("reaching" and "staying"), showed no difference between the two toothbrush groups (Table 4). In both groups, the score for "reaching" was higher than for "staying" (see Table 4).

One week after receiving brushing instructions, the score for the "reaching" component was still higher than for the "staying" component in both groups (see Table 4). The TB-PS-I of patients in the

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Table 4 Mean TB-PS-I following the first, uninstructed brushing and 1 week after receiving brushing instructions and the differences between single- and triple-headed toothbrush groups

	Uninstructed brushing			1 week following brushing instructions		
	Total	Reach	Stay	Total	Reach	Stay
Single (mean ± SD)	0.90 ± 0.15	0.97 ± 0.07	0.83 ± 0.25	0.81 ± 0.17	0.94 ± 0.10	0.67 ± 0.30
Triple (mean ± SD)	0.91 ± 0.14	0.97 ± 0.08	0.85 ± 0.23	0.89 ± 0.15	0.98 ± 0.07	0.80 ± 0.28
Total (mean ± SD)	0.90 ± 0.14	0.97 ± 0.07	0.84 ± 0.24	0.85 ± 0.17	0.96 ± 0.09	0.73 ± 0.29
P value	.61	.81	.50	.00	.00	.00
Mean difference	–0.01	0.00	–0.02	–0.08	–0.04	–0.12
95% CI	–0.09 to 0.05	–0.02 to 0.02	–0.05 to 0.03	–0.20 to –0.04	–0.07 to –0.02	–0.13 to –0.03

SD, standard deviation; CI, confidence interval.

Table 5 TB-PS-I values differences between the first uninstructed brushing and 1 week after receiving brushing instructions

	Score (divided by maximal score)	Uninstructed brushing (mean ± SD) (%)	One week following brushing instructions (mean ± SD) (%)	*P* value
Single (n = 97)	Stay	82.60 ± 24.91	67.46 ± 29.97	< .001
	Reach	97.36 ± 6.68	93.81 ± 9.90	.001
	Total	89.98 ± 14.65	80.64 ± 17.47	< .001
Triple (n = 93)	Stay	91.02 ± 13.78	88.76 ± 15.39	.232
	Reach	97.10 ± 8.29	97.85 ± 7.35	.480
	Total	84.95 ± 22.92	79.68 ± 27.52	.112

SD, standard deviation.

triple-headed toothbrush group was significantly higher than that of patients in the single-headed toothbrush group (see Table 4). Similarly, the scores for the "reaching" and "staying" components of the TB-PS-I were significantly higher in the triple-headed toothbrush group than in the single-headed toothbrush group (see Table 4). This resulted from a larger decrease in TB-PS-I among the single-headed toothbrush group compared with the triple-headed toothbrush group (Table 5).

Correlation between TB-PS-I and PI

At 1-week follow-up, TB-PS-I and PI correlated negatively (r = –0.80, $P < .01$). PI also correlated negatively with each of the two main components of the TB-PS-I: "reach" (r = –0.41, $P < .01$) and "stay" (r = –0.80, $P < .01$).

DISCUSSION

In the present study, the triple-headed toothbrush was found to promote easier toothbrushing and plaque removal both before and after toothbrushing instruction. Toothbrushing, the most widespread means of cleaning teeth and maintaining gingival health, is greatly affected by technique and brushing time, factors that are difficult to influence.[8,13,18,19] The vertical bristles of conventional toothbrushes remove plaque from flat, accessible surfaces but are less effective at the gingival margins and in approximal areas, where accumulation of plaque encourages gingivitis and deterioration of periodontal health.[18] Optimization of the design of brush heads has focused on improving elimination of plaque from these inaccessible areas.

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Toothbrushing technique has a significant effect on plaque removal, but it is difficult to influence toothbrushing behavior to maximize efficacy, especially in the long term. A simple scrubbing technique is most commonly employed and is used consistently during brushing.[20] Most people brush their teeth for a shorter-than-optimal period, and many use techniques that are inadequate to remove plaque from the gingival margins, areas that are important in maintaining periodontal health.[21–23] Given these constraints, a practical approach to improving dental health is to develop a more effective toothbrush with the potential to remove plaque more completely from tooth surfaces, which is less dependent on toothbrushing technique and provides positive sensory cues that may improve motivation and possibly increase brushing time. Toothbrush development appeared to have reached a plateau in terms of optimization, and a radically different design approach might be needed to facilitate further advances.

Dogan et al aimed to evaluate the efficacy of plaque removal of three different toothbrushes in mentally disabled children and reported that an electric toothbrush was the most effective for removing dental plaque, whereas the triple-headed brush was proposed as a good manual alternative.[24] Likewise, the triple-headed brush was found to be a practical alternative to other manual toothbrushes to improve tooth and gingival health in orthodontic patients wearing fixed appliances.[25]

Those above results, with the present findings in a healthy young adult population, might imply an additive effect of the triple-headed brush.

It is noteworthy, however, that the present work, as well as the vast majority of the previous reports on the triple-headed brush were all performed on nonperiodontal patients. Patients with periodontal disease usually present with elongated teeth, and the triple-headed brush might not be able to reach the lingual and buccal surfaces in those cases. Further investigations are warranted to reveal the role of the triple-headed brush in periodontal patients.

In the present study, the ability to brush teeth was evaluated during direct observation, according to a recently published novel brushing skill index.[8] This index was shown to be easy to implement, correlate negatively with PI, and have high reliability. Importantly, the index detects problems in brushing that are due to not "reaching" all tooth segments and to not "staying" long enough on each segment. The index might be applicable for research, as well as clinical purposes.

A major shortcoming of the present study design is that the evaluator of the brushing skill index as well as the PI was not blinded to research group assignments. However, the evaluation of toothbrushing performance could not be blinded.

CONCLUSION

The triple-headed toothbrush was found to promote easier toothbrushing and plaque removal both before and following toothbrushing instructions. Further investigations are warranted to reveal the role of the triple-headed brush in periodontal patients.

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