Gingival Margin Stability After Mucogingival Plastic Surgery. The Effect of Manual Versus Powered Toothbrushing: A Randomized Clinical Trial

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Background: Oscillating-rotating power toothbrushes have been proven to be clinically efficacious. To the best of the authors' knowledge, a clinical evaluation of the safety of these toothbrushes after surgical root coverage procedures has not been published. The aim of this study is to evaluate the gingival margin (GM) stability with the use of an oscillating-rotating toothbrush compared with a manual toothbrush.

Methods: Sixty healthy individuals with at least one Miller Class I or II gingival recession underwent a surgical root coverage procedure. Soft-bristle manual and powered toothbrushes were given to participants randomly assigned to control and test groups, respectively. Full-mouth plaque score (FMPS), full-mouth bleeding score (FMBS), probing depth (PD), and recession depth (RD) were recorded at baseline and 1, 3, and 6 months after completion of the surgical procedure. Data analyses were performed using linear random-intercept models to take into account within-participant correlations over time. Temporal trend differences across treatments by including treatment–time interaction terms were then tested using a global Wald test.

Results: Use of a powered toothbrush resulted in a significantly greater reduction of recorded periodontal clinical indices compared with a manual device (FMPS, $P = 0.05$; FMBS, $P = 0.005$; RD, $P = 0.004$). No significant differences were noticed between the two experimental groups both for PD ($P = 0.03$) and clinical attachment level ($P = 0.11$). Complete root coverage was significantly higher in participants who used the powered toothbrush compared with the manual toothbrush at 6 months (control, 66.67%; test, 96.67%; $P = 0.002$).

Conclusion: Use of an oscillating-rotating powered toothbrush with a soft-bristle head resulted in higher GM stability after root coverage procedures compared with the use of a manual soft-bristled toothbrush. *J Periodontol 2016;87:1186-1194.*

KEY WORDS

Gingival recession; oral hygiene; toothbrushing.

According to the International Workshop for a Classification of Periodontal Diseases and Conditions,[1] the gingival/soft tissue recessions on the vestibular or lingual surfaces or interproximal (papillary) areas are classified in the group of Development or Acquired Mucogingival Deformities and Conditions Around Teeth and are defined as the displacement of the marginal tissue apical to the cemento-enamel junction (CEJ).

The etiology of gingival recession (GR) is at times difficult to determine, and it should be considered a multifactorial clinical entity, both inflammatory and non-inflammatory in nature.[2]

The possibility that toothbrush trauma may be at least one of the contributing factors toward this multifactorial condition has been recognized for many years.[3] The response of localized recessions to different methods of toothbrushing, in particular manual and power-driven toothbrushes, is uncertain.[4] However, there is evidence to suggest that the use of a powered toothbrush may reduce GR by ≈0.1 mm after 12 months around recently placed dental implants.[5] Furthermore, reduction of GR in individuals using powered and manual toothbrushes over a period of 18 months has been reported.[6]

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After surgical coverage of the exposed root surface, clinicians should be able to suggest the most suitable toothbrush device to prevent the relapse of mucogingival deformities and preserve over time the clinical result achieved. Thus, the aim of the present study is to evaluate the role of powered versus manual toothbrushing in terms of gingival margin (GM) stability after mucogingival plastic surgery.

MATERIALS AND METHODS

Experimental Design

This was a single-masked randomized parallel group clinical trial. This paper was written according to the CONSORT (Consolidated Standards of Reporting Trials) statement for improving the quality of reports of parallel-group randomized trials.[7] Participants were recruited from the Department of Periodontics of the University of Milan, Milan, Italy, where they had been referred for management of localized GR defects between February 2014 and May 2014. A presurgical full-mouth professional prophylaxis appointment was scheduled 2 weeks before the scheduled surgical procedure. All surgeries were performed by the same experienced periodontist (EL). After surgical root coverage (RC) procedures, participants were randomized to receive either a manual toothbrush[§] (control group) or a powered toothbrush[‖] (test group) for the self-performed oral hygiene care maintenance for the duration of the study. The randomization sequence was generated using a block methodology for every 10 participants. Clinical outcomes were evaluated at baseline (BL) and 1 (T_1), 3 (T_3), and 6 (T_6) months after surgical RC was performed by a single calibrated examiner (RA). Intraexaminer reproducibility for probing depth (PD) and recession depth (RD) measurements was calculated.

Sample Size

The study was powered to detect a minimum clinically significant difference (δ) in the GM position no smaller than 1 mm using $\alpha = 0.05$, a power of 80%, and a standard deviation of 1.22 mm obtained from a previous study.[8] Calculations were performed using calculation software.[¶9] Twenty individuals per treatment arm were needed.

Study Population

60 adults (28 males and 32 females, aged 25 to 45 years; mean age: 35.5 years) in good general health with no untreated periodontal disease were considered eligible for this clinical trial. Inclusion criteria were as follows: 1) aged ≥18 years; 2) full-mouth plaque score (FMPS) (evaluated as six sites per tooth on all the teeth in both maxilla and mandible) ≤25%;[10] 3) full-mouth bleeding score (FMBS) ≤25%;[11] and 4) presence of isolated Miller Class I and II[12] buccal recession ≥2 mm in each patient.

Exclusion criteria included the following conditions: 1) relevant systemic condition or disease; 2) smokers; 3) teeth with prosthetic crowns or restorations located in the cervical area; 4) pulling frenum in the keratinized tissue; and 5) history of mucogingival or periodontal surgery in the experimental site.

Patient Entry (Informed Consent and Randomization)

The study protocol was reviewed and approved by the ethics committee of the University of Milan (reference 13/13). The study was registered on Clinicaltrials.gov as NCT02534220. Written informed consent was obtained from all volunteers entered into the study. The principles outlined in the Helsinki Declaration of 1975, as revised in 2013, on experimentation involving humans were followed.

Participants were enrolled in the study by a central registrar (GP) located at the Clinical Research support infrastructure of the Department of Periodontics, Dental School, University of Milan. Participants were randomized through computer-generated randomization tables. A balanced random permuted block approach was used to decrease the chances of unbalances between test and control groups in terms of BL RD. Sealed coded opaque envelopes were opened at the 1-week postoperative examination visit.

Surgical Procedure

The exposed root surfaces were covered using the coronally advanced flap (CAF) as previously described.[13]

Post-Surgical Instructions

Participants were requested to discontinue toothbrushing and avoid trauma and food impaction at the surgical site during the first week after the surgical procedure. Participants were instructed not to use any interproximal cleaning aid for the first postoperative month. A 1-minute rinse with 0.12% chlorhexidine digluconate was prescribed twice daily for the first 2 weeks after surgery.

Post-Surgical Controls and Maintenance Care Program

The sutures were removed 7 days after the surgical procedure. The randomization opaque envelope was opened at this time always by the same dental hygienist (Alessia De Vita, fellow hygienist, Department of Periodontics, University of Milan, Milan, Italy), previously trained on how to teach patients the proper brushing technique according to the study protocol. Individuals allocated in the control group were instructed to use the roll

§ Oral-B Indicator, 35-soft, Oral-B, Procter & Gamble, Cincinnati, OH.
‖ Triumph 5000, Oral-B, Procter & Gamble.
¶ PS Power and Sample Size v3.1.2, 2014, W.D. Dupont & W.D. Plummer, Vanderbilt University, Nashville, TN.

brushing technique twice daily for 2 minutes as follows: clean maxilla and mandible separately, clean a set of two teeth at the same time on the buccal, palatal/lingual, and occlusal surfaces, applying gentle pressure on the teeth. Participants allocated in the test group were instructed to brush with an oscillating-rotating toothbrush[#] with a soft-bristle head.[**] Instructions included brushing twice daily for 2 minutes according to the following instructions: 1) clean maxilla and mandible separately; 2) clean teeth one by one on the buccal, palatal/lingual, and occlusal surfaces; 3) set daily clean as the brushing mode; 4) switch the quadrant of the mouth every 30 seconds as indicated by the timer provided by the manufacturer; and 5) avoid pressure sensor lighting up during the brushing session. All participants were provided with the same toothpaste without any antiplaque agents.[††]

Patients were recalled for a gentle cleaning of the surgical site (polishing with a rubber cup) at weeks 1, 2, and 3 after surgery; they received their scheduled maintenance scaling at months 1, 3, and 6 after surgery. Interdental cleaning procedures by flossing were provided during the 4-week follow-up examination. Both experimental groups were asked to use the same type of interdental floss.[‡‡] Brushing and adherence to the technique were checked and reinforced by the same trained dental hygienist (Alessia De Vita) as follows: all participants were asked to demonstrate on a mouth plastic model the proper manual or power-driven brushing technique before leaving the clinical facility at each scheduled follow-up appointment.

Clinical Measurements

All clinical measurements were taken by a masked examiner (RA). The timeline for the study protocol is described in Figure 1. At BL (before the surgical RC procedure), the medical and dental histories were updated, and the following clinical parameters were recorded: 1) FMPS, as the number of surfaces covered with plaque over the total number of surfaces of the teeth (four surfaces per tooth) reported as a percentage; 2) FMBS, as the number of sites bleeding on probing over the total number of sites of the teeth (four sites per tooth) reported as a percentage; 3) PD, measured as the distance between the GM and the bottom of the pocket; 4) RD, measured from the CEJ to the GM; and 5) clinical attachment level (CAL), calculated as the distance between the CEJ and the bottom of the pocket.

Figure 1.
Study timeline. CAL = clinical attachment level; OHI = oral hygiene instructions.

FMPS and FMBS were recorded at 1, 3, and 6 months after surgery. PD and CAL were reassessed only at 6 months after surgery. The measurements were rounded off to the nearest millimeter and performed using a manual periodontal probe.[§§] RC was calculated at 6 months as (T_0 RD – T_6 RD) over T_0 RD and reported as a percentage. Mean RC (MRC) was calculated for each treatment group as a mean of RC in all treated sites. Complete RC (CRC) was calculated as the number of sites with 100% RC over the total number of treated sites in each group.

Statistical Analyses

Descriptive statistics were performed using mean ± SD for quantitative variables and frequencies and percentage for qualitative variables. Comparisons of variables between the two treatment groups at BL were performed using Mann–Whitney *U* test.[14] A linear random-intercept model was used to explore the within-participant correlations over time.[15] Evaluation was completed for temporal trend differences across treatments by including treatment–time interaction terms, which were then tested using a global Wald test. Statistical analyses were performed.[||||]

RESULTS

Examiner Calibration

Intraexaminer agreement between replicates for PD and RD within 1 mm was 99% to 100%. Unweighted κ scores were in the range of 0.6 to 0.9.

Compliance

Participant compliance for each visit, in each group, is shown in Figure 2. Sixty volunteers were recruited and attended the screening visit. At the end of the surgical procedure, 30 patients were randomized to the powered brush group and 30 to the manual brush group. There were no dropouts among the enrolled patients.

Demographic and Clinical Characteristics

Table 1 reports the demographic and clinical characteristics. The two groups were well balanced in terms of age, FMPS, and FMBS. Most of the treated

Triumph 5000, Oral-B, Procter & Gamble.
** Oral-B Sensitive head, Oral-B, Procter & Gamble.
†† AZ Multi-Protection Active-Shield Family Toothpaste, Oral-B, Procter & Gamble.
‡‡ Oral-B Pro-Expert Floss, Oral-B, Procter & Gamble.
§§ PCP-UNC 15, Hu-Friedy, Leimen, Germany.
|||| Stata Statistical Software v.13, StataCorp, College Station, TX.

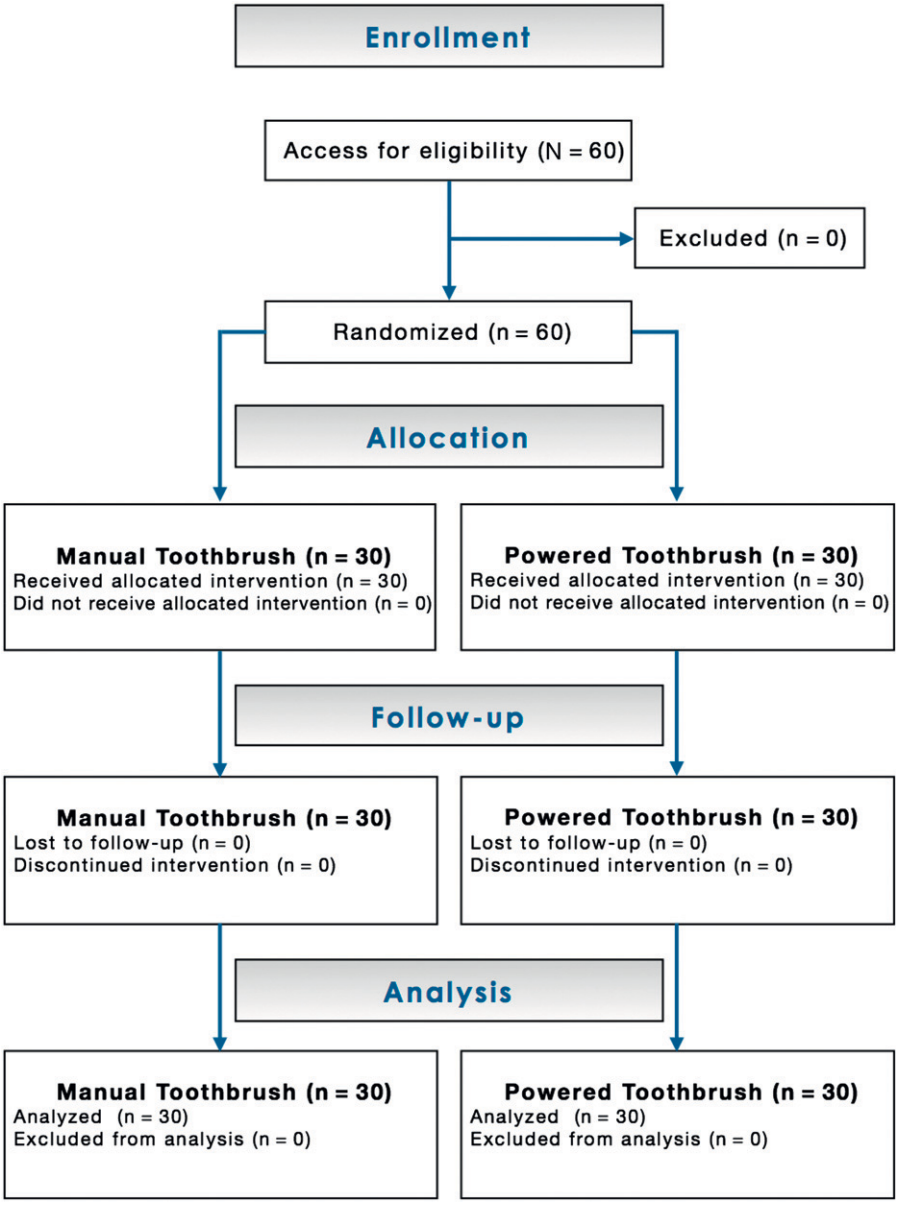

Figure 2.
CONSORT flowchart of the study.

recessions were classified as Miller Class I. No difference was noted for any of the collected clinical parameters between the two groups, except for the PD value (control, 2.10 ± 0.71 mm; test, 2.57 ± 0.94 mm; $P = 0.05$).

Periodontal Status

Intragroup analysis showed a significant reduction of all periodontal variables recorded both for manual and powered toothbrush group, as detailed in Table 2. The use of both manual and powered toothbrushes provided a reduction of plaque and bleeding indices, even considering the intergroup variations (Table 2). FMPS in the manual (T_1, 15.23%; T_3, 9.27%; T_6, 8.50%) and powered (T_1, 16.93%; T_3, 9.20%; T_6, 4.93%) toothbrush groups were significantly different at the 6-month evaluation (T_1, $P = 0.49$; T_3, $P = 0.97$; T_6, $P = 0.002$). A similar trend was observed for the FMBS index, which was not significantly different between groups at T_1 and T_3 but was significantly lower in the powered toothbrush group at T_6 (T_1, $P = 0.98$; T_3, $P = 0.29$; T_6, $P = 0.005$).

No statistically significant differences were observed between the treatment groups in terms of either PD (T_6, $P = 0.51$) or CAL (T_6, $P = 0.18$) at T_6 (Table 2).

GM Stability

RD reduction was observed both for the manual (T_1, 0.30 mm; T_3, 0.47 mm; T_6, 0.50 mm; $P<0.001$) and powered (T_1, 0.20 mm; T_3, 0.03 mm; T_6, 0.03 mm; $P<0.001$) toothbrush groups during the 6-month follow-up period compared with the BL value, as reported in Table 3. At the T_1 time point, the difference between groups did not reach statistical significance, although it did at T_3 and T_6 (T_1, $P = 0.42$; T_3, $P = 0.006$; T_6, $P = 0.004$) (Table 3).

When the MRC value was considered as a surgical outcome, the use of a manual toothbrush (T_1, 91.44%; T_3, 87.50%; T_6, 86.39%; $P = 0.02$) provided a statistically significant reduction of the covered root surface over time compared with a gradual increase of MRC value in the test group (T_1, 93.61%; T_3, 99.17%; T_6, 99.17%; $P = 0.008$). Significant differences between groups were recorded at the T_3 and T_6 time points (T_1, $P = 0.56$; T_3, $P = 0.004$; T_6, $P = 0.002$) (Table 3).

CRC was observed in all treated cases at the end of the surgery in both the manual and the powered toothbrush groups. At the T_1 time point evaluation, a reduction of the frequency of CRC was recorded in both the manual and powered toothbrush groups (powered, 83.33%; manual, 70.00%). No significant differences were observed between the two groups at T_1, although they were at T_3 and T_6 (T_1, $P = 0.23$; T_3, $P = 0.005$; T_6, $P = 0.002$) (Table 3).

Table 1.

Demographic and Clinical Characteristics at BL

Parameter	Manual Toothbrush	Powered Toothbrush	*P* Value
Age, mean ± SD years	35.70 ± 8.40	35.30 ± 10.00	0.86
Sex			
Males, n (%)	12 (40)	16 (53)	0.95
Females, n (%)	18 (60)	14 (47)	
Miller Class (at surgical site)			
I, n (%)	22 (73)	19 (63)	0.42
II, n (%)	8 (27)	11 (37)	
FMPS, mean ± SD %	22.27 ± 2.70	23.20 ± 1.80	0.48
FMBS, mean ± SD %	16.80 ± 3.40	18.90 ± 1.90	0.24
PD (at surgical site), mean ± SD mm	2.10 ± 0.71	2.57 ± 0.94	0.05
RD (at surgical site), mean ± SD mm	3.17 ± 1.09	2.83 ± 0.75	0.95
CAL (at surgical site), mean ± SD mm	5.27 ± 1.20	5.40 ± 1.13	0.48

$\alpha \leq 0.05$.

Table 2.

Intragroup and Intergroup Analysis of Periodontal Variables

	Manual Toothbrush	Powered Toothbrush	*P* Value
FMPS, mean ± SD %			
T_0	22.27 ± 2.70	23.20 ± 1.80	
T_1	15.23 ± 7.69	16.93 ± 10.92	0.49
T_3	9.27 ± 5.10	9.20 ± 6.80	0.97
T_6	8.50 ± 3.95	4.93 ± 4.68	0.002
P value	<0.001	<0.001	
FMBS, mean ± SD %			
T_0	16.80 ± 3.40	18.90 ± 1.90	
T_1	13.50 ± 11.88	13.43 ± 11.88	0.98
T_3	7.77 ± 8.34	5.77 ± 6.03	0.29
T_6	5.87 ± 7.01	1.90 ± 2.62	0.005
P value	<0.001	<0.001	
PD (at surgical site), mean ± SD mm			
T_0	2.10 ± 0.71	2.57 ± 0.94	
T_6	1.80 ± 0.76	1.93 ± 0.79	0.51
P value	0.005	<0.001	
CAL (at surgical site), mean ± SD mm			
T_0	5.27 ± 1.20	5.40 ± 1.13	
T_6	2.30 ± 1.08	1.97 ± 0.80	0.18
P value	<0.001	<0.001	

$\alpha \leq 0.05$.

Treatment–Time Interaction Model

Temporal trend differences across treatments by including treatment–time interaction terms for the tested variables are presented in Table 4. The use of a powered toothbrush resulted in a greater reduction of both FMPS and FMBS over time compared with a manual toothbrush (FMPS, $P = 0.05$; FMBS, $P = 0.005$). The results of a statistical model with PD and CAL as two independent outcome variables did not show a difference between the two experimental groups (PD, $P = 0.05$; CAL, $P = 0.11$). When change over time in RD, MRC, and CRC was considered, the powered

Table 3.

Intragroup and Intergroup Analysis of GM Stability

	Manual Toothbrush	Powered Toothbrush	*P* Value
RD (at surgical site), mean ± SD mm			
T_0	3.17 ± 1.09	2.83 ± 0.75	
T_1	0.30 ± 0.47	0.20 ± 0.48	0.42
T_3	0.47 ± 0.82	0.03 ± 0.18	0.006
T_6	0.50 ± 0.82	0.03 ± 0.18	0.004
P value	<0.001	<0.001	
MRC (at surgical site), mean ± SD %			
T_1	91.44 ± 13.66	93.61 ± 15.11	0.56
T_3	87.50 ± 20.78	99.17 ± 4.56	0.004
T_6	86.39 ± 20.98	99.17 ± 4.56	0.002
P value	0.02	0.008	
CRC (at surgical site), mean ± SD %			
T_1	70.00 ± 46.61	83.33 ± 37.91	0.23
T_3	70.00 ± 46.61	96.67 ± 18.26	0.005
T_6	66.67 ± 47.95	96.67 ± 18.26	0.002
P value	0.37	0.02	

$\alpha \leq 0.05$.

Table 4.

Treatment–Time Interaction Model

	Estimate	Standard Error	95% CI (lower)	95% CI (upper)	*P* Value
FMPS	0.41	0.03	0.35	0.47	0.05
FMBS	0.47	0.03	0.41	0.52	0.005
PD (at surgical site)	0.47	0.20	0.71	0.90	0.05
CAL (at surgical site)	0.13	0.27	–0.40	0.67	0.11
RD (at surgical site)	0.38	0.04	0.30	0.46	<0.001
MRC (at surgical site)	0.13	0.38	0.05	0.20	<0.001

CI = confidence interval. $\alpha \leq 0.05$.

toothbrush provided a significant improvement of the tested outcomes (RD, $P<0.001$; MRC, $P<0.001$; CRC, $P = 0.002$).

DISCUSSION

Power toothbrushes have been available well before the 1960s.[16] The technology related to these products has gradually been improved, and today they are widely used.[16] In this study, the stability of the GM was tested in individuals who underwent a surgical RC procedure and adopted a manual or powered toothbrush during the tissue maturation period.

Both groups experienced a reduction in FMPS and FMBS, but FMPS reduction was the greatest in the test group at 6 months. Improvements in PD and CAL were similar in both groups. Recession decreased in both groups, but the test group performed better at 3 and 6 months. MRC decreased in the manual toothbrush group, but it improved in the powered toothbrush group. CRC was significantly higher in the test group at 3 and 6 months. The use of a powered toothbrush resulted in greater reduction of periodontal indices compared with a manual device at 6 months.

To the best of the authors' knowledge, this is the first study to evaluate treatment outcomes of an RC procedure in patients adopting either a manual or a powered toothbrush. The results were not expected and may help clinicians recommend better post-surgical oral hygiene instructions. Additional studies

should be performed to evaluate the effect of the adopted brushing device in different populations with surgical procedures performed by different clinicians. Moreover, the effect of powered toothbrushes in the healing and stability of other periodontal procedures should be addressed in future studies. One factor that could not be controlled in this study is the force applied to the manual toothbrush. Although the method for brushing was demonstrated and reinforced during the course of the study, individuals using the powered toothbrush could benefit from the built-in pressure-sensor feature that was not present in the manual toothbrush, which may partially explain the results of this investigation. Still, it should be noted that soft-bristled brushes were used in this investigation. The results may vary with the use of medium-bristled toothbrushes.

Previous studies demonstrated that, among the several modes of action (sonic, counter-rotational, rotary/circular, oscillating-rotating, ionic, and ultrasonic), oscillating-rotating powered toothbrushes reduce plaque and gingivitis more than manual toothbrushes.[17,18] Similar results were attained in this clinical trial with a significantly greater reduction both for FMPS (from 22.27% to 8.50% in the control group; from 23.20% to 4.93% in the test group) and FMBS (from 16.80% to 5.87% in the control group; from 18.90% to 1.90% in the test group). The reductions were significantly higher in the test group for FMPS ($P = 0.002$) and FMBS ($P = 0.005$).

The most desirable outcome of a surgical GR treatment is the long-term stability of RC. Preferably, CRC or maximum RD reduction should be preserved in the long term.[19] A recent consensus report suggested that the adopted surgical technique plays an important role in the stability of the RC.[20] Moreover, oral hygiene habits should be controlled to achieve optimal plaque control and avoid possible soft tissue trauma.

Toothbrushing is a known potential risk factor for soft or hard tissue damage in terms of tooth surface loss[21] and gingival abrasion/GR development.[22] A recent systematic review on the clinical efficacy and safety of oscillating-rotating powered toothbrushes and manual toothbrushes concluded that both toothbrushes are safe and do not produce a risk for gingival injury or hard tissue damage.[23] Tooth abrasion seems to be related more to individual inappropriate brushing techniques rather than to the adopted toothbrush.[4] The meta-analysis by Heasman et al.[24] suggested that, in patients with non-inflammatory GR, the correct use of either a powered or a manual toothbrush could potentially prevent the progression of GR. Moreover, Dorfer et al. in 2009[25] and 2016[26] showed that both manual and powered toothbrushes reduced recession after 6 months of brushing and attributed this to the brushing technique. Conversely, Dentino at al.[27] showed that the oscillating-rotating toothbrush provided clinical benefits in plaque and calculus reduction over a manual brush even in individuals with no formal oral hygiene instruction, with no detrimental effects on soft tissues being observed. In the present investigation, both experimental groups received toothbrushes with the same bristle hardness and same oral hygiene instructions in every visit (toothbrushing duration/frequency and oral hygiene home-care instructions). Still, participants who used the oscillating-rotating powered toothbrush had greater GM stability and GR reduction compared with the use of a manual toothbrush.

Excessive brushing force can also contribute to tooth surface loss.[28] In this study, the strength exerted while brushing was not controlled in the manual toothbrush group, whereas the force was controlled in the powered toothbrush group. Two investigations that assessed the relative force of powered and manual toothbrushes under similar conditions concluded that the powered toothbrush use was associated with a lower mean force.[29,30] This provides a potential explanation for the results of improved gingival stability observed in this study. Therefore, the built-in pressure-sensor features introduced in some powered toothbrushes may prove to be an important feature. Another factor that may affect soft and hard tissue damage is the distance covered by bristles (because work is the result of force × distance), which is longer on powered toothbrushes than on manual toothbrushes. Unfortunately, there is no information on the effect of the distance covered by bristles on soft and hard tissue damage; it is believed that studies are needed to evaluate this specific issue. Finally, the length of the brushing strokes may be considered of importance, especially when evaluating soft tissue damage. Manual toothbrushes are often used with long strokes, whereas powered toothbrushes perform oscillating-rotating movements that may be better tolerated by soft tissues.

The higher performance of oscillating-rotating toothbrushes in plaque removal and the improved control over toothbrushing force may explain the difference between the two experimental groups in terms of MRC and CRC value. The ability to achieve and preserve a clean post-surgical area without traumatizing the marginal soft tissue may promote a spontaneous creeping attachment,[31,32] improving the amount of RC obtained after the early healing phase by coronal displacement of the GM.

Within its limitations, the implications of this study are of interest to the clinician. Showing an improved surgical outcome by simply suggesting the use of a powered toothbrush compared with a manual

toothbrush in patients treated with a CAF for RC purposes enhances the knowledge of clinical wound healing patterns and helps the clinician provide better recommendations to his/her patients.

Moreover, these result open a new field of research in which the use of a powered toothbrush versus a manual toothbrush can be evaluated during the healing of different surgical procedures for RC, periodontal regeneration, and implant therapy. If the results of these CAF surgeries can be improved by simply providing a different toothbrush to patients, the outcome of other treatments may be improved as well.

CONCLUSION

The use of an oscillating-rotating toothbrush with a soft-bristled head after an RC surgical procedure showed higher GM stability compared with a manual soft-bristled toothbrush.

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