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# Clinical effectiveness of two different toothbrushes in the elderly

## Summary

Proper tooth brushing is the simplest way to maintain oral health. Still, it can cause considerable manipulative difficulties among parts of the population, like the elderly. The aim of this study was to evaluate a tool that could make tooth-brushing more effective and easier for this age group. Therefore, in a population of 34 elderly people aged 65 and over, we compared the plaque-removing ability of the Superbrush, a three-headed toothbrush, with the Elmex interX and the toothbrush normally used.

A balanced cross-over design was chosen and the study was operator-blind. Two indices were used to measure the plaque-removing abilities of the toothbrushes, the QHI (Quigley-Hein plaque index) and the API (proximal plaque index). Professional tooth cleaning was performed to obtain a plaque-free condition at the beginning of the study as well as before switching to a new toothbrush. After one week of using each toothbrush, the QHI and API were determined to assess the oral hygiene status of each participant.

The overall plaque removal was similar for the Superbrush, the Elmex interX and the patients' own toothbrushes. However, at the oral surfaces of the teeth, the Superbrush was significantly more effective than the other toothbrushes. No or only small differences were found for other surfaces (posterior and front teeth and facial surfaces).

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## Introduction

Increased dental care and a longer life expectancy in industrialised countries have led to a growing number of elderly people who have been able to keep their own teeth (ETTINGER & MULLIGAN 1999). A Swiss study by ZITZMANN et al. (2001) revealed that two-thirds of the elderly population between 65 and 74 had retained a large number of their natural teeth. The same study showed, however, that the older the people get, the less likely they are to visit a dentist. With increasing age and decreasing mobility, people tend to regard oral health as being of secondary importance.

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Among the institutionalized elderly, FISKE & LLOYD (1992) showed that 70% of the subjects needed dental treatments as judged by a professional, but only 30% of them thought themselves in need of dental care. The elderly, and especially the institutionalized, seem to be a segment of the population where dental prevention has not been effective enough (AMMANN 1987, WIRZ & TSCHÄPPÄT 1989). This can be seen, for example, in their hygiene routines, where about 50% cleaned their teeth with a toothbrush only once a day (WIRZ & TSCHÄPPÄT 1989).

The manual toothbrush is still the most important tool for oral hygiene and disease prevention. However, with increasing age, reduced manual and sensory abilities can make daily oral hygiene more difficult. It has been suggested by SAUVETRE et al. (1995) that the triple-headed Superbrush could be a useful tool for specific populations with reduced oral hygiene abilities, such as the elderly.

The Superbrush (Fig. 1a) was designed for the simultaneous cleaning of several surfaces (oral, facial and occlusal), thus shortening the total brushing time required for the total dentition. Additionally, another advantage is that the bristles are automatically at an angle of 45° to the gum. The Superbrush has already been tested on adults and children but with mixed results (SAUVETRE et al. 1995, BLOCH-ZUPAN & MANIERE 1996, ZIMMER et al. 1999, KICHE et al. 2002, DOGAN et al. 2004, SCHEIDEGGER & LUSSI 2005).

In order to evaluate whether this toothbrush is better suited for the elderly, we compared its plaque-removing abilities in a group

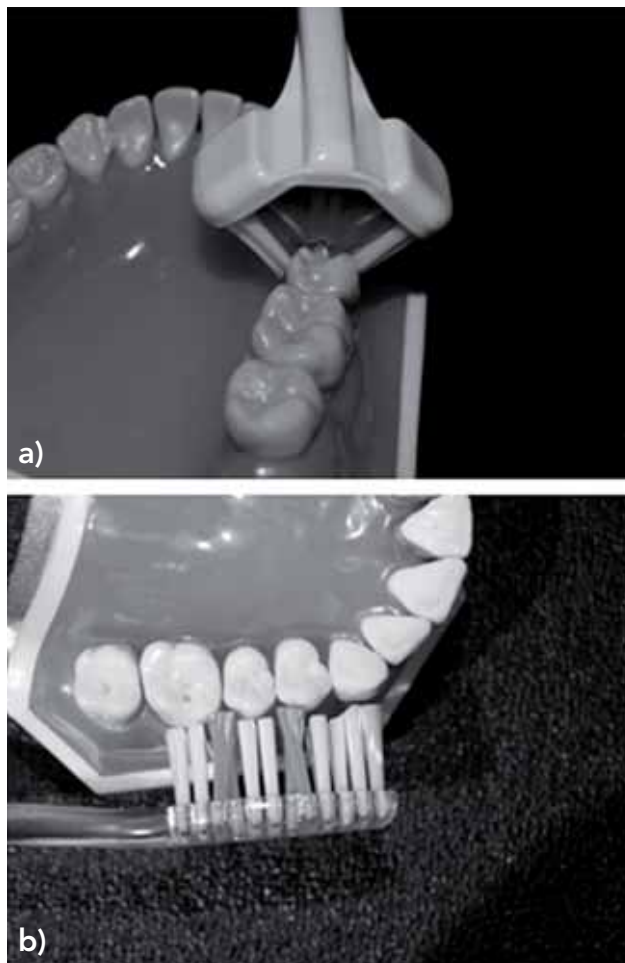


Fig. 1 a) Superbrush and b) Elmex interX.

Tab. I Some characteristics of the volunteers participating in the study.

number of subjects	34
mean age (range)	74 (65 min, 82 max)
number of women	18
number of men	16
mean number of teeth (range)	21 (7 min, 30 max)
participants taking medication	18
subjects taking potentially xerostomic medication*	3
physically handicapped**	2

\* Potentially xerostomic medication: beta-blocker, antidepressive medication, diuretics.

\*\* Parkinson's, apoplexy.

of elderly people. The other toothbrushes tested in this study were the participants' normal toothbrush and the Elmex interX (Fig. 1b) where some of the bristles are placed at an angle 60° to the rest of the bristles, allowing better interdental cleaning (YANKELL et al. 2002, SGAN-COHEN & VERED 2003).

## Materials and methods

### Subjects

Thirty-eight subjects were recruited from the same private clinic in Basel. Persons who fulfilled the criteria of being aged 65 or over and had at least two times three teeth in contact were included in this study. The study was approved by the State of Basel Ethic Commission (Nr 84/00). Two subjects were excluded from the study for failing to follow the instructions properly and two did not complete the study, leaving 34 volunteers, as described in Table I.

### Oral hygiene procedure

Three toothbrushes were tested: a) the Superbrush, adult model (Denta Co AS Minde/Bergen, Norway); b) Elmex interX, adult model/medium bristles (Gaba AG, Therwil, Switzerland); and c) the participants' own toothbrushes. The same toothpaste (Elmex Sensitive; Gaba AG, Therwil, Switzerland) was distributed to all participants and had to be used with every toothbrush. The subjects were asked to abstain from using any mouth rinses, gels or aids for interdental cleaning and to use only the appropriate recommended toothbrush throughout the duration of the study. All these oral hygiene instructions were additionally given in writing to the participants. They were recommended and instructed to use the Bass technique (BASS 1954) for the Superbrush as well as for the Elmex interX. Since the Bass technique had been routinely instructed to the patients in the private clinic, the subjects were not specifically instructed on how to use their own toothbrush during the study. The recommended brushing time was one minute twice a day.

### Study design

The volunteers were randomly assigned into six groups, with different orders of toothbrush use. The study had a balanced cross-over design and was operator-blind.

Each subject was given four appointments with exactly one week between each. At the first appointment, a complete dental status, including registration of fillings and crowns, was obtained. The teeth were then cleaned professionally to give completely plaque- and tartar-free teeth at the baseline. Finally, the subjects were given the toothpaste and were either instructed to use their own

toothbrush, or received one of the new toothbrushes and practical instructions on how to use it.

An analogous procedure was followed at the second and third appointments, except that the subjects were asked to fill out a short questionnaire about the toothbrush that they had been using for the previous seven days. The plaque was then stained with a disclosing agent (erythrosine solution). Two indices were used to register the amount of plaque: a) the Quigley-Hein plaque index (QHI, QUIGLEY & HEIN 1962) and b) the proximal plaque index (API, LANGE et al. 1977). All indices were determined by the same examiner during the whole study. Finally, the teeth were again cleaned professionally to obtain a plaque-free condition for the following test week. At the end of the appointment, the subjects were instructed to use the next toothbrush. At the final appointment, the procedure was the same except that no new toothbrush was given and the participants received the final evaluation questionnaire to fill out.

### Questionnaires

There were four questionnaires distributed to the subjects. The questionnaires for the Superbrush and the Elmex interX were identical, and the questions were mainly concerned with handling and cleaning effectiveness. The third questionnaire focused on the patient's own regular toothbrush (description, name, manual or electrical).

At the final appointment the participants received the last questionnaire. They were asked to compare the toothbrushes tested with respect to their cleaning abilities and their handling. All the questionnaires had multiple-choice answers.

### Statistical analysis

For the statistical analysis, the open source programming language R version 1.6.1 ([www.r-project.org](http://www.r-project.org)) was used. Non-transformed QHI-values and log-transformed API-values were analyzed by one-way ANOVA applying linear mixed models, with or without the covariable "age". In order to determine which means were significantly different from which others, the 95% confidence intervals (CIs) were estimated using the treatment contrasts of the ANOVA. A difference between means is statistically significant if its confidence interval does not include the value zero.

No deviation from the normality assumption (boxplots, QQ-plots) was observed for the QHI-values.

## Results

### Plaque indices

The QHI values determined after one test week were between 0.58 and 3.75. All QHI values increased slightly with age, although the covariable "age" ( $p > 0.41$ ) was statistically not significant. No significant carry-over effect ( $p > 0.28$ ) was observed. The over-all QHI (Fig. 2) was similar for all toothbrushes ( $p = 0.18$ ). However, the three toothbrushes differed at oral surfaces of the teeth ( $p < 0.0001$ ). Analysis of the 95% confidence intervals indicated that the Superbrush was significantly more effective in plaque removal than the Elmex interX (95% CI: 0.07–0.59) and the subjects' own toothbrush (95% CI: 0.27–0.69), whereas there was no significant difference between the Elmex interX and the subjects' own toothbrush (95% CI: –0.38–+0.14). Statistical analysis indicated that there was also a significant difference at posterior teeth ( $p = 0.04$ ). Again, the Superbrush was better in plaque removal than the Elmex interX (95% CI: 0.8–0.63) and the subjects' own toothbrush (95% CI: 0.17–0.68), whereas there was no

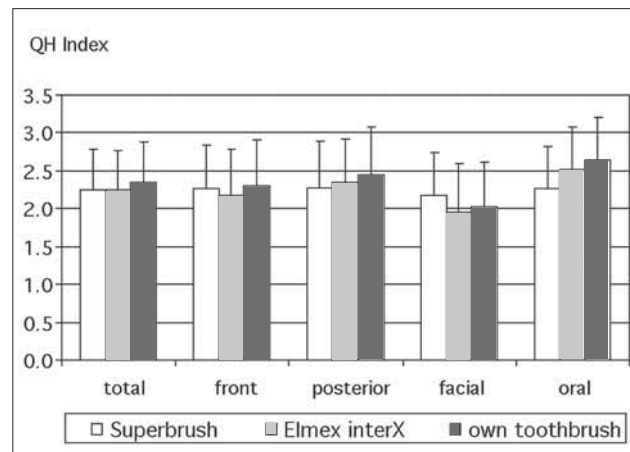


Fig. 2 Mean QHI values (with standard deviation) determined after one week brushing with the Superbrush, the Elmex interX or the participant's own toothbrush. Shown are the Quigley-Hein indices for all surfaces (total), for front and posterior teeth, and for facial and oral surfaces.

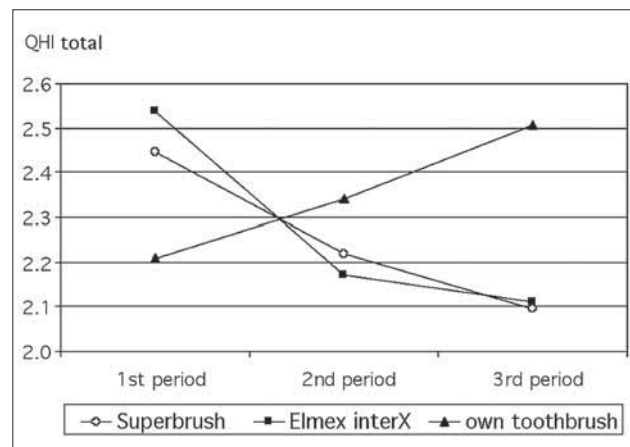


Fig. 3 Influence of the period on the mean total Quigley-Hein plaque index.

significant difference between the Elmex interX and the subjects' own toothbrush (95% CI: –0.34–+0.20). Elmex interX appeared best at cleaning front teeth and facial surfaces, but the differences were statistically not significant ( $p = 0.28$  and  $p > 0.05$ , respectively).

Three subjects were taking medications which affected the salivary flow (xerostomic medications). Although these were too few subjects for a statistical analysis, the QHI values of these three persons were in the same range as those of the other participants. The two physically handicapped subjects generally had high QHI values with all three toothbrushes, and achieved the best cleaning effect with their own toothbrushes.

Interestingly, a period effect was observed. Subjects using the Superbrush or the Elmex interX in the second and third period of the experiment had lower QHI values than those using either of them in the first week (Fig. 3). However, the QHI values increased in these periods when the patients were using their own toothbrushes.

Mean API values for total, front and posterior teeth are shown in Figure 4. No significant difference was detected between the toothbrushes ( $p > 0.9$ ).

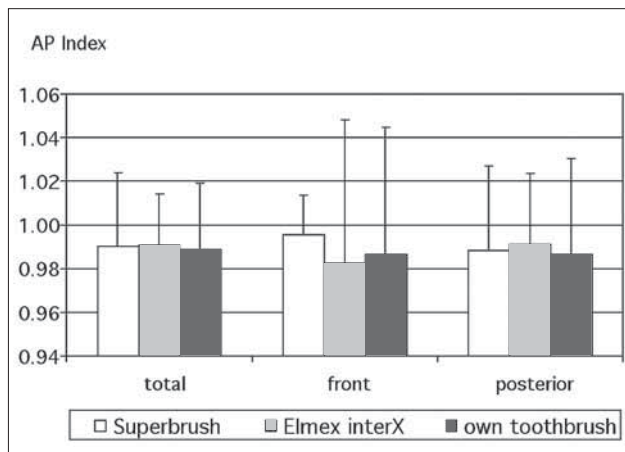


Fig. 4 Proximal plaque indices (with standard deviation) determined after one week brushing with either the Superbrush, the Elmex interX or the participant's own toothbrush. Shown are the proximal plaque indices for all surfaces (total), and the front and posterior teeth.

### Evaluation by participants

According to the questionnaire, 27 of the 34 participants were using manual toothbrushes, representing 20 different toothbrush brands. Two people were using both a manual and an electrical toothbrush. In the description of their manual toothbrushes, 22 of these 27 participants described them as clearly different in design to the Superbrush or the Elmex interX. Nine participants were using an electrical toothbrush. Eight of them used the same model (Oral B 3D, Braun). These eight persons achieved the lowest QHI using the Elmex interX, but the differences between toothbrushes were non-significant.

The participants' subjective impressions of the new, as well as of their own toothbrushes, are summarized in Tables II and III. In the beginning of the test week, about a third of the participants found the Superbrush difficult or very difficult to handle, whereas only one person reported difficulties with the Elmex interX (Tab. IIa). The subjective impression did not change much after one week. More than half of the participants found the interdental cleaning good or very good with the Elmex interX, in comparison to less than one third for the Superbrush (Tab. IIb).

In the final evaluation of all three toothbrushes (Tab. III), the highest values were given to the Elmex interX and the subjects' own toothbrushes. Over 80% of the participants found their handling (Tab. IIIa) as well as their cleaning abilities (Tab. IIIb) very good or good.

### Discussion

In this study among senior volunteers aged 65 and over, the overall plaque removal was similar for the three toothbrushes tested, the Superbrush, Elmex interX, and the subjects' own toothbrushes. This is in line with two studies of children attending primary school and using the Superbrush or a conventional brush, which showed similar overall plaque removal (KICHE et al. 2002, SCHEIDEGGER & LUSSI 2005). In two other studies of mentally disabled/retarded persons, the Superbrush was not significantly better in its overall cleaning effectiveness than the manual toothbrushes tested or an electrical toothbrush (SAUVETRE et al. 1995, DOGAN et al. 2004). In contrast, BLOCH-ZUPAN & MANIERE (1996) found a significantly lower plaque index after one week

Tab. II Patients' ratings for the Elmex interX and the Superbrush. Opinion on a) the handling at the beginning of the test week and at the end of the test week, and b) the cleaning of the interdental spaces.

a)		at the beginning	after one week
<b>Handling Superbrush</b>	Very easy	10 (29.5%)	11 (33%)
	Easy	12 (35%)	11 (33%)
	Normal	1 (3%)	4 (12%)
	Difficult	11 (32.5%)	6 (18%)
	Very difficult	0	1 (3%)

<b>Elmex interX</b>		
Very easy	9 (26.5%)	13 (38%)
Easy	9 (26.5%)	9 (26.5%)
Normal	15 (44%)	11 (32.5%)
Difficult	1 (3%)	1 (3%)
Very difficult	0	0

b)		
<b>Cleaning of interdental spaces Superbrush</b>	Very good	2 (6%)
	Good	7 (21%)
	Normal	11 (33%)
	Bad	11 (33%)
	Very bad	2 (6%)

<b>Elmex interX</b>		
Very good	3 (10%)	
Good	16 (53%)	
Normal	10 (33%)	
Bad	1 (3%)	
Very bad	0	

Tab. III The participants' final evaluation of all toothbrushes concerning a) the handling and comfort and b) the ability to clean the teeth.

a)		Superbrush	Elmex interX	own toothbrush
<b>Handling/Comfort</b>	Very good	8 (24%)	13 (38%)	14 (42%)
	Good	11 (32%)	15 (44%)	14 (42%)
	Sufficient	6 (18%)	6 (18%)	4 (12%)
	Insufficient/bad	9 (26%)	0	1 (3%)

b)		Superbrush	Elmex interX	own toothbrush
<b>Cleaning ability</b>	Very good	8 (25%)	9 (28%)	10 (31%)
	Good	14 (44%)	19 (59%)	16 (50%)
	Sufficient	4 (12%)	4 (13%)	5 (16%)
	Insufficient/bad	6 (19%)	0	1 (3%)

of using the Superbrush, in comparison to a conventional toothbrush, in a group of children aged 4–15 years. Also, in the study by ZIMMER et al. (1999) the Superbrush was significantly better on all surfaces for the three age groups tested, young children



(6–12 years), dental students (23–35 years), and older adults (37–60 years).

The participants in this study preferred the Elmex interX to the other toothbrushes. Almost one-third of the subjects found the Superbrush insufficient in its handling and subjective cleaning ability. The unusual form of the Superbrush may be more difficult to accept, especially for older people. As the patients get older and more disabled they may have more difficulties in using and accepting a new toothbrush.

Another aspect of the fixed size and shape of the Superbrush is that it may not be able to clean older persons' teeth, which are often longer than younger people's because of gum retraction. In this case, to be able to clean the teeth properly, the toothbrush has to be tipped either to the inside to clean the oral part or tipped to the outer side to clean the facial part of the teeth. As the gums often retract more facially this may be a reason why the QHI was higher at facial surfaces when using the Superbrush (Fig. 2), although this effect was not statistically significant.

The Superbrush was inferior as well in cleaning the buccal surfaces in a group of 78 children when compared to a conventional toothbrush (KICHE et al. 2002). As in our study, the Superbrush was significantly better at removing plaque orally in children (BLOCH-ZUPAN & MANIERE 1996). ZIMMER et al. (1999) found the Superbrush to be better than a conventional toothbrush and an electrical toothbrush on all surfaces. DOGAN et al. (2004) also compared the Superbrush to an electrical and a conventional toothbrush and found it to be significantly better than the conventional toothbrush both on the front and the posterior teeth. However, it is difficult to compare the various studies carried out with the Superbrush. They have all been different regarding the methods used, surfaces measured, and age of participating subjects. Even so, the Superbrush was regarded by SAUVETRE et al. (1995) and DOGAN et al. (2004) as a suitable alternative to an electrical or conventional toothbrush because of the ease of demonstrating and using it. Similarly, BLOCH-ZUPAN & MANIERE (1996) recommended that carers should use the Superbrush to clean younger and handicapped children's teeth.

Apparently, as is seen in the proximal plaque index (Fig. 4), it was almost impossible for the participants to clean the interdental surfaces properly within one minute and without any special aids. This was also the case for the Elmex interX which was specially designed to clean the interdental surfaces. In contrast, YANKELL et al. (2002) in an in-vitro study using two laboratory methods (IAE and PTSC), and SGAN-COHEN & VERED (2003) in a clinical study, showed a statistically better plaque removal using the Elmex interX in comparison to more conventional toothbrushes. We chose a brushing time of one minute to get as close to reality as possible (FRUNZ 1979, EMLING et al. 1981, SAXER & YANKELL 1997) and because the recommended brushing time for the Superbrush is one minute (Denta Co AS, Minde/Bergen, Norway). This may represent a bias favouring the Superbrush.

The interproximal area was difficult to score because of limited visual accessibility. SAXER & YANKELL (1997) suggested that, in a situation like that, a gingivitis index might be a better option.

The QHI-values were lower for the Superbrush and the Elmex interX during the second and third periods, while this effect was the opposite when the patient's own toothbrush was used. This period effect might be due to a novelty effect or the participants' belief in the superiority of the two newly introduced toothbrushes. This effect might be eliminated by longer test periods, during which the subjects can get to know the new toothbrushes properly. SAXER & YANKELL (1997) recommended that brushes

with a new element should be studied for up to six months, giving enough adaptation time for reliable results.

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## Zusammenfassung

Für die Zahngesundheit ist eine optimale Pflege mit der Zahnbürste sehr wichtig. Eine korrekte Handhabung der Zahnbürste kann jedoch für gewisse Bevölkerungsgruppen schwierig sein, zum Beispiel für ältere Personen. Das Ziel dieser Studie war es deshalb, Zahnbürsten mit unterschiedlichen Köpfen zu vergleichen, welche die Zahnreinigung bei älteren Personen vereinfachen und effizienter machen könnten. Dazu wurde bei 34 Freiwilligen im Alter von 65 und darüber die Plaqueentfernung durch die Superbrush, die Elmex interX und die Zahnbürste, die die Volontäre normalerweise verwendeten, verglichen.

Die Studie war randomisiert und hatte ein balanciertes, einfach-blindes Crossover-Design. Zur Messung der Plaqueentfernung wurden zwei Indices bestimmt, der QHI (Quigley-Hein-Plaque-Index) und der API (Approximalraum-Plaque-Index). Am Anfang der Studie und vor jedem Wechsel zu einer neuen Zahnbürste wurden die Zähne professionell gereinigt, um plaquefreie Bedingungen zu erreichen. Am Ende jeder Testwoche wurden die QHI- und API-Werte erfasst, um die orale Hygiene jeder Person zu messen.

Aufgrund des QHI wurden insgesamt keine signifikanten Unterschiede bei der Plaqueentfernung nachgewiesen. Bei den oralen Flächen der Zähne war die Superbrush jedoch signifikant besser als die anderen Zahnbürsten. Hingegen wurden keine oder nur geringe Unterschiede für die anderen Flächen (Seitenzahnbereich, Frontzähne und faciale Flächen) gefunden.

## Résumé

Un brossage de dents adéquat est le moyen le plus simple de maintenir la santé buccale. Cependant, il peut s'avérer difficile pour certains groupes de population, tels que les personnes âgées. Le but de cette étude était d'évaluer une approche destinée à rendre plus efficace et plus facile le brossage des dents pour ce groupe. Dans cette optique, l'efficacité d'une brosse à dent à trois têtes, la *Superbrush*, a été comparée chez un collectif de 34 personnes âgées avec celle de l'*Elmex interX* et la brosse à dents normalement utilisée par les patients.

Une approche de «cross-over» balancé a été choisie et l'étude conduite selon le principe du simple aveugle. Deux indices, à savoir le QHI (Quigley-Hein plaque index) et le API (proximal plaque index), ont été utilisés pour mesurer l'efficacité des différentes brosses pour éliminer la plaque. Au début de l'étude, un nettoyage professionnel a été effectué afin d'obtenir des conditions sans plaque, ainsi qu'avant changement de brosse. Après une semaine d'utilisation, le QHI et le API ont été déterminés pour évaluer le niveau d'hygiène orale de chaque patient.

De façon générale, le niveau d'élimination de plaque dentaire était similaire pour la *Superbrush*, l'*Elmex interX* et la brosse à dents habituelle du patient. Cependant, au niveau des faces orales des dents, la *Superbrush* était significativement plus efficace que les autres brosses. Aucune ou seulement une faible

différence a été trouvée pour les autres faces (dents postérieures et antérieures, ainsi que les faces faciales).

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