Clinical evaluation of the plaque-removing ability of three different toothbrushes in a mentally disabled group

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The aim of the study was to evaluate the efficacy of plaque removal of three different toothbrushes on mentally disabled children in two different age groups. A manual triple-headed brush (SuperBrush; Dento Co. AS [junior, regular]) compared with a new manual toothbrush (CrossAction; Oral-B [35 compact, 40 regular]) and an electric toothbrush with an oscillating rotating head (Braun Plaque Control 3D [Braun 3D]; Oral-B [D15525]). Fifteen children aged 6–12 (Group A) and 15 children aged 13–18 (Group B) with mild mental disabilities participated in the single-blind clinical study. To obtain a plaque-free condition at baseline, professional tooth-cleaning was performed on each participant. After instructions on how to use the toothbrushes, each group started the experiment. After 1 week of application, the Quikley Hein (QH) plaque index and the approximal plaque index (API) were used to assess the oral hygiene status of each participant. This was followed by a week of recess before each group switched to the next type of toothbrush. The study lasted for 5 weeks. Compared to the two other brushes, the Braun 3D was more effective in removing plaque (means of QHI: 1.54 (Braun 3D), 1.77 (SuperBrush), and 2.15 (CrossAction) in total; means of API 1.37 (Braun 3D), 1.52 (SuperBrush), 1.94 (CrossAction). The study indicated that the electric toothbrush is the most effective for removing dental plaque in mentally disabled children, whereas the SuperBrush is a good alternative. □ *Mentally disabled; plaque removal; toothbrush*

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Efficient mechanical plaque removal by means of toothbrushing is one of the most important oral health measures preventing the initiation and progress of dental and periodontal diseases. However, the high prevalence of periodontal disease in the general population indicates that individual tooth-brushing performance is often inadequate (1, 2). Children are no exception in this case (3).

Although international studies do not provide definitive data on the prevalence of dental and periodontal conditions among mentally disabled children, many investigators agree that these children have poor oral hygiene compared to the general population (4–7). Studies indicate that the most common oral health problems of this group are dental caries and periodontal disease. The incidence of these problems is undoubtedly increased due to limited dental services targetting this group of children (8–10).

Mentally disabled children are generally incapable of obtaining an adequate oral hygiene level by manual brushing because of their limited motor skills, their lack of knowledge about oral hygiene and effective brushing, and the reduced amount of time spent brushing their teeth. It has been suggested that complete plaque removal with a conventional toothbrush is not realistic for this group (10–12).

For this reason, studies were directed at developing new toothbrushes to improve effective plaque removal (13–15). According to some investigators, powered toothbrushes are especially suited for people with reduced motor skills (3). In previous studies, the positive effect of electric toothbrushes on plaque control in preschool children has indeed been reported (3, 16).

On the other hand, many different types of specially designed manual toothbrushes have been developed. Among them is the triple-headed SuperBrush (SB), which is designed to clean the oral, buccal, and occlusal surfaces of the teeth with a single stroke and is recommended in particular for individuals with limited manual skills (e.g. children) (17).

CrossAction (CA), too, is a new manual toothbrush with special unique criss-cross bristles. The aim of this study is to determine the plaque removing capability of the three different toothbrushes on mentally disabled children in two age groups.

Materials and methods

Thirty children attending the same class in a professional education center participated in this study. They were all defined as mildly mentally disabled by a specialist of the school according to their Intelligence Quotient (IQ) data.

The children were assigned to two groups according to their chronological ages and dentition. Their ages ranged between 6 and 18 (see Table 1). Group A consisted of 15 participants in mixed dentition between 6 and 12 years of age while the other 15 participants ranged in age between

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Table 1. Age distribution of children

Group A (6–12 years of age)	No. of children	Group B (13–18 years of age)	No. of children
6	1	13	4
7	2	14	1
8	1	15	–
9	4	16	5
10	4	17	3
11	2	18	2
12	1		
Total	15	Total	15

13 and 18 in permanent dentition, forming Group B. The study was analyzed and approved by the Research Ethics Committee of Cukurova University.

All the subjects who were selected fulfilled the following modified criteria of Chava (18): 1) no history of receiving antibiotic and/or antiseptic therapy, 2) no use of supplemental plaque control aids over the previous 5 months, 3) a minimum of 20 teeth present with no interposed edentulous spaces or loss of interdental contacts, 4) in same range of intelligence and ability to brush their own teeth. Prior to the baseline clinical registration, informed consent was obtained from each parent.

The three tested toothbrushes (Fig. 1) were the CrossAction (Oral-B [35 compact, 40 regular]), a manual triple-headed brush SuperBrush (Dento Co. AS [junior, regular]), and an electric toothbrush with an oscillating rotating head Braun Plaque Control 3D (Braun 3D; Oral-B [D15525]).

Each participant went through professional prophylaxis to ensure a plaque-free starting point. The baseline scores were verified by a plaque disclosing erythrosine solution. Before the experiment, the children were randomly assigned to 3 groups with 10 participants each. These groups consisted of 5 children from both Groups A and B.

After instructions on how to use the toothbrushes, each group started the experiment with a different type of toothbrush. The modified Stilmann method (19), which is a combined vibratory action of bristles with a stroke movement of the brush along the long axis of the teeth, was used by all participants for brushing their teeth with the manual toothbrush CrossAction. Brushing time was 3 min; frequency twice a day. The same toothpaste was used during the entire study.

The plaque-removing effectiveness of the three brushes was evaluated at the end of the first week using the modified Quigley-Hein plaque index (QHI) (20) and the approximal plaque index (API) (21). The QHI was registered on both the oral and buccal sides of all the teeth. All measurements were performed by the same examiner, whose identity was concealed to the children. The examiner was calibrated and standardized through a previous examination of 10 children. Calibration was accepted if the measurements of these patients were similar at a $\geq$88% level on two separate occasions.

Following a 1-week 'wash-out', professional tooth-

Fig. 1. The three tested toothbrushes: the CrossAction (Oral-B (35 compact, 40 regular)), a manual triple-headed brush SuperBrush (Dento Co AS (junior, regular)), and an electric toothbrush with an oscillating rotating head Braun Plaque Control 3D (Braun 3D) (Oral-B (D15525)) (from left to right).

Table 2. Mean and standard deviation (*s*) of QHI and API for the different age groups and in total at the final examination

	QHI Mean ± *s*			API Mean ± *s*		
	CrossAction	SuperBrush	Braun 3D	CrossAction	SuperBrush	Braun 3D
6–12 years	2.18 ± 0.64*	1.82 ± 0.61#	1.56 ± 0.80	1.92 ± 0.69*	1.46 ± 0.67#	1.36 ± 0.76
13–18 years	2.13 ± 0.53*	1.72 ± 0.64#	1.52 ± 0.65	1.97 ± 0.55*	1.58 ± 0.62#	1.37 ± 0.73
Total	2.15 ± 0.58*	1.77 ± 0.62#	1.54 ± 0.71	1.94 ± 0.62*	1.52 ± 0.64#	1.37 ± 0.73

* $P < 0.01$ between CrossAction and SuperBrush, Braun 3D.
# $P < 0.01$ between SuperBrush and Braun 3D.

cleaning was done repeatedly. After another instruction session, each group went on to use the next type of toothbrush. The experiment ended after each participant had repeated this sequence with all three types of toothbrush.

Statistical analyses were performed using the statistical package SPSS vs 10.0. Normality was checked for continuous variables. Since the data were distributed normally, Student's *t* test was chosen for comparing age groups. Repeated measure of analysis of variance and paired *t* test were applied to compare brushes within groups. $P < 0.01$ was considered as the significant level. Results were presented as mean ± standard deviation.

Results

The results showing the final means of QHI and API in total and for two age groups are summarized in Table 2. For both indices and age groups there was a statistically significant difference ($P < 0.001$) between the Braun 3D and the other toothbrushes. There is also a statistically significant difference between the manual SuperBrush and the manual CrossAction. For every analysis, the indices of the electrical Braun 3D were the lowest and the manual CrossAction the highest (Table 2).

In order to take a closer look at the cleaning ability of the different brushes, a separate analysis for the oral and buccal sites and posterior and front teeth was performed (Table 3). For every analysis of QH indices the electrical Braun 3D and the manual SuperBrush were lower than the manual CrossAction. The scores for Braun were also statistically lower than SuperBrush, except in the buccal posterior maxilla of Group A, in the maxilla of Group B, and in the mandibular posterior teeth of Group A.

For AP indices the results are similar to those observed in the QHI (Table 4). In this respect, we also detected a significant difference among Braun 3D, SuperBrush, and CrossAction. Braun 3D and SuperBrush showed lower scores than CrossAction. With the exception of the mandibular teeth of Group B, the scores for the electrical Braun 3D and the manual SuperBrush show no statistical difference.

Table 3. Mean and standard deviation (*s*) of the QHI for posterior and anterior teeth at the final examination

			QHI Mean ± *s*		
			CrossAction	SuperBrush	Braun 3D
Maxilla 6–12 years	Posterior	Oral	2.3 ± 0.6	2.0 ± 0.6#	1.6 ± 0.9
		Buccal	2.0 ± 0.7*	1.7 ± 0.5	1.6 ± 0.9
	Anterior	Oral	1.9 ± 0.7*	1.6 ± 0.6#	1.3 ± 0.7
		Buccal	1.9 ± 0.7*	1.7 ± 0.7#	1.3 ± 0.7
Maxilla 13–18 years	Posterior	Oral	2.4 ± 0.5*	2.0 ± 0.6	1.9 ± 0.7
		Buccal	2.2 ± 0.5*	1.7 ± 0.7	1.6 ± 0.7
	Anterior	Oral	1.9 ± 0.6*	1.3 ± 0.8	1.3 ± 0.6
		Buccal	1.8 ± 0.5*	1.3 ± 0.8	1.2 ± 0.7
Mandibula 6–12 years	Posterior	Oral	2.5 ± 0.6*	2.1 ± 0.6	1.9 ± 0.9
		Buccal	2.2 ± 0.7*	1.8 ± 0.6	1.7 ± 0.9
	Anterior	Oral	2.2 ± 0.8*	1.7 ± 0.7#	1.3 ± 0.8
		Buccal	2.1 ± 0.7*	1.7 ± 0.8#	1.4 ± 0.8
Mandibula 13–18 years	Posterior	Oral	2.4 ± 0.6*	2.2 ± 0.6#	1.7 ± 0.6
		Buccal	2.2 ± 0.5*	1.9 ± 0.7#	1.5 ± 0.7
	Anterior	Oral	1.9 ± 0.5*	1.5 ± 0.7#	1.3 ± 0.7
		Buccal	1.9 ± 0.5*	1.5 ± 0.5#	1.3 ± 0.6

s = standard deviation.
* $P < 0.01$ between CrossAction and SuperBrush, Braun 3D.
# $P < 0.01$ between SuperBrush and Braun 3D.

Discussion

Dental and periodontal problems are more prevalent in mentally disabled patients although the etiology is similar to that of healthy children (4, 8). Since the families of mentally disabled children tend to focus on their mental problems, they neglect their oral hygiene. However, it is of utmost importance to control and treat oral and dental diseases at an early stage of development, especially for this group.

Studies have shown that the inability of mentally disabled patients to clean the oral cavity sufficiently is the main reason for their poor oral hygiene (11, 17, 22). It is known that effective toothbrushing is dependent on the toothbrush, brushing time, manual dexterity, motivation, and ability to follow instructions. Poor development of manual dexterity and motor functions in these individuals results in ineffective use of the toothbrush. It is therefore believed that the shape of the toothbrush might increase the brushing effectiveness for this group of patients.

The importance of toothbrushing techniques and the relative effectiveness of different types of toothbrush have been the focus of many studies in this research area (18, 23, 24). Different shapes and locations for the handle and bristles have been designed to increase plaque removing efficiency in hard-to-reach places.

Evidently, the effectiveness of a toothbrush is dependent on the user in both guiding the head to all accessible surfaces of the teeth and providing the appropriate mechanical action to enable the filaments to remove surface deposits (25). For electric toothbrushes, the user needs only to guide the head of the brush around the dentition, and according to our results it is easier to guide the manual SuperBrush than it is a conventional toothbrush. Jongenalis & Wiedemann (3) stated that the electric toothbrush removed significantly more plaque than a manual toothbrush when used by children in the age range 5–10 years. In summary, and parallel with other studies (17, 22), this study demonstrates that the manual SuperBrush and electric toothbrush had better cleaning efficiency in both groups compared to a conventional manual toothbrush.

Table 4. Mean and standard deviation (*s*) of the API for posterior and anterior teeth at the final examination

		API Mean ± *s*		
		CrossAction	SuperBrush	Braun 3D
Maxilla 6–12 years	Posterior	2.2 ± 0.8*	1.6 ± 0.6	1.5 ± 0.7
	Anterior	1.4 ± 0.7*	1.1 ± 0.7	1.1 ± 0.7
Maxilla 13–18 years	Posterior	2.2 ± 0.5*	1.8 ± 0.7	1.7 ± 0.7
	Anterior	1.6 ± 0.7*	1.1 ± 0.7	1.0 ± 0.8
Mandibula 6–12 years	Posterior	2.1 ± 0.6*	1.8 ± 0.6	1.6 ± 0.8
	Anterior	1.8 ± 0.7*	1.2 ± 0.7	1.1 ± 0.7
Mandibula 13–18 years	Posterior	2.2 ± 0.5*	2.0 ± 0.6#	1.5 ± 0.7
	Anterior	1.7 ± 0.6*	1.3 ± 0.7#	1.1 ± 0.7

* $P < 0.01$ between CrossAction and SuperBrush, Braun 3D.
# $P < 0.01$ between SuperBrush and Braun 3D.

Pannuti et al. (26) mentioned that approximal areas of teeth have more plaque than the other sides of teeth, buccal, or lingual surfaces. Consequently, the plaque scores are generally high on approximal surfaces. This is particularly important for special patients and is why the API was used in the present study for testing the plaque-removing efficiency of the toothbrushes. The results of the present study show that in both age groups the manual SuperBrush and the electric Braun 3D were significantly more effective in terms of plaque-removal efficiency than the manual CrossAction brush, and there were few statistically significant differences between the SuperBrush and the Braun 3D in both age groups for QHI and API in some areas.

Contradictory results have been reported in studies evaluating the plaque-removing efficiencies of toothbrushes (23, 25, 27–29). The contradictions arise mainly from the differences in design and duration of the studies. Studies on toothbrushes are carried out in either long-term or short-term studies. Although it is claimed that long-term studies (27, 29) yield the more reliable results, Weinstein et al. (30) reported in a study of oral hygiene practices that a 30% concordance to hygiene criteria in patients had been achieved at the end of 6 weeks. These results suggest that patients lose motivation in the course of a long-term study. On the other hand, in short-term studies of toothbrush efficiency, potential clinical differences can be disguised by elevated motivation levels of the patients, known as the Hawthorne effect (31). Zimmer et al. (17) argue that 1 week is enough to assess plaque-removing efficiency because it is a matter of only hours before visible plaque reappears even on professionally cleaned teeth. These suggestions were taken into account at the design stage of the present study. Many short-term studies comparing electric and manual toothbrushes report the superior efficiency of the electric toothbrush (23, 25, 28). The results presented here are in accordance with those previous findings.

Electric toothbrushes have been used by the mentally disabled over the years owing to their advantage for not requiring much manual dexterity. Although it has long been argued by researchers that electric toothbrushes can be used to advantage also by healthy individuals, it was only confirmed at the end of the 1990s by U.S. and European periodontologists that electric toothbrushes perform better in plaque removal compared to manual toothbrushes (28). Studies conducted to investigate the reasons for the lack of popularity of electric toothbrushes have found that these brushes were not recommended by dentists and the patients were not adequately informed (32). Other disadvantages of the equipment the higher costs and maintenance.

In this study, all three toothbrushes were found to be similarly effective across both age groups. It is thought that a child of 6 years is capable of independent brushing (33). The development of manual dexterity is not only related to

chronological age but also to the level of intelligence and to the amount of education received (11, 19). Considering the fact that all of the students in both age groups were in the same class, the children in this study were nearly all in the same developmental age range with similar dexterity in each age group.

Although it is concluded that the electric toothbrushes are still the most effective in the mentally retarded groups, the triple-headed manual SuperBrush could be a suitable alternative given the additional facts that it is cheaper to obtain and easier to use.

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References

1. Van der Weijden GA, Timmerman MF, Piscaer M, IJzerman Y, Van der Velden U. Plaque removal by professional electric toothbrushing compared with professional polishing. J Clin Periodontol 2004;31:903–7.
2. Hunter ML, Addy M, Kingdom A, Dummer PMH, Shaw WC. An 8-year study of changes in oral hygiene and periodontal health during adolescence. Int J Paediatr Dent 1994;4:75–80.
3. Jongenelis APJM, Wiedemann W. A comparison of plaque removal effectiveness of an electric versus a manual toothbrush in children. ASDC J Dent Child 1997;64:176–82.
4. Adiwoso ASAW, Pilot T. Results of oral health and hygiene education in an institution for multiple handicapped children in Indonesia. Int Dent J 1999;49:82–9.
5. Bhavsar JP, Damle SG. Dental caries and oral hygiene amongst 12–14 years old handicapped children of Bombay, India. J Indian Soc Pedod Prev Dent 1995;13:1–3.
6. Randel DM, Harth S, Seow WK. Preventive dental health practices of non-institutionalized Down syndrome children: a controlled study. J Clin Pediatr Dent 1992;16:225–9.
7. Waldman HB, Perlman SP. Community-based dental services for patients with special needs: a reasonable goal for New York State. NY State Dent J 2001;67:39–42.
8. Allison PJ, Hennequin M, Faulks D. Dental care access among individuals with Down syndrome in France. Spec Care Dentist 2000;20:28–34.
9. Newacheck PW, McManus M, Fox HB, Hung Y, Halfon N. Access to health care for children with special health care needs. Pediatrics 2000;105:760–6.
10. Waldman HB, Perlman SP. Deinstitutionalization of children with mental retardation: what of dental services? ASDC J Dent Child 2000;67:413–7.
11. Martens L, Marks L, Goffin G, Gizani S, Vinckier F, Declerck D. Oral hygiene in 12-year-old disabled children in Flanders, Belgium, related to manual dexterity. Community Dent Oral Epidemiol 2000;28:73–80.
12. Mitsea AG, Karidis AG, Donta-Bakoyianni C, Spyropoulos ND. Oral health status in Greek children and teenagers, with disabilities. J Clin Pediatr Dent. 2001;26:111–8.
13. Bratel J, Berggren U. Long-term oral effects of manual or electric toothbrushes used by mentally handicapped adults. Clin Prev Dent 1991;13:5–7.
14. Carr MP, Sterling ES, Bauchmoyer SM. Comparison of the Interplak and manual toothbrushes in a population with mental retardation/developmental disabilities (MR/DD). Spec Care Dentist 1997;17:133–6.
15. Haesman PA, Stacey F, Heasman L, Sellers P, Macgregor IDM, Kelly PJ. A comparative study of the Philips HP 735, Braun/Oral B D7 and the Oral B Advantage toothbrushes. J Clin Periodontol 1999;26:85–90.
16. Hall AW, Conroy CW. Comparison of automatic and hand toothbrushes: toothbrushing effectiveness for preschool children. ASDC J Dent Child 1971;38:309–13.
17. Zimmer S, Didner B, Roulet JF. Clinical study on the plaque-removing ability of a new triple-headed toothbrush. J Clin Periodontol 1999;26:281–5.
18. Chava VK. An evaluation of the efficacy of a curved bristle and conventional toothbrush. A comparative clinical study. J Periodontol 2000;71:785–9.
19. Dean J, Hughes CV. Mechanical and chemotherapeutic home oral hygiene. In: McDonald RE, Avery DR, editors. Dentistry for child and adolescent. 7th ed. Philadelphia: Mosby; 2000. p. 247–82.
20. Quigley GA, Hein JW. Comparative cleansing efficiency of manual and power brushing. J Am Dent Assoc 1962;65:26–9.
21. Lange DE, Plagmann HC, Eenboom A, Promesberger A. Klinische Bewertungsverfahren zur Objektivierung der Mundhygiene. Deutsche Zahnärtzl Zeitschrift 1977;32:44–7.
22. Sauvetre E, Rozow A, de Meel H, Richebe A, Abi-Khalil M, Demeure F. Comparison of the clinical effectiveness of a single and a triple-headed toothbrush in a population of mentally retarded patients. Bull Group Int Rech Sci Stomatol Odontol 1995;38:115–19.
23. McCracken GI, Heasman L, Stacey F, Kelly PJ, Heasman PA. Testing the efficacy of plaque removal of a prototype brush head for a powered toothbrush. J Clin Periodontol 2000;27:542–8.
24. Warren PR, Ray TS, Cugini M, Chater BV. A practise-based study of a power toothbrush: assessment of effectiveness and acceptance. J Am Dent Assoc 2000;131:389–94.
25. Stoltze K, Bay L. Comparison of a manual and a new electric toothbrush for controlling plaque and gingivitis. J Clin Periodontol 1994;1:86–90.
26. Pannuti CM, Saraiva MC, Ferraro A, Falsi D, Cai S, Lotufo RFM. Efficacy of a 0.5% chlorhexidine gel on the control of gingivitis in Brazilian mentally handicapped patients. J Clin Periodontol 2003;30:573–6.
27. Ainomo J, Xie, Ainomo A, Kallio P. Assessment of the effect of an oscillating/rotating electric toothbrush on oral health. A 12-month longitudinal study. J Clin Periodontol 1997;24:28–33.
28. Renton-Harper P, Addy M, Newcombe RG. Plaque removal with the uninstructed use of electric toothbrushes: comparison with a manual brush and toothpaste slurry. J Clin Periodontol 2001;28:325–30.
29. Van der Wejden GA, Timmerman MF, Reijerse E, Danser MM, Mantel MS, Nijboer A, et al. The long-term effect of an oscillating/rotating electric toothbrush on gingivitis. J Clin Periodontol 1994;21:139–45.
30. Weinstein P, Milgrom P, Melnick S, Beach B, Spadafora A. How effective is oral hygiene instruction? Results after 6 and 24 weeks. J Public Health Dent 1989;49:32–8.
31. Haesman PA, McCracken GI. Powered toothbrushes: a review of clinical trials. J Clin Periodontol 1999;26:407–20.
32. Saxer UP, Yankell SL. Impact of improved toothbrushes on dental diseases. II. Quintessence Int 1997;28:573–93.
33. Choo A, Delac DM, Messer LB. Oral hygiene measures and promotion: review and considerations. Aust Dent J;46:166–73.

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