

The effect of a color-changing toothbrush with and without instruction on the duration of toothbrushing

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Introduction

Toothbrush design,^{1,2} brushing method,^{3,4} manipulative skills of the child,^{5,6} parental involvement,⁷ brushing instruction,⁸ and brushing duration^{9,10} are most cited as determinants of toothbrushing efficacy. Of these, Honkala¹¹ and coworkers found that brushing duration was consistently correlated with plaque removal in children. Further, the brushing times produced a nearly perfect monotonic progression of plaque reduction.¹⁰ While no one method was found to be superior to another, recommendations to emphasize duration of brushing in dental health education have been forthcoming.

Most recently, Mandel¹² summarized that the manipulative skills and thoroughness of the brusher were the critical determinants of effective plaque removal, rather than the brush design or specific brushing method. Toothbrushing instruction also has a significant effect on plaque reduction and brushing efficacy. When toothbrushing instruction was followed by supervision, a significant reduction on plaque scores was seen in kindergarten children.⁸

As a child's perception of time does not correlate well with actual time lapsed when performing work-type tasks,¹³ many have advocated timing a child's daily brushing.

The purpose of the present study was to evaluate the relative merit of two toothbrush types and of toothbrushing instruction on brushing duration.

Materials and methods

Participants in the study were patients presenting for recall visits at two similar private pediatric dental offices in Massachusetts. Randomized by convenience, parental consent was sought but no other screening was used. In total, 140 children aged 6–11 who were waiting to see the dentist were selected.

The children were divided into four cells of 35 children each:

Office 1:

- 35 children (mean age 8.4 years)
 - No instruction
 - Character toothbrush of their choice (Butler—John O. Butler Co., Chicago, IL; Oral B—Oral B Laboratories, Redwood, CA; Sensodyne—Block Drug Co., Jersey City, NJ)

- 35 Children (mean age 8.3 years)
 - Instruction (30-sec video on proper brushing)
 - Character toothbrush of their choice (Butler, Oral B, Sensodyne)

Office 2:

- 35 children (mean age 7.6 years)
 - No instruction
 - Color-changing toothbrush (Jordan Magic—Dep Corp., Pancho Dominguez, CA)
- 35 children (mean age 8.5 years)
 - Instruction (30-sec video on proper brushing)
 - Color-changing toothbrush (Jordan)

The child was directed to an area of the office that had a sink, toothbrushing supplies and (for the instruction cells) a video playback machine. A study examiner waited to see the child, who was not aware that someone was timing him/her. Coordinators memorized a script to communicate with each child.

The instruction cell video presentation showed a dental hygienist not known to the children in either office. It provided 30 sec of toothbrushing instruction, including the need to brush the occlusal surface of the tooth as well as the lingual and facial surfaces, but no mention of the length of time that should be spent brushing. The hygienist in the video used a large toothbrush and an oversized model of teeth to demonstrate proper technique.

In order to blind study examiners to the objective of the study, a two-office design was used. The examiners were told only that they were studying the effect of instruction on toothbrushing times. One examiner in Office 1 (character brushes) and another in Office 2 (color-changing brushes) were trained to use identical stop watches. They were instructed to start the watch when the child placed the toothbrush in the mouth and stop when the child removed the toothbrush prior to expectorating. Although the children were asked to notify the study examiners when they had finished, the examiners were instructed to discreetly watch the children to eliminate any child who dawdled or engaged in any behavior that could not be considered normal toothbrushing.

The two-factor ANOVA for independent samples was used to test effects of brush type and instruction. The examiners were compared by two cross-over cell

examinations at the end of the study. Ten age-comparable patients using color-changing toothbrushes with instructions and ten age-comparable patients using character toothbrushes without instruction were examined by the other examiner and tested for comparability with the Student's *t*-test for independent samples.

Results

Mean brushing time across the four cells of toothbrush type, with and without instruction, is shown in the Table.

Analysis of brushing time data produced statistically significant main effects for "brush type" at $F = 22.46, P < 0.0001$ and for "instruction procedure" (with or without) at $F = 6.84, p < 0.01$. The interaction of "brush type by procedure" was not significant, $F = 0.53, P = 0.469$. These findings indicate that there are highly significant differences in mean brushing times between toothbrush type (character and color-changing) regardless of whether or not subjects received prebrushing instruction. In addition, there are significant differences in mean brushing time between instruction procedures (with and without) regardless of the type of toothbrush used.

Applying the *t*-test for simple effects for differences between pairs of means, a highly significant difference was shown between children who used the character versus color-changing brush ($P < 0.001$). Significant differences in brushing times were also found between children with prebrushing versus no prebrushing instructions ($P < 0.01$).

Interexaminer comparisons showed no significant differences for either of the cross-over cells tested: the character brush without instruction ($t = 0.587, df = 43, P > 0.10$) or the color-changing brush with instruction ($t = 1.600, df = 43, P > 0.10$).

Discussion

Duration of toothbrushing in children aged 6–11 (mean 8.2) was found to be dependent on both factors of brush handle color change and prebrushing instruc-

tion. The results indicate that children who use a color-changing toothbrush brushed significantly longer than children using a character toothbrush, whether or not they received prior toothbrushing instruction ($P < 0.0001$).

This is of particular interest since other motivators used by parents to increase brushing time, such as disclosing solution or tablets, greater amounts of toothpaste on brush, independent timing devices and parental involvement, may not be practical or may even be contraindicated at every brushing session. Since 95% of children use fluoridated toothpaste, this may lead to excess fluoride ingestion (only a pea-size amount is considered prudent).^{14, 15} Further, Emling,¹⁶ in studying estimated versus actual brushing times, found that the only factor related to increased brushing time was the overall rating of the toothpaste.

The actual brushing-time mean of the group using the character brush without instruction (57.8 sec, SD 23.6) was similar to Kleber,¹⁷ who concluded that un instructed, unsupervised children brush for approximately 1 min. For comparison, MacGregor and Rugg-Gunn⁹ reported that 30% of un instructed English students aged 11–13 brushed longer than 60 sec, whereas 43% of children using the character brush, without instruction in the present study, brushed longer than 60 sec. Further, the mean (90.9 sec, SD 45.3) brushing time of children using the color-changing brush without instruction represents a group in which 86% of the children brushed 60 sec or longer. The participation effect, which might tend to artificially increase brushing times in children who were aware of being observed, was not seen to be a factor in this study design.

Prebrushing instruction significantly increased brushing times of children using either the character brush or color-changing brush ($P < 0.01$). Although there was a marked increase from 57.8 (SD 23.6) to 78.1 sec (SD 40.2) when instruction was given to children using the character brush, it was still less than the 90.9 sec (SD 45.3) mean of the color-changing brush group without instruction. Thus, the color-changing brush appears to be self-instructional to the extent it increases the brushing time without prebrushing instruction.

With the exception of the color-changing brush with instruction (1.8 index of skew), the standard deviations of brushing duration times for all of the other groups were larger than expected. Since this was also observed in the cross-over cell examiner comparisons, it reinforces the finding of

Table. Mean brushing times (and standard deviations) by instructional status and toothbrush type (seconds)

	Type of Brush		
	Character	Color Change	Character and Color Combined
Instruction	78.1 ± 40.2 N = 35	102.4 ± 30.3 N = 35	90.2 ± 37.4 N = 70
No instruction	57.8 ± 23.6 N = 35	90.9 ± 45.3 N = 35	74.4 ± 39.6 N = 70
Instruction and no instruction combined	67.9 ± 34.3 N = 70	96.7 ± 38.7 N = 70	
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1 = Significant difference at $P < 0.001$.

2 = Significant difference at $P < 0.01$.

comparability of the two examiners and points out the great variability between children — even in a controlled environment.

Although only time differences are reported in the present study, previous reports have shown that the duration of brushing correlates with plaque reduction.^{10,11} Recently, Van der Weyden and coworkers¹⁸ found that there was, in fact, statistically significant improvement in the efficiency of plaque removal as brushing time increased. Only Pinkham¹⁹ observed an indication that, for certain age groups, cleanliness may not be related to time spent brushing.

Further studies are needed to test whether the benefits of a color-changing brush and toothbrushing instructions shown in this study have a lasting effect on plaque reduction.

Conclusions

1. Children who used a color-changing toothbrush brushed significantly longer ($P < 0.0001$) than children using a character toothbrush, whether or not they received prior toothbrushing instruction.
2. Prior toothbrushing instruction was significant, ($P < 0.01$) but not as profound a factor in increasing brushing times as use of a color-changing toothbrush, ($P < 0.001$)

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