

A Randomized Controlled Trial on the Efficacy of Two Types of Manual Toothbrushes in Patients with Fixed Appliances

Zurairah Ibrahim^{1*}, Syiral Mastura Abdullah¹, Azrul Hafiz Abdul Aziz¹, Ainuddin Yushar Yusof¹,
Diana Md Zahid¹, Rohaya Megat Abdul Wahab²

1. Faculty of Dentistry, Universiti Sains Islam Malaysia, Pandan Indah 55100 Ampang Kuala Lumpur, Malaysia.
2. Faculty of Dentistry, Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia.

Abstract

This research is a randomized controlled trial to compare the effectiveness of plaque removal between manual conventional and orthodontic toothbrushes in patients having fixed orthodontic treatment using Orthodontic Plaque Index (OPI). This study was conducted by two orthodontists at USIM Specialist Dental Clinic with almost perfect agreement level (Kappa score: 0.95). A total of 58 orthodontic patients were divided into 2 groups; first group were patients given manual conventional toothbrush (CTB) and the other were given orthodontic toothbrush (OTB). Consent obtained, and participants were instructed to follow standardized specific oral hygiene care regimes. Orthodontic Plaque Index (OPI) was then recorded during baseline (V_0), 1 month (V_1), 2 months (V_2), and 3 months (V_3) reviews for all participants.

Out of 58 patients, only 26 participants (5 male and 21 female) completed the 3 review visits. Median values were used as data was not normally distributed. At baseline, both OTB and CTB group median values were 2.00 ± 1.00 . At first month review, V_1 the median values for both groups maintained at 2.00 ± 0.00 . The same values maintained at second month review, V_2 where OTB was 2.00 ± 0.00 and CTB was 2.00 ± 1.00 . During last review visit, V_3 the median values for OTB was 2.00 ± 1.00 and CTB was 2.00 ± 0.00 .

Overall mean values were 1.94 (SD=0.42) for the OTB group and 2.02 (SD=0.49) for CTB group. The mean's significant differences of OPI score between two groups was compared using Mann Whitney's U test and the resulted p value was found to be insignificant ($p > 0.05$) where p -value for OTB is 0.42 and $p = 0.65$ for CTB group.

These results suggested that there were no significant differences in plaque removal ability between OTB and CTB in patients undergoing fixed orthodontic treatment.

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Introduction

Decalcification or caries and gingival diseases are common adverse effects associated with fixed orthodontic treatment. This is due to the increase of plaque retention factors present in the mouth during active fixed orthodontic treatment such as brackets, bands, ligature wires, and elastomeric chains. A scanning electron microscopic examination looking at bacterial

colonization during orthodontic treatment found presence of mature plaque around orthodontic brackets within 2-3 weeks of bonding despite daily conventional oral hygiene measures¹. Richter et al., 2011 reported development of at least one white spot lesion in 72.9% of orthodontic patients². In 2005, observation using quantitative light-induced fluorescence (QLF) in patients receiving orthodontic treatment found at least 30% of patient's buccal surface will develop white spot lesion³. Karadas et al., in 2011 also found an increase of caries prevalence in both low and high caries-risk patients after orthodontic treatment⁴. An increase of plaque and gingival index measurement during first 3 months of bonding was also noted to be contributed to the plaque retention factors introduced in the mouth by fixed orthodontic appliances⁵. Lack of

*Corresponding author:

Zurairah Ibrahim

Faculty of Dentistry, Universiti Sains Islam Malaysia,
Kuala Lumpur, Malaysia.

E-mail: izurairah@usim.edu.my

emphasis to oral hygiene cleanliness especially around bracket and interdental areas will impose patients to the risk of developing caries and gingival diseases.

Prevention of dental caries and periodontal diseases caused by plaque requires daily effective toothbrushing practise by patient. This will be challenging for patients who are undergoing active fixed orthodontic treatment. Sarrutichart et al. have shown that mechanical cleaning is still required for removal of plaque especially at the surrounding areas of bonded bracket⁶. There were many clinical trials conducted to look at the differences of effectiveness between powered and manual toothbrush cleaning during fixed orthodontic treatment. There were a mixed of findings achieved from randomized clinical trials done by different groups looking at the effectiveness between manual and electric toothbrushes in orthodontic patients. Some studies concluded that the electric or powered toothbrushes are superior than manual toothbrushes in reduction of plaque^{7,8}. But there were several studies that found no differences in cleaning efficiency between electric or powered and manual toothbrushes by looking at plaque reduction and gingival inflammation^{9,10}.

However, there were limited studies done to compare the effectiveness between manual toothbrushes during orthodontic treatment. It is a known fact that an electric or powered toothbrush is more expensive than conventional manual toothbrush. Studies that show similar effectiveness between powered and manual toothbrushes^{9,10,11} suggest that conventional toothbrushes maybe sufficient to maintain good oral hygiene and plaque free mouth during fixed orthodontic treatment. Hence, it will be beneficial to investigate which type of manual toothbrushes that will be more effective in plaque removal for our orthodontic patients during treatment. A study by Rafe et al. in 2006 has managed to show that the triple-headed toothbrush is more effective than orthodontic and conventional toothbrushes during fixed orthodontic treatment¹². A conflicting finding by Williams et al., found a small but significant superiority of the orthodontic toothbrush in respect of plaque removal on the buccal surfaces, although this appeared to be confined to the anterior teeth. Nevertheless, they stated that there was no major differences found between orthodontic and a conventional

toothbrush in respect of gingivitis because it is unlikely that the differences between brushes elicited by this study are of clinical importance¹³. However in 2007, Arici et al. have emphasized on the use of interdental brush with orthodontic toothbrush to be more effective to remove plaque than curved-bristled toothbrush alone for orthodontic patients¹⁴.

Therefore, our randomized controlled trial was to compare the effectiveness of plaque removal between conventional and orthodontic toothbrush during 3 months of active orthodontic treatment.

Materials and methods

This research is a randomized controlled trial on patients ongoing fixed orthodontic treatment at Polyclinic USIM, aged between 16 to 35 years old conducted over 3 monthly review by two orthodontists. This study was conducted following guidelines from the Medical Ethics Committee, Faculty of Dentistry [USIM/FPg-MEC/2013/No. (8)]. Exclusion criteria are: patients who are having single arch treatment and patients who has underlying medical problems or active periodontal diseases.

The Oral Plaque Index (OPI), developed by Bieberhold et al. (Table 1) was used to record the current oral hygiene status of patients undergoing multibracket appliances and assess the risk of caries and gingivitis. The plaque accumulation on each tooth surface adjacent to the bracket (mesial, distal, occlusal/incisal and cervical) were evaluated. The dentition is divided into six sextants and scored from 0 to 4 (Figure 1).

Score	Criteria
0	No plaque deposits on the tooth surface surrounding bracket base.
1	Plaque deposit on one tooth surface at the bracket base.
2	Plaque deposit on two tooth surfaces at the bracket base.
3	Plaque deposit on three tooth surfaces at the bracket base.
4	Plaque deposit on four tooth surfaces at the bracket base and/or gingival inflammation indicators (plaque deposit near the gingiva do not necessarily have to be present).

Table 1. OPI scoring with criteria description.

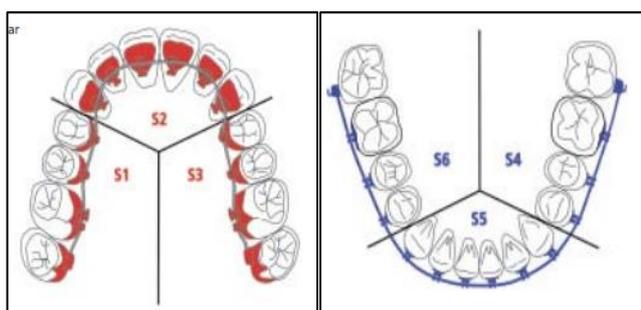


Figure 1. Division of the dentition into sextants.
 (With permission by Dr Dirk Ziebolz).

Intra and inter agreement scoring of plaque between two examiners was done on 10 orthodontic patients that were not involved in the study, and the agreement level between both examiners was almost perfect ($\kappa=0.95$).

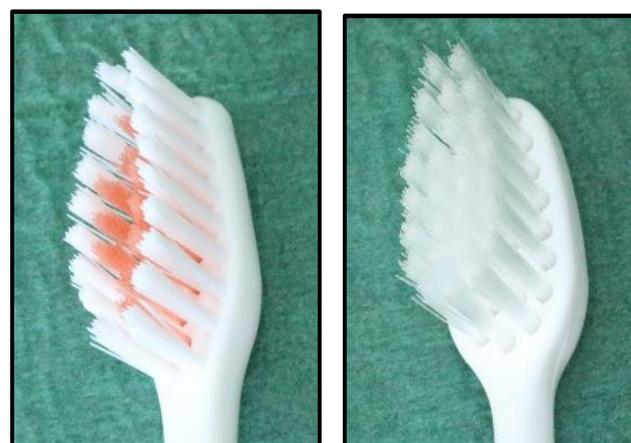
Initially, a total number of 58 patients was recruited for the study. Baseline OPI (V_0) was recorded after consent obtained from participants. Samples were divided randomly into two, where the first group of 29 patients received conventional toothbrush and the other 29 patients will be using orthodontic toothbrush (Figure 3). The toothbrushes that is used in this study are the Deep Clean and Orthodontic toothbrushes, manufactured by Colgate© (Figure 2). As seen in Figure 2, both toothbrushes are similar in size and shape. The obvious differences are the bristles arrangement, where the Deep Clean toothbrush has flat 0.05mm bristles arranged at the same level meanwhile the Orthodontic toothbrush has a deepened centre bristles that is meant for orthodontic brackets.



OTB CTB
 (i) Lateral view



OTB CTB
 (ii) Front view



OTB CTB
 (iii) At 45° angle view

Figure 2. (i – iii) showing the lateral, front and 45° angle view of orthodontic (OTB) and conventional toothbrush (CTB) from Colgate© that is used in this study.

Toothbrushes were handed out alternately by the research assistant to ensure equal number of participants for each group is recruited. Examiners were blinded as only the research assistant knows which group the participants are assigned to. All participants were instructed to follow a standardised oral hygiene care regime and is not allowed to use any mouth rinse during the period of study. Patient was asked to use the toothbrush for at least 2 minutes twice a day using modified bass technique with toothpaste given. All samples were supplied with oral hygiene care brochure, interdental brush and toothpaste. Patients were asked to brush their teeth before coming to each appointment visits and oral hygiene were reinforce throughout the research after every review visit.

The OPI for all participants were recorded at one-month review (V₁), at two-months review (V₂) and at last review (V₃) at three months after baseline. All scores recorded are then analysed using SPSS version 21 software.

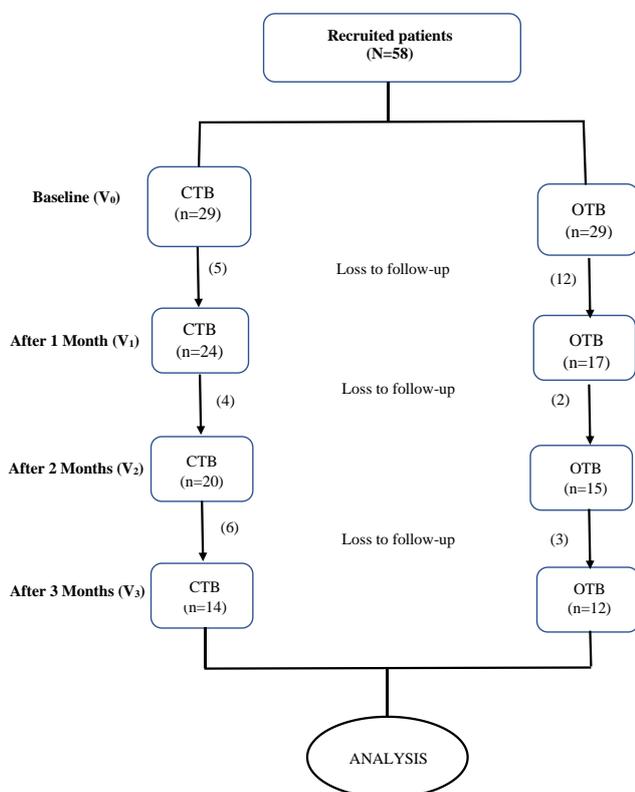


Figure 3. Flow chart showing number of samples for each group at every visit.

Statistical analysis

All the data collected was not normally distributed according to Shapiro Wilk test hence, median and inter quartile values were used for analysis. For comparison within the same group for each visit Friedman test was used meanwhile, error bar plot was used to check for significance between groups at each visit. Mann Whitney test was used for inter-group comparisons. Results were considered significant when *p*-value is less than 0.05 (*p*<0.05).

Results

At baseline, demographic analysis showed a total number of 58 patients (mean age of 21.32±4.17) with majority of samples recruited were female (47) and 11 males (Table 2). Majority of the participants were Malay (48), followed by Chinese (9) and Indian (1). There

was almost 50% drop out of samples at the end of the study making the total number of samples left to only 26, with 14 samples in the conventional toothbrush group and 12 in the orthodontic toothbrush group. There were balanced number of dropouts between OTB and CTB. The biggest number of patient loss to follow-up (17) was during the first review, leaving 24 patients in the conventional toothbrush group and 17 patients in the orthodontic toothbrush group. During the second review visit, another 6 patients were loss to follow-up leaving 20 patients in the conventional toothbrush group and 15 patients in the orthodontic toothbrush group. The reasons for drop out were mainly because patients were unable to comply to the appointment date as they have been admitted into boarding schools or colleges. There were also a few patients excluded because they did not use the toothbrush given as they thought it was too soft for them to use.

Characteristics	Freq (%)
Gender	
Male	11 (19.0)
Female	47 (81.0)
Ethnicity	
Malay	48
Chinese	1
Indian	9

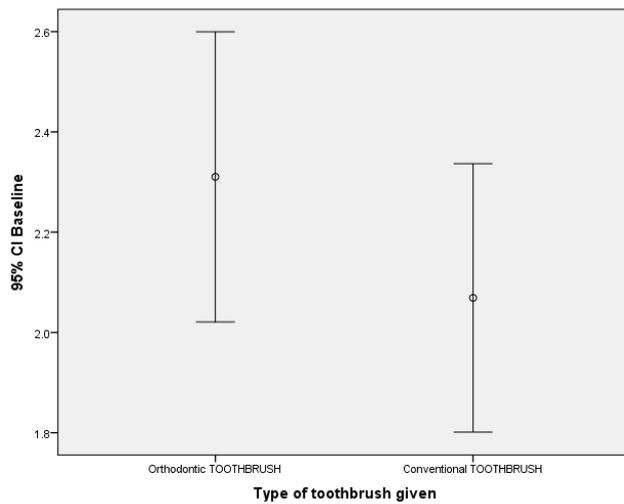
Table 2. summary characteristics of patient participated in this study based on gender and ethnicity.

Analysis within the same groups between the baseline to last review visit using Friedman test has shown that there was no significance difference in the OPI for both groups. For the conventional toothbrush [$\chi^2(df) = 2.610(3)$, *p*= 0.456] and the values for orthodontic toothbrush is [$\chi^2(df) = 1.824(3)$, *p*= 0.610] (Table 3). Comparison between groups showed that there were also no significant differences found between the orthodontic and conventional toothbrush groups (*p*-values > 0.05) (Figure 4).

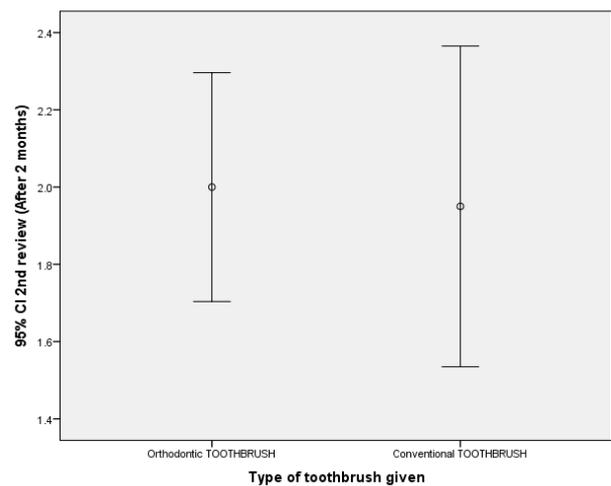
Visits	Oral Plaque Index (OPI) Median (IQR) value	
	OTB	CTB
Baseline (V ₀)	2.00 (1.00)	2.00 (1.00)
1 st review, after one month (V ₁)	2.00 (0.00)	2.00 (0.00)
2 nd review, after two months (V ₂)	2.00 (0.00)	2.00 (1.00)
3 rd review, after three months (V ₃)	2.00 (0.00)	2.00 (1.00)

p-value > 0.05 showed no significance between groups at every review visits (V₀ – V₃)

Table 3. Statistical analysis for comparison between CTB and OTB groups.

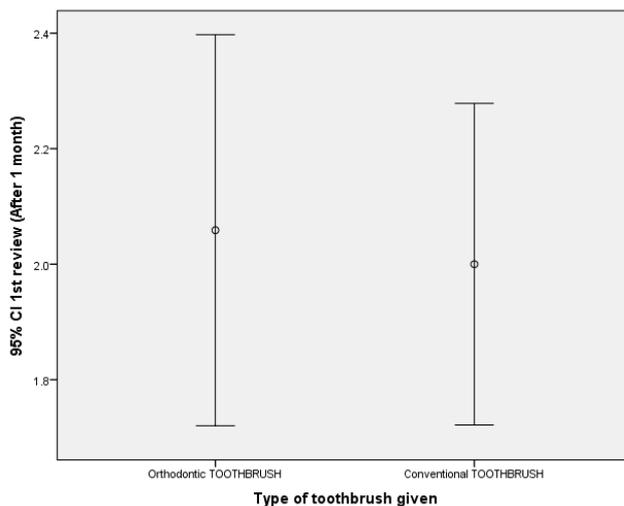


Graph 1: At baseline (V₀)

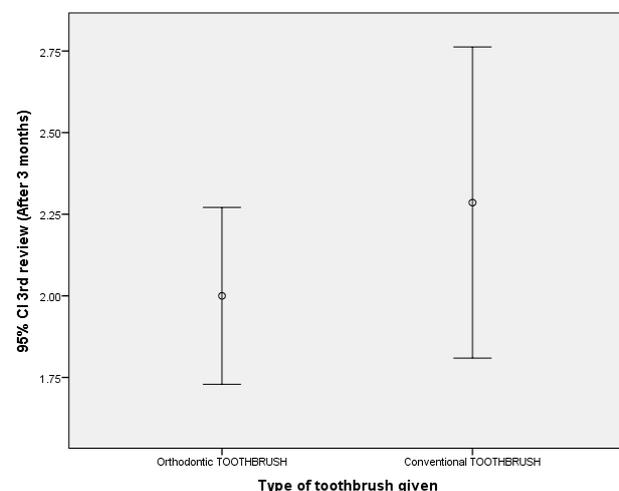


Graph 4: At last review (V₃)

Figure 4. Graph 1-4 showing oral plaque index (OPI) between both groups at every visit intervals (V₀ – V₃). Error bar plot showed no overlapping between two groups indicating no significant differences found between both groups.



Graph 2: At first review (V₁)



Graph 3: At second review (V₂)

Discussion

The aim of this study was to compare the effectiveness of two manual toothbrushes during fixed orthodontic treatment. Although there were many previous studies have showed that electrical or powered toothbrushes were more effective than conventional toothbrushes in orthodontic patient^{7,8} but, majority of patients still preferred manual toothbrushes either conventional or orthodontic toothbrush as it is cheaper and easier to use. As some studies^{9,10} have shown equal effectiveness in plaque removal between powered and manual toothbrushes for orthodontic patients, it will be beneficial to assess which of these manual toothbrushes is most effective for orthodontic patients to facilitate their oral hygiene care and minimising risk of decalcification and gingivitis during active orthodontic treatment.

Various steps were taken during the study to minimise bias between samples. This include ensuring all samples from both group had comparable OPI scores at start (V₀) and implementation of standardised plaque removal technique by all sample throughout the study by delivery of standardised oral hygiene steps after consent taken. Use of interdental brush by all samples during this study were emphasised as study by Arici et al.¹⁴ has shown that brushing

alone is not sufficient for elimination of plaque especially around bracket surroundings. Examiners were calibrated at start of study and blinded from knowing which groups the samples fall into.

Drop out of almost 50% of participants were due to a number of samples have to continue their studies at colleges/ university levels outside of Kuala Lumpur area after getting their higher secondary results and some could not commit to the respective appointment times given for follow up due to personal reasons. Although they were excluded from the study, certificate treatment was continued as usual.

Most of previous studies comparing effectiveness of toothbrushes in fixed orthodontic patients uses plaque index (PI)^{6,9,12,14} for the evaluation of plaque removal effectiveness and some study added gingival index (GI)^{7,9,10,12} to supplement their findings. Evaluation for plaque retention and gingival status for fixed orthodontic patients are slightly different as plaque tends to be accumulated at tooth surfaces surrounding the orthodontic base bracket and approximal surfaces. Most of the mentioned studies^{7,9} used orthodontic modified version of Silness and Loe index to enable better assessment to reflect amount of plaque around bracket base. At present there are only limited plaque indices developed specifically for evaluation of plaque retention in fixed orthodontic patients. There were some studies that used modified plaque index for orthodontic patients termed as plaque index bracket (PIB)⁶. Oral plaque index (OPI)¹⁵ was used instead of PI and GI in this study as it has the ability to gain the necessary information as mentioned above. The easy use of this index is also useful in facilitating the conduct of the study. Previous studies used various methods of plaque quantification apart from PI and GI, such as digitised photograph of stained plaque¹⁴ and quantification of *Strep. mutans* from salivary samples⁶ to support their findings.

Findings of this study is similar to Heasman et al. (1998) and Kiliçoğlu et al. (1997) where there were no differences found between conventional and orthodontic toothbrushes efficacy of plaque removal. Similar finding was noted by Hickman et al. (2002) where there were no significant differences in plaque, gingivitis and interdental bleeding between manual and orthodontic toothbrushes, although the orthodontic toothbrush used in this study was

powered toothbrush type.

In order to improve the study in the future, it is suggested that a higher number of samples be recruited to counter the high dropout number during the study. The length of study should also be increased to allow observation of the changes in plaque accumulation. It is worthwhile to know whether there are any differences at different stages of treatment such as alignment and space closure stages which obviously may have more plaque retention from the power chain or closing coil spring used at this stage.

Conclusions

This study has shown that both conventional toothbrush and orthodontic toothbrush were equally effective tools in removal of plaque during orthodontic treatment with fixed appliances. Although there were no significant differences found, majority of the patients prefer using orthodontic toothbrush as they claim that it is easier to clean the areas around the bonded bracket using the orthodontic toothbrush due to its unique bristle design.

Declaration of Interest

The authors report no conflict of interest and this study had been done by using financial from Universiti Sains Islam Malaysia under grant number PPP/USG-0116/FPG/30/13916.

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