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ORIGINAL ARTICLE

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The safety and efficacy of a powered toothbrush on soft tissues in patients with implant-supported fixed prostheses

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Abstract The safety, efficacy and acceptability of an oscillating/rotating powered toothbrush was assessed in patients rehabilitated with fixed prostheses on implants. One hundred consecutive patients (aged 18–80; mean 56.3; 51 females), who met the inclusion/exclusion criteria and who participated in a regular annual recall scheme, were enrolled. They were instructed on how to use the powered toothbrush, as well as on classical interdental plaque control. The electric toothbrush had to be used twice daily for 2 min. The following periodontal parameters were measured at baseline and at 3 months, 6 months and 12 months: presence/absence of gingival and/or mucosal ulceration/desquamation; sulcus bleeding index; probing pocket depth; periodontal pocket-bleeding index and gingival recession. At 3 months and at the end of the study, patients completed a questionnaire concerning the overall acceptability and convenience of the powered toothbrush, as compared with their habitual manual toothbrush. A total of 80 patients completed the study. No dropouts were related to the use of the powered toothbrush. All parameters improved over the course of the study. The mean overall pocket depth decreased from 3.3 mm at baseline to 3.0 mm at 12 months, while the mean decrease in recession was 0.1 mm at 12 months. During the 1-year observation, there was a slight gain in periodontal attachment level. Gingival ulcerations were not observed at any point in the study. High scores for convenience and comfort of the powered toothbrush were reported, and the majority (95%) said that they would continue to use it for habitual oral hygiene. It is concluded that the powered toothbrush investigated is effective, safe and comfortable for patients rehabilitated by means of oral implant-supported prostheses.

Keywords Powered toothbrush · Implants · Periodontology · Electric toothbrush

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Introduction

Implant-supported partial and full bridges represent an effective way of oral rehabilitation, if a proper implant design is used [5, 16]. Once osseointegration has progressed, failures occurring after abutment installation can be mainly attributed to either mechanical overload or plaque induced peri-implantitis [9, 10]. The latter seems mostly associated with very roughened implant surfaces. The long-term success of any implant configuration can be improved by maintaining a rigorous oral hygiene and by preventing plaque accumulation around the transgingival part of the implant or the abutment. Lekholm et al. [3] already showed a correlation between levels of plaque and gingivitis and between the latter and increased probing depth. The roughness of the transgingival abutment surface is a key factor [7]. Failing implants were associated with higher plaque levels than successful implants [17], and a higher level of marginal bone loss around implants was reported in patients with poor oral hygiene [4], especially smokers.

Good oral hygiene can be achieved with interdental aids and a manual toothbrush when motivation and manual dexterity reach acceptable levels. However, for patients rehabilitated by means of oral implants, during the time in which they were edentulous, oral hygiene procedures were less required than if they were partially edentulous. The prostheses on implants have contours that regularly render plaque removal difficult. For these patients a powered toothbrush might represent a useful aid for plaque removal. A powered toothbrush provides the

user with a good brushing technique without the need for substantial training. It can even help to overcome limitations in manual dexterity [13]. In addition, where motivation is less than ideal, switching to a powered toothbrush can have a positive benefit. Hellstadius et al. [2] reported on patients with periodontitis who exhibited a poor compliance with their conventional oral hygiene procedures, despite a prolonged training period. Switching to a powered toothbrush improved their plaque control, which was maintained over a considerable period (up to 36 months). Thus, the improvement could not be attributed to a transient Hawthorn effect. Prior to using the powered brush, the patients said that oral hygiene procedures were time-consuming and cumbersome, but in contrast they found the powered brush simple and time-saving.

In this study the safety and efficacy of an oscillating/rotating powered toothbrush was conducted on a group of patients rehabilitated with fixed prostheses on implants. They were monitored over a period of 12 months.

Materials and methods

This open prospective study investigated the safety and acceptability of an oscillating/rotating powered toothbrush and its efficacy with respect to peri-implant mucosal health. The study was given ethics committee approval.

Study population

One hundred consecutive patients (aged 18–80, mean of 56.3 years; 51 females) who visited at least annually the Department of Periodontology of the Catholic University Hospital of Leuven, were enrolled. Each had to be rehabilitated by means of implants (Brånemark system, Nobel Biocare, Gothenburg, Sweden) for partial or complete loss of teeth. The fixed prostheses had been fabricated by the prosthetic department of the same institution or by referring dentists. Prior to entering the study all subjects were on a regular home oral hygiene involving manual toothbrush and interdental devices. Subjects receiving antibiotics, anti-inflammatory drugs, steroids or hormones, 1 month before the start of the study were excluded. Other exclusion criteria included periodontal pocket depths greater than or equal to 6 mm, obvious active caries, orthodontic treatment, diabetes, rheumatic fever, leukemia or immunocompromising diseases.

Study design

This prospective study has a 12-month duration. At baseline, subjects were provided free of charge with a Braun Oral-B Plaque Control Ultra (D9) powered toothbrush (Kronberg, Germany) to replace their normal manual toothbrush.

The D9 has an oscillating/rotating action and operates at a frequency of 63Hz (3,800 strokes/min). The brush head is small and circular with a diameter of 13 mm. The soft end-rounded bristles are arranged in a cup-shaped configuration, with a longer circular ring of outer bristles and two inner rings of shorter bristles both 0.15 mm in diameter.

Subjects were instructed in the use of the D9 and were asked to brush for 2 min, twice each day. They had to stick to their normal interdental cleaning procedures, which mostly consisted of the use of interdental brushes and, eventually, Superfloss. Subjects returned for control at 3 months, 6 months and 12 months. The clinical evaluation included: presence/absence of ulceration/desquamation of gingival or alveolar mucosa surrounding the abutments (visual inspection); the sulcus bleeding index [6] measured at four sites (mesiobucally and distobucally and mesiolingually and distolingually) around each abutment, in addition to, at the same sites, probing pocket depth, periodontal pocket bleeding index [15] and recession of the gingival margin (measured towards a fixed reference point).

At the 3-month and 12-month follow-ups, subjects were asked to fill in a questionnaire regarding their subjective experiences with the powered toothbrush. Questions included overall acceptability, convenience of the device, and a comparison with their previous manual toothbrush. Answers were given on numeric scales, on which "0" represented a negative response and "10" a positive response. Finally, subjects were also asked whether they intended to keep using the power toothbrush rather than returning to the use of their manual brushes.

Statistical analysis

For all parameters, a paired Student's *t*-test was used to evaluate statistical significance between baseline and the different follow-up visits, respectively. For each variable, a mean value per follow-up visit was calculated so that the patient served as statistical unit.

Results

Of the 100 patients enrolled into the study, 96 patients (429 abutments) were screened at 3 months, 88 (393 abutments) at 6 months and 80 (361 abutments) after 12 months. Reasons for withdrawal from the study included ten patients being unable to return, three for medical reasons and seven for unspecified reasons unrelated to the study. No patients withdrew for reasons related to the use of the powered toothbrush.

Ulceration/desquamation

Over the 12 months of the study, the D9 powered toothbrush was found to be safe to use with no evidence of trauma or ulceration/desquamation of the gingival and oral mucosa.

Periodontal parameters

Changes in periodontal pocket bleeding index, probing depth, sulcus bleeding index or recession were observed between baseline and 12 months (Fig. 1). Patients sustained the standard of oral hygiene that they achieved during the previous years with a regular maintenance scheme. After 3 months, all parameters decreased over time. At 12 months probing depth was reduced by 0.3 mm ($p<0.05$) and recessions decreased by 0.1 mm ($p<0.01$), indicating a gain in attachment of 0.4 mm ($p<0.01$).

Keratinized versus non-keratinized mucosa

As shown in Fig. 2 and Table 1, change in probing depth and recession over the course of the study was similar for

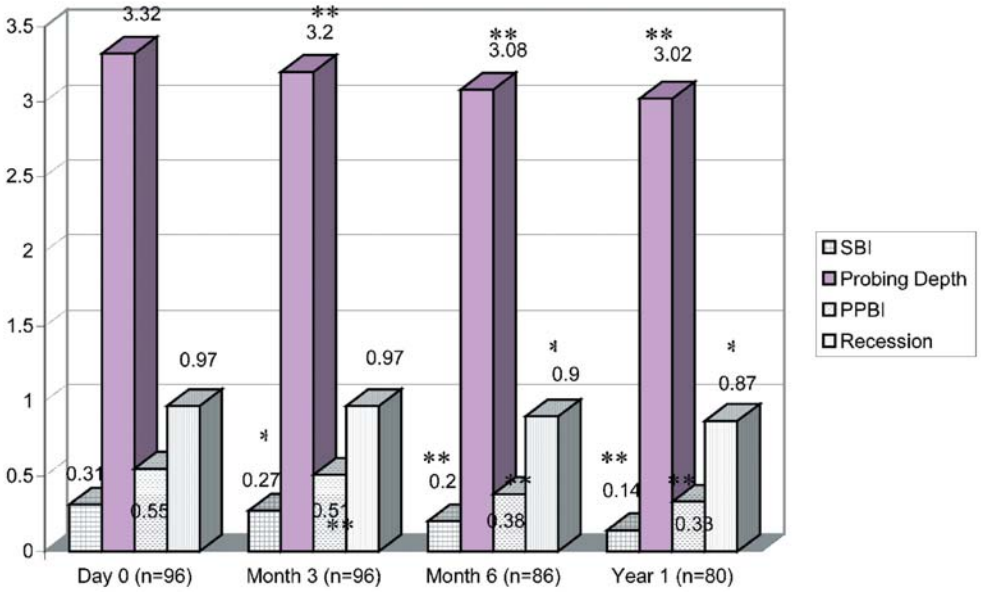

Fig. 1 Periodontal parameters at baseline, 3 months (n=96 patients), 6 months (n=86 patients) and 12 months (n=80 patients). *Asterisks* indicate the level of significance of the variation from baseline (*p<0.05, **p<0.01). The data are presented in means

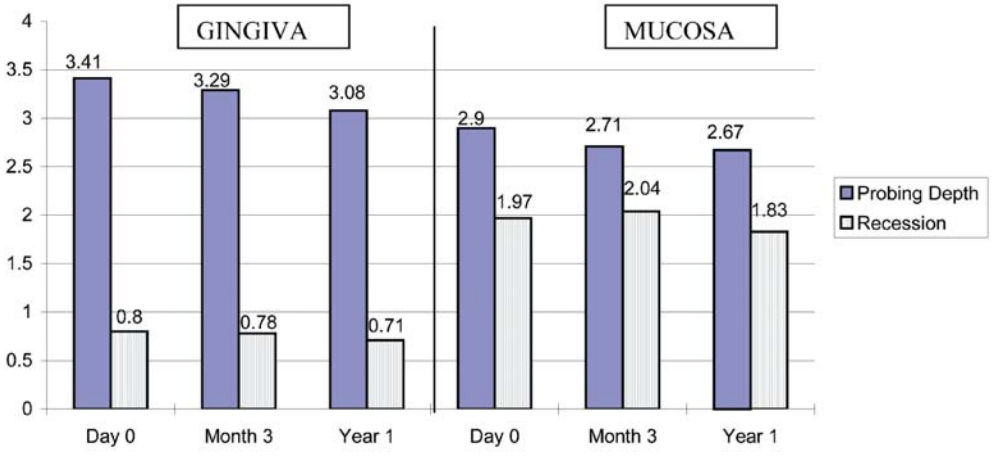

Fig. 2 Probing depth and recession at abutment sites surrounded by keratinized gingiva (n=2,022 at month 3 and n= 1,531 at month 12) or non-keratinized mucosa (n= 362 at month 3 and n=268 at month 12). The data are presented in means

Table 1 Influence of presence/absence of keratinized mucosa around abutment sites on periodontal parameters (*G* gingival, *M* mucosal). Means and standard deviations within brackets are indicated

	Gingivitis index (SBI)	Probing depth (mm)	Bleeding index	Recession (mm)
Day 0 (G)	0.29 (0.6)	3.41 (1.1)	0.55 (0.5)	0.8 (1.2)
Month 3 (G)	0.24 (0.5)	3.29 (1.0)	0.51 (0.5)	0.78 (1.1)
Month 12 (G)	0.12 (0.4)	3.08 (1.0)	0.32 (0.5)	0.71 (1.1)
Day 0 (M)	0.46 (1.3)	2.83 (0.8)	0.51 (0.5)	1.98 (1.4)
Month 3 (M)	0.46 (0.7)	2.71 (0.7)	0.52 (0.5)	2.04 (1.4)
Month 12 (M)	0.25 (0.5)	2.67 (0.8)	0.41 (0.5)	1.83 (1.4)

both gingival and alveolar mucosa. Similarly, when one looks at percentage change from baseline for all four parameters, it can be seen that the changes over time are all of a similar magnitude.

Subjective evaluation of the powered toothbrush

At 3 months and 12 months, the questionnaire revealed (Table 2) high scores for the powered toothbrush. Means

Table 2 Response to questionnaire (0 being very negative, 10 very positive) regarding characteristics of the D9 (mean scores)

Questions	3 months	12 months
Level of comfort?	8.2	8.7
Ease of use?	8.4	8.7
Overall satisfaction?	8.4	8.7
Satisfaction compared with previous brush?	8.5	9.0
Will you keep on using the powered brush?	9.5	9.5

on the 0-to-10 scale were 8.2 for convenience and 8.4 for comfort at 3 months, and 8.7 and 8.7 at 12 months. The percentages of scores of 7 or lower were respectively 18.8% for convenience and 12.5% for comfort at month 3 and 11.9% and 11.9% at month 12. When asked whether they would continue to use the powered toothbrush after the study had ended, approximately 95% said that they would.

Discussion

The maintenance of good oral hygiene, especially around abutment sites, is pivotal if patients rehabilitated with implant-supported prostheses are to achieve long-term success. A number of studies have shown that long-term failures, especially for implants with a very roughened surface, are associated with high plaque levels [1, 21]. This contrasts with implants that have a lower roughness, such as a machined surface. Thus any technique or device that can enhance plaque control would be of particular value to this group of patients. A limited number of studies have investigated the effect on plaque control for the natural dentition, when changing from a manual toothbrush to a powered toothbrush [7, 19]. The results have been largely encouraging. A powered toothbrush confers good brushing technique and appears to enhance the patient's motivation to brush [2, 12]. Manual dexterity and motivation varies from one patient to another and it is, therefore, likely that a large number of patients rehabilitated with implants, often elderly, can benefit from switching to a powered toothbrush.

The cantilevered prostheses on implants, resulting from the discrepancy between the resorbed jaw bone anatomy and the dental arch, further renders plaque control difficult for these patients. Evidence for the benefits of using a powered toothbrush in such patients is limited. Wolff et al. [22] compared a sonic and a manual toothbrush with respect to reducing plaque and gingivitis around oral implants and found a greater effect with the sonic brush. A similar finding was reported by Truhlar et al. [14] where a counter-rotational-powered toothbrush and a manual toothbrush were compared. In a group of elderly patients, both a manual toothbrush and an oscillating/rotating powered toothbrush were found to be equally effective [13]. It should be stressed that this concerned overdentures on implants, for which accessibility of implant surfaces is easy and for which oral hygiene is not difficult.

In the present study, patients who were already achieving good long-term success with their implants were switched from a manual toothbrush to a Braun Oral-B powered toothbrush after which their oral hygiene status was followed for a period of 12 months. Patients were motivated because of the regular controls at the department of periodontology. Thus, no significant improvement in periodontal parameters was anticipated. The main aim of the study was to evaluate safety of the powered toothbrush and the attitudes of the patients towards this new tool.

With respect to safety, the study found no evidence of any hard/soft tissue trauma and no ulceration/desquamation of the soft tissues, neither in the mouth as a whole nor around abutment sites in particular. From this it can be concluded that this powered toothbrush is safe for homecare for patients with oral implants. This finding is in agreement with the large number of studies on patients with a natural dentition [11, 18].

The general appreciation of patients towards the powered toothbrush was very positive. As shown in Table 2, patients gave scores of 8 or more out of a maximum of 10, for level of comfort, ease of use and overall satisfaction. Compared with their manual brush, they gave the D9 a score of 9 out of 10, and approximately 95% said that they intended to continue using the powered toothbrush rather than revert to their manual brush. Although the group of patients in this study already maintained a good oral hygiene, they preferred the help of a powered toothbrush. In a retrospective study of a powered toothbrush used by a population of periodontal patients, it was found that the compliance level when using the powered toothbrush was high and unrelated to social factors [12]. Thus, it appears that powered toothbrushes have the potential to enhance compliance, a factor that could be of particular importance to any implant patients who are achieving less than ideal levels of oral hygiene.

Periodontal parameters showed a consistent trend towards improvement from month 3 on. This suggests that the switch from manual to powered has a positive effect, in line with the studies of Wolff et al. [22] and Truhlar et al. [14]. When periodontal parameters were analyzed for both keratinized gingiva or non-keratinized mucosa surrounding the abutment sites, change in probing depth and recession over the course of the study was similar for both tissue types (Fig. 2 and Table 2). The lack of difference in periodontal parameters between keratinized and non-keratinized tissues around implants when a manual toothbrush was used has been previously reported [20].

Comparative studies with a sonic toothbrush and a counter-rotational-powered toothbrush in implant patients both found greater plaque removal with the powered toothbrush when compared with a manual brush [14, 22].

In conclusion, this study demonstrates that the Braun Oral-B Ultra Plaque Remover (D9) is safe for patients with fixed prostheses on implants. It has no adverse effect on soft tissues. The powered toothbrush was well-received by patients in the study, and 95% said that they would not revert to using a manual brush.

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