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Experimental assessment of oral hygiene achieved by children wearing rapid palatal expanders, comparing manual and electric toothbrushes

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Mazzoleni S, Bonaldo G, Pontarolo E, Zuccon A, De Francesco M, Stellini E. Experimental assessment of oral hygiene achieved by children wearing rapid palatal expanders, comparing manual and electric toothbrushes.

Abstract: *Objectives:* The aim was to compare the efficacy of the electric versus the manual toothbrush in terms of the oral hygiene achieved by patients wearing rapid palatal expanders (RPEs). *Methods:* Forty patients were randomly divided into two groups; one equipped with a manual toothbrush (Group A), the other with an electric toothbrush (Group B). Each child's plaque index (PI) and gingival index (GI) were calculated at banded molar level at times T0 (before banding), T1 (a month later), T2 (3 months later) and T3 (when the expander was removed). At each appointment, the PI and GI were recorded and the patient was remotivated. *Results:* The level of oral hygiene achieved by the group using an electric toothbrush produced a greater improvement in the two indexes than in the group using the manual toothbrush that showed no statistically significant improvement (PI T0–T3: $P = 0.309$; GI T0–T3: $P = 0.141$). Both indexes dropped considerably in both groups from T0 to T2, but more so in the group B. From T2 to T3, although the electric toothbrush continued to be substantially more effective, Group B showed a statistically significant deterioration in the oral hygiene (PI +20%; GI +33%). Other assessments conducted on particular areas of the tooth showed improvements in the PI (−33%) for the vestibular region, and for the GI (−57%) in the palatal region among the patients in Group B, while there were no significant changes in these indexes in Group A. *Conclusions:* Our findings show that the electric toothbrush is statistically more efficient in performing an adequate level of oral hygiene in children wearing RPE.

Key words: dental hygienist; electric toothbrush; interceptive orthodontics; manual toothbrush; oral hygiene in orthodontic patients; rapid palatal expander

Introduction

In pedodontics, a very important role is attributed to interceptive orthodontics, that is, the use of devices for the purpose of preventing, removing or attenuating dental–skeletal anomalies that can occur in developmental age.

One of the appliances most often used in this setting is the rapid palatal expander (RPE), which enables the transverse diameter of the maxillary arch to be corrected by applying appropriate orthopaedic forces in paediatric patients, usually before their puberal growth spurt.

The indications for the use of the RPE may be not only for skeletal correction but also to restore a proper respiratory function (1, 2).

In any case, as the RPE is applied in young patients, it is easy for their oral hygiene to deteriorate because the bands and medial palatal screws interfere with optimal plaque control, in much the same way as when fixed vestibular orthodontics are fitted with arches, couplings or hooks.

At each check-up during the course of the orthodontic therapy, it is therefore fundamentally important for the operator to reassess and discuss with patients how well they are controlling the deposition of plaque, judging the efficacy of each child's technique and of the instruments they use (which have to be straightforward and practical given the patients' young age).

An alternative to the traditional manual toothbrush is the electric toothbrush, which is now used by more and more people.

Several studies in the literature have demonstrated that patients' oral hygiene tends to deteriorate after they have been fitted with orthodontic appliances (3–7).

In developmental age, any build-up of plaque seems to facilitate the onset of caries (8, 9) rather than periodontal disease, and having to wear orthodontic devices is certainly an important causal factor in a child's poor oral hygiene.

Hence, this study is used to compare the efficacy of electric and manual toothbrushes in terms of the oral hygiene achievable by young patients wearing RPEs.

Materials and methods

Whether or not the use of an electric instead of a manual toothbrush might influence the level of oral hygiene in patients wearing palatal expanders has yet to be studied scientifically.

The present assessment protocol was established by drawing from the study conducted by Matic *et al.* in 2011 (10) to assess the efficacy of a prevention programme for patients wearing fixed orthodontic appliances by means of a plaque index (PI) and a gingival index (GI), and also taking into account the conclusions from the systematic review by Heanue *et al.* in 2003 (11) on the efficacy of electric versus manual toothbrushes for the oral health of patients wearing vestibular devices.

Our study was conducted at the University of Padova's Pedodontics Unit at the Castelfranco Veneto general hospital (Treviso, Italy) and involved 40 children (20 females and 20 males) whose ages ranged from 7 to 12 years, diagnosed with the need to normalize the diameter of their maxillary arch by means of a rapid palatal expander (RPE).

The appliance adopted in all patients consisted of smooth bands cemented to the first upper molars, with no vestibular tubes or auxiliaries, and a 10-mm medial screw (Fig. 1).

This clinical research was designed as a single blind study (Fig. 2), that is, the examiner responsible for the follow-up, and for recording the indicators was always unaware of which group a given patient belonged to.

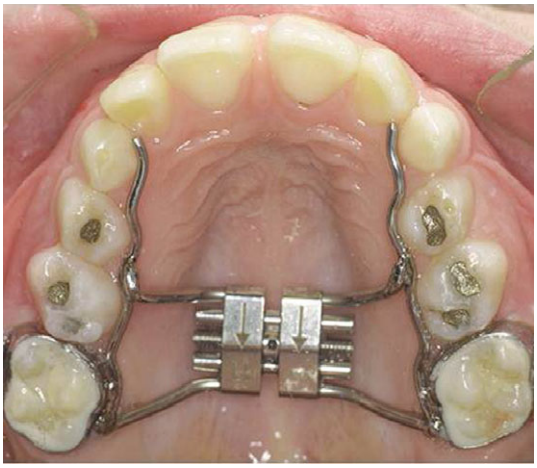

Fig. 1. The rapid palatal expander (RPE) is an appliance comprising a screw located in the middle of the palate, coinciding with the medial line, with two anterior and two posterior arms welded to the palatal surfaces of the bands placed up against the first molars.

For the purpose, using computer-generated random numbers, the sample was randomly divided into two groups, A and B, and all the children were given the same instructions concerning their oral hygiene, but Group A was to use a manual toothbrush, Group B an electric toothbrush.

The children in Group A were given a manual toothbrush with a small head so that they could reach all the areas of their teeth, even the most critical. To be specific, the toothbrush used was a Classic Gum (GUM Sunstar Americas, Inc., Chicago, IL, USA) with rounded synthetic bristles and an ergonomically shaped handle to make it easier to hold and manipulate (Fig. 3). Patients were told how to brush their teeth using a rolling technique, positioning the brush on a level with the gum margin and applying a mild pressure while rotating it slightly towards the tooth. They were asked to do so at home for 2 min (1 min on each side), three times a day, using a fluorinated toothpaste to maintain their dental hygiene while wearing the RPE. Patients were also shown how to use a cylindrical interdental brush 0.32 mm in diameter (ORALPROX; International Dental Supply Savona, Italy) and a specific dental floss (SUPERFLOSS; Oral-B, Procter & Gamble, Weybridge, UK) only to help them clean the palatal areas and arms of the RPE.

The same home hygiene protocol was recommended to patients in Group B, the only difference being that they were instructed to use an electric toothbrush fitted with ahead that had a rotating–oscillating motion with 5600 oscillations per minute and rounded nylon bristles, all of the same height ('Motion'; Colgate-Palmolive Company, New York, NY, USA) (Fig. 4). Patients were told to move the brush over all sides of their teeth, guiding the head over the surfaces of the teeth, concentrating for 1 min on the molars affected by the orthodontic bands.

The electric and manual toothbrushes were replaced with a new one every 3 months.

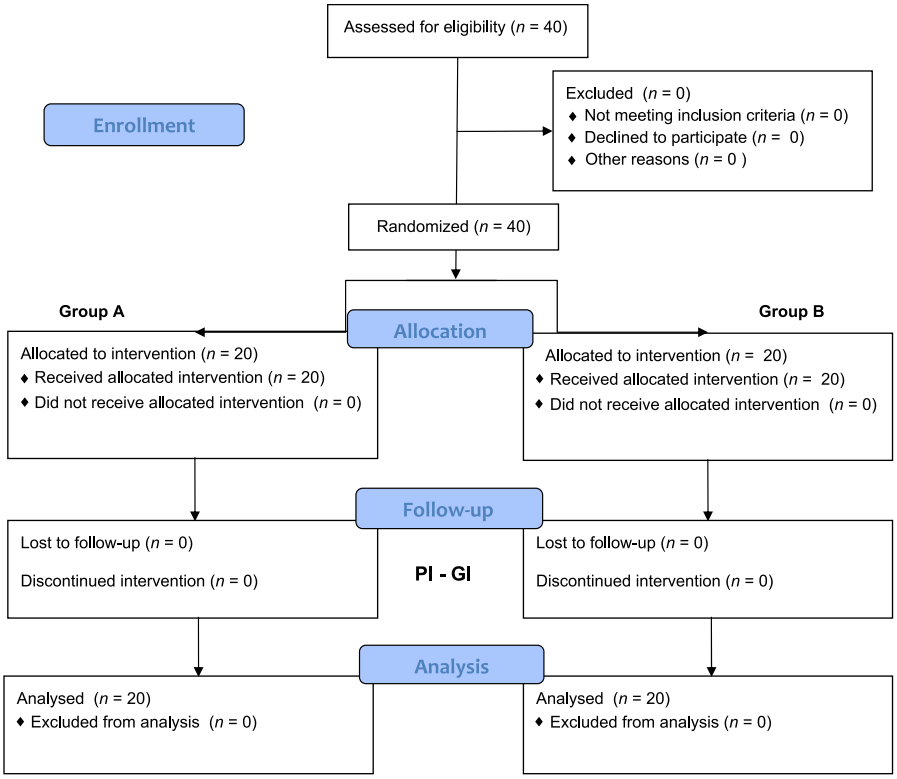

Fig. 2. Flow diagram illustrating the study design.

Fig. 3. Manual toothbrush.

Fig. 4. Electric toothbrush.

During the clinical follow-up, all participants in both groups were asked how they habitually cleaned their teeth at home. From the data collected, it was clear that all of the children examined had previously been using a manual toothbrush for <2 min and rarely more than twice a day. Only two patients had occasionally used a fluorinated mouthwash and none of them had ever used dental floss.

Our data collection protocol involved using a millimetric periodontal probe to assess the PI (Silness and Loe, 1964) and GI (Loe and Silness, 1967) on a level with all the surfaces (medial, distal, vestibular and palatal) of the banded molars, which were considered as the area most difficult to clean because of the presence of the bands and the soldered sections on the arms. This measurement was taken at the time of banding (T0), 1 month later (T1), 3 months after cementing the bands (T2) and when the appliance was removed (T3), which differed from one patient to another but was always at least 8 months after cementing the RPE.

The above-mentioned indicators were obtained by an operator expert in periodontology and suitably trained for said purpose.

At each appointment, the children were examine, and their plaque and gingival indexes were recorded. They were remotivated and instructed once again about their oral hygiene.

Statistical analyses were performed on our data using Student's t-test ($P < 0.05$). All the patients were included in the statistical analyses. The evaluation was performed comparing GI and PI from T0 to T3 in each group (Table 1). For Group A, there was no evidence of any statistically significant differences during the study period.

Table 1. **Student's t-test results**

	T0–T1	T0–T2	T0–T3	T1–T2	T1–T3	T2–T3
Group A						
PI	0.458	0.012	0.309	0.062	0.054	0.047
GI	0.226	0.024	0.141	0.104	0.639	0.304
Group B						
PI	0.000	0.000	0.000	0.000	0.000	0.000
GI	0.002	0.000	0.000	0.026	0.031	0.001

$P < 0.05$.
PI, plaque index; GI, gingival index.

Results

Plaque index and GI values were obtained at all the time points (T0–T3) for all 40 participants, and the means of these values were calculated for each group and for the various surfaces of the children's first upper molars (Table 2).

Then overall mean PI and GI values were calculated for the two groups at the different time points (Table 3) (Figs 5 and 6). The PI remained constant in Group A from T0 to T3, while in Group B this index changed significantly. The GI likewise gradually dropped over time for the patients using the electric toothbrush and remained virtually stable for the patients using a manual toothbrush.

For both PI and GI, there was evidence of a relative increase in the indexes from T2 to T3 in the patients in Group B, although they continued to have better mean values than the children in Group A.

Discussion

On analysing the trends of the indexes considered, it was clear that the electric toothbrush was more effective for the purposes of oral hygiene, especially in the period from T0 to T2 (Figs 5 and 6).

In Group B, the PI changing from a mean 1.7 to a mean 1.2 (*P*: 0.000), revealing a significant improvement in the intermediate periods too, from T0 to T1 (−5.8%) and from T0 to T2 (−41.1%), while the children's plaque was less effectively controlled during the third interval, T2 to T3 (+20%).

In Group A, the mean PI remained much the same in the subsequent periods as at the baseline (T0), showing no significant improvement throughout the period examined (Fig. 5).

During the study period, the GI showed a similar trend to the PI in Group B, with a significant mean reduction in the period from T0 to T2 (−45.5%). The GI also became worse in the final period examined (from T2 to T3), although the overall reduction in this index was still better in Group B than in the Group A children, whose GI and PI both remained more or less constant throughout the study (Fig. 6).

It is worth emphasizing that using the electric toothbrush achieved an effective reduction in the patients' PI and GI over the course of the study period, while this was not true of the manual toothbrush.

Table 2. **Mean PI and GI for single upper molar surfaces in Groups A and B at times T0, T1, T2 and T3**

	T0							T1							T2							T3						
	16V	16P	16D	16M	26V	26P	26D	26M	16V	16P	16D	16M	26V	26P	26D	26M	16V	16P	16D	16M	26V	26P	26D	26M	16V	16P	16D	16M	26V	26P	26D	26M
Group A																																
Mean P	1.8	2.0	1.3	1.3	2.0	1.7	1.4	1.4	1.7	1.7	1.6	1.6	1.8	1.8	1.6	1.6	1.6	1.5	1.2	1.2	1.7	1.5	1.4	1.4	1.9	1.9	1.6	1.2	1.8	1.7	1.3	1.2
Mean GI	0.9	1.0	0.8	0.8	1.2	1.0	0.8	0.8	0.8	0.9	0.7	0.7	1.2	0.7	0.6	0.6	0.9	0.7	0.5	0.5	1.1	0.6	0.8	0.7	1.2	0.7	0.7	0.5	1.0	0.9	0.7	0.5
Group B																																
Mean PI	2.0	2.0	1.4	1.5	2.2	2.0	1.4	1.5	2.0	1.7	1.4	1.6	1.7	1.5	1.4	1.5	1.3	1.1	1.0	1.0	1.3	1.0	1.0	1.0	1.2	1.7	1.0	1.2	1.6	1.3	1.0	1.2
Mean GI	1.2	1.0	1.2	0.9	1.4	1.5	1.2	1.0	1.4	1.0	0.7	0.8	1.1	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.9	0.5	0.5	0.5	0.8	1.0	1.0	0.6	1.1	0.7	1.0	0.5

PI, plaque index; GI, gingival index.

Table 3. **Mean overall PI and GI for Groups A and B**

	T0	T1	T2	T3
Group A				
PI	1.6	1.6	1.4	1.5
GI	0.9	0.7	0.7	0.7
Group B				
PI	1.7	1.6	1.0	1.2
GI	1.1	0.9	0.6	0.8

PI, plaque index; GI, gingival index.

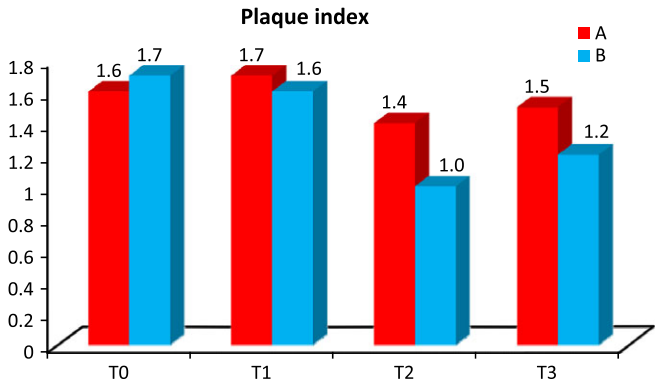

Fig. 5. Plaque index from T0 to T3 in Groups A and B.

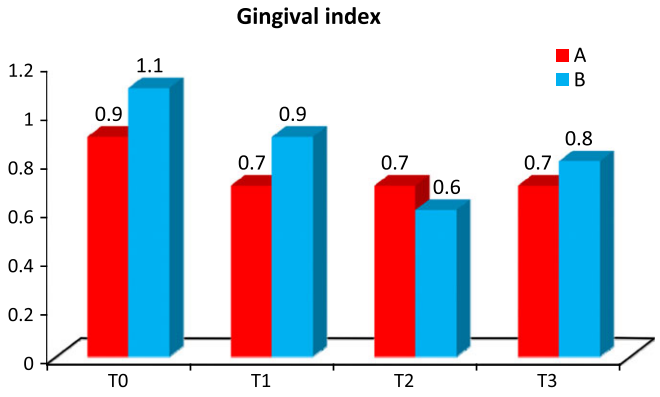

Fig. 6. Gingival index from T0 to T3 in Groups A and B.

With time, however, the beneficial effect of the electric toothbrush tended to fade. There were signs of it proving less effective in the final period considered (from T2 to T3) than earlier on, although the Group B patients' indexes remained better than those of the patients using a manual toothbrush.

This was probably due to a '*novelty effect*', also described in the studies by Muhler (7) and Owen (12), which leads to devices used for the first time proving more effective in short-term follow-up studies because participants are initially more motivated to use them, but later on the novelty wears off. This would also explain why the efficacy of the manual toothbrush, in terms of the PI and GI indexes, remained constant during the period considered.

Our findings are consistent with those of other studies on samples of patients treated with vestibular orthodontic appliances (13, 14), which demonstrated that using an electric toothbrush led to a more marked reduction in patients' plaque and gingival indexes than when a manual toothbrush was used (15–18).

As for our data on the time trends of the indexes measured in different surfaces of the banded teeth, our statistical analyses revealed no significant changes in Group A, whereas Group B patients experienced a marked improvement in their PI in both the vestibular region and the palatal regions, while their GI improved particularly in the palatal region (Figs 7 and 8) during the interval between T0 and T3.

It has not been included in our protocol the use of mouthwashes because the long-term utilization of them, especially those containing alcohol, it is not recommended in children (19).

Consistently with other reports in the literature (3, 20), we found a greater accumulation of plaque in the vestibular and palatal regions, although the level of oral hygiene improved in all areas of the tooth among the electric toothbrush users during the study period as a whole (T0–T3). Because no similar studies were available in the literature, for the purposes of

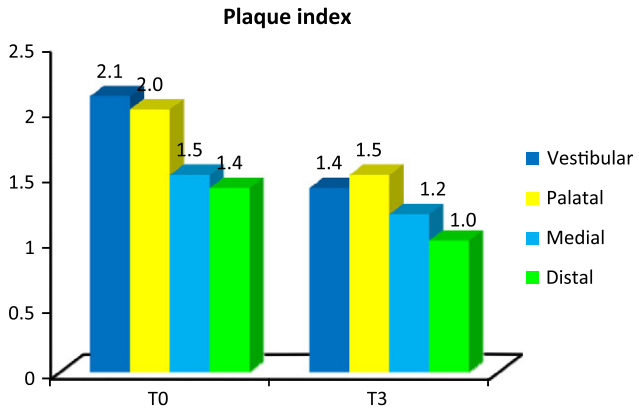

Fig. 7. Plaque index in Group B in the vestibular, palatal, medial and distal regions.

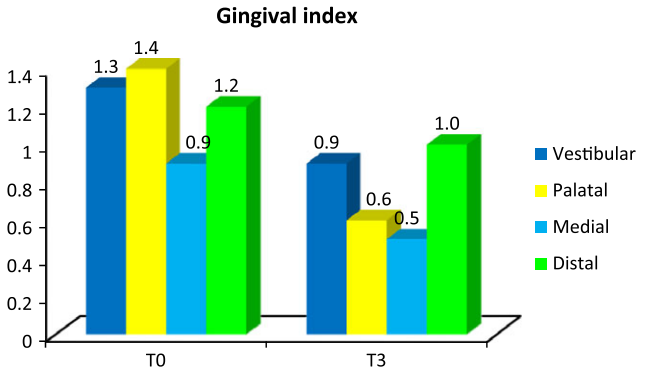

Fig. 8. Gingival index in Group B in the vestibular, palatal, medial and distal regions.

assessing plaque control in the palatal region, we compared our findings with reports relating to fixed lingual orthodontics (20, 21). As a rule, patients undergoing lingual treatments reportedly have greater difficulty in ensuring a good oral hygiene in the palatal region, but we found that patients using the electric toothbrush succeeded in keeping even this area of the banded molars clean (the RPE naturally affected a more limited area than treatments involving the whole arch).

Conclusion

Judging from our findings, we conclude that the electric toothbrush has a statistically significant greater efficacy than the manual toothbrush in maintaining an adequate level of oral hygiene in patients wearing RPE.

This greater efficacy was particularly evident in the early months of using the electric toothbrush and, although it faded to some degree, it nonetheless continued to produce better results obtained than the manual toothbrush. In addition, using the electric toothbrush coincided with an improvement in oral hygiene not only in the vestibular but also in the palatal region.

Clinical relevance

One of the devices most often used in interceptive orthodontics is the rapid palatal expander. The application of this fixed orthodontic unit in very young children makes fundamental to find simple but effective methods to control their oral hygiene.

Due to the presence of the bands and the palatal components is not easy to ensure proper level of plaque control by traditional manual techniques.

In our study, the use of the powered toothbrush showed a greater effectiveness and seems to be a potential more efficient resource in ensuring a correct level of dental hygiene in young orthodontic patients.

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