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Comparative evaluation of effects of manual and powered tooth brushing on biofilm formation on metal orthodontic brackets and on gingival and periodontal health- an in-vivo study

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ABSTRACT

Aim: To evaluate and compare the effects of manual tooth brushing and powered tooth brushing on biofilm formation on metal orthodontic brackets and on gingival and periodontal health of the patient undergoing orthodontic treatment.

Materials and Methods: This randomized controlled clinical trial comprised a total of 36 patients in the age group 15-25 years, coming to Outpatient Department (OPD) of Orthodontics and Dentofacial Orthopedics and undergoing orthodontic treatment. Periodontal evaluation was performed for each patient at four intervals of time, before oral prophylaxis, 1 week after oral prophylaxis, after 3 months of bonding and after 6 months of bonding which constituted the readings at T_0, T_1, T_2 and T_3, respectively. Patients were instructed to use manual toothbrushes for 3 months after bonding. Post 3 months, the patients were divided into two groups- Group I and II as Group I- patients using powered toothbrush and Group II- patients using manual toothbrush, for next 3 months. At both the intervals (T_2 and T_3), two brackets were debonded from central incisors and second premolars from each patient and studied under scanning electron microscope for biofilm formation.

Results: Powered toothbrushing was more effective in reducing API and SBI scores, statistically high significant difference was seen in API score ($P = .004$) and SBI score ($P < .001$) between T_3 & T_2 time intervals on comparing both the groups. Both the manual and powered toothbrushing had equal effect on GI scores, no significant difference was seen in GI score ($P = .540$) between T_3 & T_2 time intervals on comparing both the groups. On inter group comparison of amount of biofilm formation between T2 & T3 time intervals in anterior and posterior region, higher amount of biofilm formation in both the anterior and posterior regions in group II patients (Anterior region= 12.05±6.90, $P = .001$, posterior region= 10.32±9.75, $P = .001$).

Conclusion: Powered toothbrushes are more effective in removing plaque and thus reducing gingival inflammation in patients with fixed orthodontic appliances.

1. Introduction

Individuals who seek orthodontic treatment to correct dental malocclusions often have difficulty in keeping their teeth clean due to malocclusion.[1] The insertion of fixed orthodontic appliances induces an increase in plaque formation associated with a qualitative bacterial shift from aerobic to anaerobic micro flora that endangers the integrity of hard and soft tissues.[2]

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In clinical studies, an increased incidence of incipient carious lesions and generalized gingival inflammation has been found in patients undergoing fixed orthodontic appliance therapy. The ecological changes in oral microbiota affect the composition, metabolic activity and pathogenicity of the biofilm and can be explained by a higher number of plaque-retentive sites and impaired mechanical plaque removal. Furthermore, it has been observed that the material and surface properties of the bracket can influence bacterial attachment, plaque retaining capacity and microbial diversity.[2] A significant relationship exists between bracket material and biofilm formation on bracket surfaces.[3,4]

The wires can be secured to the bracket by different methods that is, ligation with steel wires, with elastomeric ligatures or self-ligating brackets. Studies suggest that the elastomeric ligatures increase the retention of dental biofilm compared with the two other methods.[1–5] Recently, lingual treatment technique is being used, to meet the increasing esthetic expectations of orthodontic patients and studies have demonstrated increased biofilm formation with lingual brackets.[6]

Numerous clinical and laboratory studies have been conducted in patients receiving fixed orthodontic treatment which compared the effectiveness of different types of manual and powered toothbrushes with conventional and advanced designs. However, the results were found to be conflicting.[7] Hence, to overcome the lacunae in literature, the aim of the present study was to evaluate and compare the effects of manual tooth brushing and powered tooth brushing on biofilm formation on metal orthodontic brackets and on gingival and periodontal health of the patient undergoing orthodontic treatment.

2. Materials and Methods

It was a randomized controlled clinical trial conducted in the department of Orthodontics and Dentofacial Orthopaedics, Chhattisgarh Dental College and Research Institute, Rajnandgaon, Chhattisgarh. A total of 36 healthy patients (no infections or non-infectious diseases, example, HIV, diabetes) in the age range of 15 to 25 years, treated with fixed labial orthodontic appliance with stainless steel brackets, having crowding less than 5 mm and were able to understand and willing to follow the instructions were selected from the Out Patient Department (OPD) of Orthodontics and Dentofacial Orthopaedics and undergoing orthodontic treatment. Subjects with history of professional oral prophylaxis within 6 months before the start of the study, any systemic diseases, immunosuppressant drugs, mentally handicapped subjects, poor manual dexterity, history of periodontal disease or extensive dental restorations or missing central incisors or second premolars were excluded from the study.

A total of 36 patients meeting the inclusion criteria from the out-patient department, were enrolled in the study. Baseline periodontal evaluation that is, API, GI and SBI constituted the readings at T_0 and was performed as follows- API, given by Lange (1977)[8] is used to evaluate the level and rate of plaque formation on tooth surfaces, and to test the efficacy of oral care products for removal and prevention of plaque deposits from these surfaces. API was determined by moving a periodontal probe within the gingival sulcus, buccally in the first and third quadrants, and lingually in the second and fourth quadrants. The presence of plaque after probing was recorded as a positive finding. The API was calculated by dividing the number of positive findings by the number of examined sites, resulting in a percentage index. SBI is an index for assessment of gingival bleeding, developed by Muhlemann and Son.S (1971).[9] This index system is a modification of the papillary-marginal index of Muhlemann & Mazor (1958).[10] The presence of early inflammatory gingival disease can be assessed by gentle probing on the gingival sulcus. SBI was determined by moving a WHO probe within the gingival sulcus towards the papilla from both sides, buccally in the first and third quadrants, and lingually in the second and fourth quadrants. After 10-30 seconds, the results were recorded dichotomously as "+ if bleeding" and/or "- if not bleeding" for every interproximal area. The SBI was calculated by dividing the number of bleeding points by the number of probing sites, resulting in a percentage index. The GI given by Loe and Silness (1967)[11] is used to determine the gingival inflammation. This index scores the marginal and interproximal tissues of the gingiva separately on the basis of score 0 to 3. The GI was evaluated from each of the four gingival areas (buccal, mesial, lingual/palatal, and distal) of the tooth and was given a score from 0 to 3, as shown in the table given below.

Löe and Silness Gingival Index[11]

Table 1:

Score 0	Normal gingiva.
Score 1	Mild inflammation - slight change in color, slight edema. No bleeding on probing.
Score 2	Moderate inflammation - redness, edema, glazing. Bleeding on probing.
Score 3	Severe inflammation - marked redness and edema, ulceration. Tendency toward spontaneous bleeding.

The scores from the four areas of the tooth were added and divided by four to get the GI for the tooth. Finally, by adding the indices for the teeth and dividing them by the total number of teeth examined, the GI for the individual was obtained. The index for each subject was thus an average score for the areas examined. The study participants were subjected to professional oral prophylaxis and periodontal evaluation was repeated 1 week after

professional oral prophylaxis as described above. This constituted the readings at T_1. After periodontal evaluation, fixed labial orthodontic treatment was started and bonding of the Koden MBT 0.022" slot brackets using Koden orthodontic adhesive and Bluemax LED light curing unit was performed. The patients were instructed and trained to clean their teeth using toothpaste and Manual Toothbrush for 3 months. After 3 months, periodontal evaluation as described above was performed and readings at T_2 were obtained. A set of two quadrants (first and third quadrant / second and fourth quadrant) was randomly selected, using lottery system, in each patient. A bracket was debonded randomly from central incisor and second premolar from selected quadrant. Thus, two brackets were debonded from each patient. The brackets were carefully removed using J. J Orthodontics Bracket debonding plier without disrupting the biofilm layer and placed in a sterile tray. Immediately after debonding, new Koden MBT 0.022" slot brackets were bonded on the respective tooth. The debonded brackets were stored in separate boxes at room temperature.[6] The brackets were then studied under the SEM for quantitative analysis of biofilm formation, at T_2. Biofilm formation was screened using the Rutherford backscattering detection (RBSD) method on SEM. This technique measured the backscattering of high-energy electrons impinging on a sample. Due to different atomic weights, areas with lighter elements (example, carbon in biofilm) appeared as dark surfaces, and areas with heavier elements (example, iron in stainless steel brackets) appeared as bright surfaces. Biofilm was verified with SEM at high magnification. After conversion to a binary display, the extent of biofilm coverage was calculated based on the different grey values.[3] A binary image was obtained by determining the threshold value in the gray scale. The dark areas of the biofilm, the entire bracket surface area, and their ratio were calculated. Photomicrographs from the vestibular aspect of each bracket were obtained by RBSD method at 20 kV and 50X magnifications. The photomicrographs were analyzed for quantitative biofilm formation.[6] After bonding with new brackets, the patients were randomly divided into two groups (18 participants in each group), using lottery system. Group 1: Patients for Powered toothbrush; Group 2: Patients for Manual toothbrush. Group 1 patients were instructed and trained to clean their teeth using toothpaste and Powered toothbrush while Group 2 patients continued to clean their teeth using toothpaste and Manual toothbrush for next 3 months. After 3 months, periodontal evaluation as described previously was performed again and readings at T_3 were obtained. Then, the brackets were debonded and studied under SEM, at T_3 in a similar way as described above.

3. Statistical Analysis

Data obtained was compiled on a MS Office Excel Sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States). Data was subjected to statistical analysis using the Statistical package for social sciences (SPSS v 26.0, IBM). In this study, biofilm formation with manual and powered toothbrush as well as various periodontal evaluation such as approximal plaque index, sulcular bleeding index and gingival index were tested and compared. All the values for each index were recorded, tabulated, and statistically analyzed to calculate the mean and standard deviation for each group. All data was entered into a computer by a coding system and was checked to avoid any entry errors or repetitions. Descriptive statistics like frequencies and percentage for categorical data, Mean & SD for numerical data have been depicted. Friedman, Wilcoxon signed rank, Mann-Whitney U and Shapiro-Wilk test were the various tests used for testing of data.

4. Results

All 36 patients completed the study with no adverse effects reported by any of the subjects or noted by the examiner. No difference was found in the brushing skill of the patients with manual toothbrushes in reducing plaque on metal orthodontic brackets. No significant difference was seen in API (P = .249), SBI (P = .643) and GI (P = .104) values between T_2 & T_1 time intervals on comparing both the groups. The inter-group comparison of differences in values for API, SBI, GI score between T_2 & T_1 time intervals is shown in Table 1.

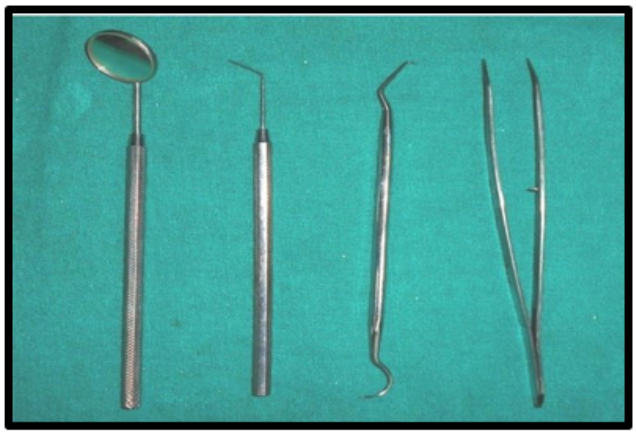

Figure 1: Diagnostic instruments

All the patients cleaned their teeth with equal efficiency in both the groups. The inter group comparison of values for API, SBI, GI at T2 time interval as shown in Table 2, showed statistically significant difference between the groups for GI score (P = .016). No statistically significant difference was observed for API (P = .248) and SBI (P = .086) scores.

Powered toothbrushing was found to be more effective in reducing API and SBI scores, as statistically high significant difference was seen in API score (P = .004) and SBI score (P < .001) between T_3 & T_2 time intervals on comparing both

Figure 2: Orthodontic bonding material

Figure 3: Colgate manual (Left) and powered toothbrush (Right)

the groups. Both the manual and powered toothbrushing had equal effect on GI scores, no significant difference was seen in GI score (P = .540) between T_3 & T_2 time intervals on comparing both the groups (Table 3).

At T_3 time interval, powered toothbrushes were found to be more effective in reducing gingival inflammation, statistically high significant difference for the values between the groups for all the three parameters (API, SBI and GI). API, SBI and GI showed higher values for group II patients (Manual toothbrushing) (API= 70.23±15.45, SBI= 73.61±15.97, GI= 0.72±0.12) (Table 4).

On inter group comparison of amount of biofilm formation between T2 & T3 time intervals in anterior and posterior region, higher amount of biofilm formation in both the anterior and posterior regions in group II patients (Anterior region= 12.05±6.90, P = .001, posterior region= 10.32±9.75, P = .001) (Table 5).

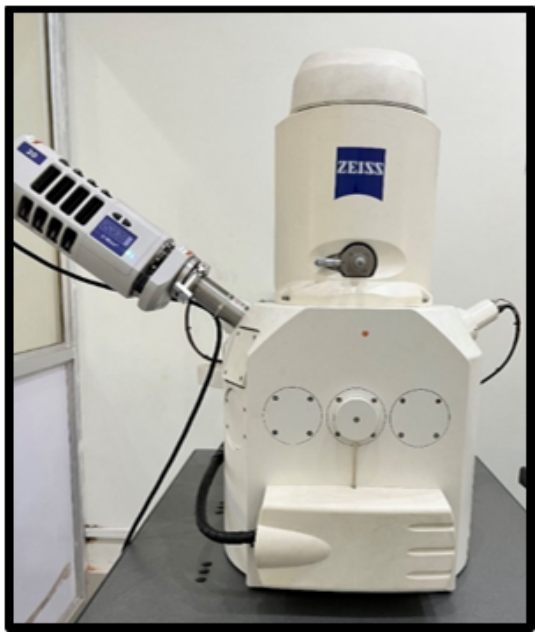

Figure 4: Scanning electron microscope

Figure 5: Setup of Scanning electron microscopy

Figure 6: Loading of samples for SEM testing

Table 2: Inter group comparison of differences in values for API, SBI, GI at T2-T1 time intervals using Mann-Whitney U test

	BT groups	N	Mean	Std. Deviation	Mann-Whitney U value	Z value	P value of Mann-Whitney U test
API T2-T1	II	18	29.16	23.089	160.000	-.157	.249#
	I	18	34.72	17.445			
SBI T2-T1	II	18	36.11	21.390	148.000	-.391	.643#
	I	18	34.72	17.44			
GI T2-T1	II	18	0.29	0.11	123.000	-.984	.104#
	I	18	0.30	0.088			

Table 3: Inter group comparison of values for API, SBI, GI at T2 time interval using Mann-Whitney U test

	BT groups	N	Mean	Std. Deviation	Mann-Whitney U value	Z value	P value of Mann-Whitney U test
API T2	II	18	66.67	17.150	129.000	-1.156	.248#
	I	18	59.72	17.445			
SBI T2	II	18	70.83	15.459	113.000	-1.716	.086#
	I	18	61.11	17.620			
GI T2	II	18	0.71528	0.127227	89.000	-2.420	.016*
	I	18	0.61111	0.134826			

Table 4: Inter group comparison of differences in values for API, SBI, GI at T3-T2 time intervals using Mann-Whitney U test

	BT groups	N	Mean	Std. Deviation	Mann-Whitney U value	Z value	P value of Mann-Whitney U test
API T3-T2	I	18	13.89	15.392	89.000	-2.856	.004**
	II	18	-4.16	9.587			
SBI T3-T2	I	18	9.72	15.192	67.500	-3.592	.000**
	II	18	-2.77	8.084			
GI T3-T2	I	18	0.028	0.101	144.000	-.613	.540#
	II	18	0.009	0.023			

Table 5: Inter group comparison of values for API, SBI, GI at T3 time interval usingmann-whitney U test

	BT T3	N	Mean	Std. Deviation	Mann-Whitney U value	Z value	P value of Mann-Whitney U test
API T3	II	18	70.83	15.458	15.000	-4.990	.000**
	I	18	45.83	9.587			
SBI T3	II	18	73.61	15.978	35.500	-4.243	.000**
	I	18	51.39	18.134			
GI T3	II	18	0.72466	0.12348	78.000	-2.751	.006**
	I	18	0.63889	0.12783			

Table 6: Inter group comparison of amount of biofilm formation between T2 & T3 time intervals in anterior and posterior region using t-test

	Group	N	Mean	Std. Deviation	t	P value
Anterior (T2-T3)	Group I	18	-2.7622	10.08652	5.144	.001*
	Group II	18	12.0594	6.90795		
Posterior (T2-T3)	Group I	18	-2.4328	8.55076	4.172	.001*
	Group II	18	10.3272	9.75928		

Figure 7: SEM images of upper central incisor bracket

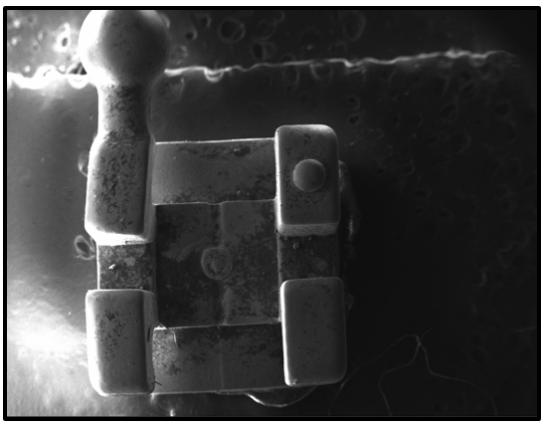

Figure 8: SEM images of upper second premolar bracket

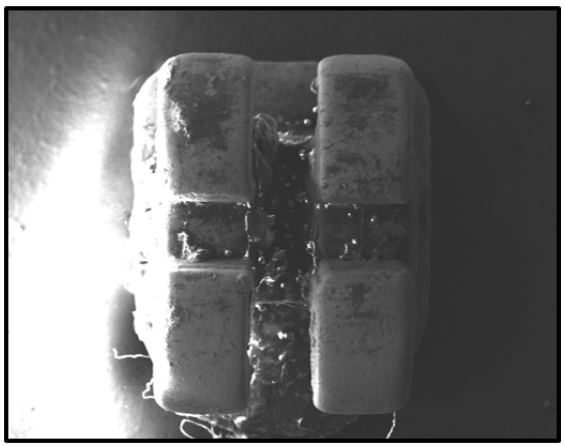

Figure 9: SEM images of lower central incisor bracket

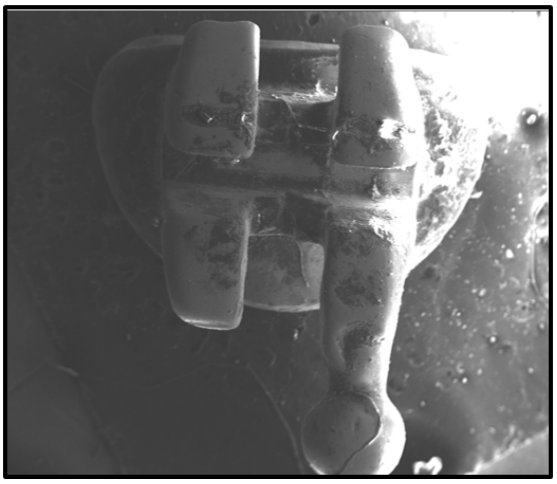

Figure 10: SEM images of lower second premolar bracket

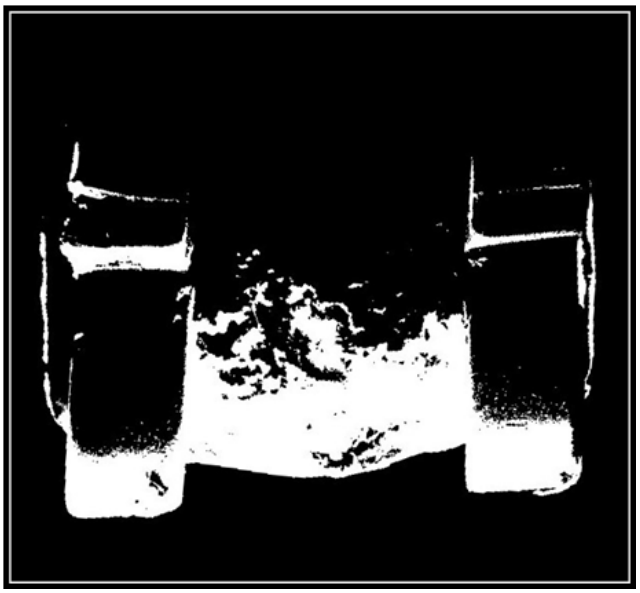

Figure 11: Binary image of a central incisor bracket

Figure 12: Periodontal evaluation at T_0

Figure 13: Periodontal evaluation at T_1

Figure 14: Periodontal evaluation at T_2

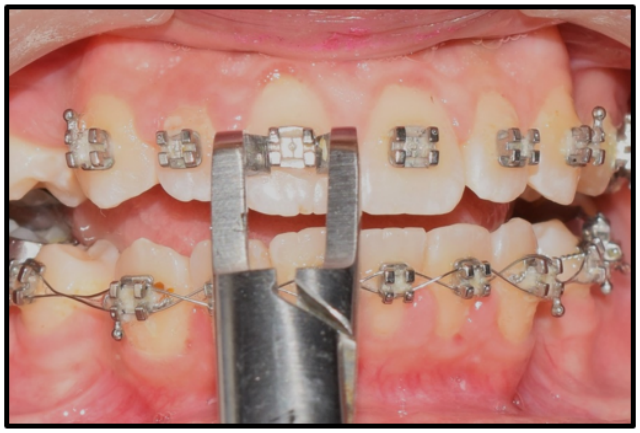

Figure 15: Debonding of the bracket for SEM evaluation

Figure 16: Periodontal evaluation at T_3

5. Discussion

Fixed orthodontic treatment allows three-dimensional correction of malocclusions.[12] Bonding of orthodontic brackets presents a major advancement in orthodontics after years of using multi banded fixed appliances.[13] Epidemiological and experimental studies have demonstrated that gingival inflammation, as well as dental caries, is dependent upon the presence of bacterial plaque on the teeth.[14]

The most interesting field of research presents the determination of periodontopathogenic bacterial changes in subgingival dental plaque in patients undergoing fixed orthodontic treatment.[15,16] This includes evaluation of quantitative and qualitative shifts of dangerous, black-pigmented anaerobes such as Prevotella inter media and Actinobacillus actinomycetemcomitans, the microbes solely responsible in the initiation and progression of periodontitis.[17–19]

The placement of fixed appliances not only encourages biofilm formation but also raises the level of acidogenic bacteria inside the biofilm.[20] If patients do not maintain good oral hygiene during orthodontic treatment, the dental biofilm will produce acids that lead to enamel demineralization and white spot lesions around the orthodontic appliance. Development of the biofilm is related to the presence of gingivitis, and greater the plaque accumulation, the higher the gingival bleeding index.[21,22] Because of the unpredictable nature of periodontal disease progression, orthodontic patients with gingivitis must be considered to be at risk of periodontal damage.

Toothbrushing is an important procedure to maintain oral hygiene and therefore, gingival, and periodontal health, during orthodontic treatment. There are many evidences that toothbrushing reduces gingivitis. It may prevent periodontitis and certainly prevents tooth decay if carried out in conjunction with fluoride toothpaste. These benefits occur whether the brush is manual or

powered and the results of review conducted by Lang et al do not indicate that toothbrushing is only worthwhile with a powered toothbrush.[13] This randomized controlled clinical trial provides important information on the efficacy of powered toothbrush, for the oral health of patients undergoing fixed orthodontic therapy, using scanning electron microscope.

The novelty of the present study was that in this study, along with periodontal evaluation i.e., API, SBI and GI, quantitative evaluation of amount of biofilm formation on metal orthodontic brackets under scanning electron microscope using Rutherford back scattering detection (RBSD) was done. The RBSD photomicrographs allowed the detection of biofilm-coated surfaces. Biofilm coverage was validated by using SEM with high magnification. In the RBSD technique, primary electrons leave the sample as a consequence of an elastic scattering process depending on atomic weight (Rutherford backscattering). In these element-contrast photomicrographs, surfaces covered with elements of low atomic weight (such as oral biofilms) give darker images than surfaces with a higher atomic weight (such as stainless steel) and software-assisted analysis of biofilm coverage can be performed on the basis of the resulting differences in grey values. Plaque- and non-plaque covered surfaces were differentiated on the basis of the grey values after conversion to a binary display. The extent of coverage with biofilm was calculated using surface analysis software (Image J software). A lesser ratio indicated less biofilm accumulation.[3–6]

In this study periodontal indices, including API, SBI and GI, were recorded at four sessions for each patient i.e., before oral prophylaxis (T_0), after oral prophylaxis (T_1), after 3 months of bonding (T_2) and after 6 months of bonding (T_3). 3 months after bonding, T_2 readings were recorded and then the participants were divided into two groups i.e., Group I- Powered toothbrushing & Group II- Manual toothbrushing, before which all patients were performing manual toothbrushing. The study design offered an advantage that effects of the two types of toothbrushes can be measured in the same participant as half of the study participants used manual toothbrush for first three months after bonding (T_1 to T_2) and then were asked to use powered toothbrush for the next three months (T_2 to T_3). These advantages include a decrease in within-subject confounding factors (e.g., age, gender, and hand skills). Also, intragroup comparisons could be made as group II patients continued manual toothbrushing for the entire 6 months of the study (T_1 to T_3) i.e., toothbrushing skill of individual patients could be evaluated.

It was observed that all the three periodontal indices scores i.e, API, SBI and GI increased significantly between T_1 & T_2 time intervals for patients of both the groups [API mean difference= -34.72±17.44, P = 0.000 (group I), mean difference= -29.16±23.08, p value = 0.001 (group II), SBI mean difference= -34.72±17.44, P = 0.000 (group I), mean difference= -36.11±21.39, P = 0.000 (group II), GI mean difference= 0.30±0.08, P = 0.000 (group I), mean difference= 0.29±0.11, P = 0.000 (group II)] and this increase in periodontal indices scores from T1 to T2 time intervals was expected because at T1, they were recorded immediately after oral prophylaxis. All the patients showed satisfactory and similar dexterity for cleaning their teeth using manual toothbrushing.

In group I patients, API and SBI scores improved significantly between T_2 & T_3 time intervals (API mean difference= 13.89±15.39, P = 0.004), SBI mean difference= 9.72 ±15.19, P = 0.020) while GI scores showed no significant difference was found between T_2 & T_3 time intervals (mean difference= 0.02±0.10, P = 0.248). The contrasting results of API & SBI scores being significant between T2 & T3 time intervals while GI scores being insignificant between T2 & T3 time intervals may be due to the fact that the API (Lange, 1977)[8] and SBI (Muhlemann and Son.S, 1971)[9] were evaluated dichotomously being either positive if the plaque/bleeding was present or negative if the plaque/bleeding was absent while GI (Loe and Silness, 1967)[11] was evaluated more specifically with scores ranging from 0-3 with 0= Normal gingiva, 1= Mild inflammation, 2= Moderate inflammation and 3= Severe inflammation. Hence, there was a difference in the method of evaluation of API & SBI as compared to that of GI.

In group II patients, API, SBI and GI scores showed no significant difference between T_2 & T_3 time intervals. (API mean difference= -4.16±9.59, P = 0.08, SBI mean difference= -4.55±11.64, P = 0.015, GI mean difference= 0.04±0.06, P = 0.223). Thus, on intragroup comparison, group I patients showed better cleaning efficiency with powered toothbrushing as compared to the first three months, when these participants were using manual toothbrush while the group II patients showed similar efficiency as they used manual toothbrushing for the entire six months.

In the study by P. Heaseman et al. (1998)[23] no significant difference was found in the reduction of API and SBI score on comparing different types of toothbrushes. Other studies by Lamendola-Sitenga K et al. (1998),[24] Veronique Thienpont et al. (2001)[25] also found no significant difference in reduction of API score on comparing different types of toothbrushes. Yılmaz Zafer Bilen et al. (2021),[26] Lahcen Ousehal et al. (2011)[27] found electric toothbrush to be more efficient than manual toothbrush in improving only the API scores while in the study by Boyd et al. (1989)[28] found electric toothbrush more efficient than manual toothbrushing in improving both the plaque index and bleeding index scores.

Seong-Joon Park et al (2005)[29] found no statistically significant differences in the SBI and GI scores between the electric and the manual toothbrush groups. While some

other studies conducted by Heymann P Ho et al (1997)[30] comparing Sonicare sonic toothbrush and a traditional manual toothbrush found reduction of SBI and GI scores was significantly greater in the Sonicare group than in the manual group ($P < 0.001$).

In the present study, at T_2 time interval, the highest amount of biofilm formation was seen on lower anterior region (78.40±12.60) while the lowest amount of biofilm formation was seen on upper anterior region (32.93±16.74). This can be attributed to the fact that a higher amount of plaque formation is seen in lower anteriors due to salivary proteins. No statistically significant difference ($P > 0.05$) was observed in the amount of biofilm formation between the two groups in all the four quadrants as well as in the anterior and posterior region of each quadrant. Thus, we can infer from the results that manual toothbrushing was effective in reducing the biofilm accumulation equally in all areas of the oral cavity if the patients are properly trained and they follow correct brushing technique.

As seen at T_2 time interval, the patients in both group I and group II showed the highest amount of biofilm formation on lower anterior region (Group I=71.70±12.34, Group II= 76.88±9.61) and the lowest amount on upper anterior region (Group I=32.49±12.76, Group II= 53.22±18.75) at T_3 time interval also, owing to the similar reason. Statistically significant difference ($p<0.05$) was observed in the amount of biofilm formation between the two groups in upper and lower left premolar region. This can be attributed to the fact that right-handed subjects are more successful in plaque control of the left quadrants and vice versa[31] and all the participants in current study were right-handed. Group II patients (manual tooth brushing) showed a higher amount of biofilm accumulation in both the regions. Thus, powered toothbrushing was more effective than manual toothbrushing, in reducing the amount of biofilm accumulation around orthodontic brackets, especially on the left premolar regions.

On comparing the amount of biofilm formation in anterior and posterior regions of the groups between T_2 & T_3 time intervals, statistically significant difference was found. Group II patients showed higher amount of biofilm formation in both the anterior and posterior regions (Anterior mean= 12.05±6.90, posterior mean= 10.32±9.75) i.e., patients who used manual toothbrush for the entire 6 months (from T_1 to T_3) after bonding showed higher amount of biofilm accumulation. Thus, we can infer from the results that powered toothbrushing was more effective in reducing the biofilm accumulation around the metal orthodontic brackets in both anterior and posterior regions.

There are no documented studies testing the amount of biofilm accumulation under scanning electron microscope on labial metal orthodontic brackets comparing the efficacy of manual and powered toothbrushing. But other SEM studies have been done evaluating the biofilm formation on different bracket materials i.e., ID Lindel et al (2011)[3] conducted a study to analyse the long-term impact of the bracket material (stainless steel and ceramic) on the extent of biofilm coverage under clinical conditions. They found that ceramic brackets exhibit less long-term biofilm accumulation than metal brackets. SB Yener et al (2020)[6] conducted a study to evaluate and compare the biofilm formation between labial and lingual orthodontic brackets. Total biofilm formation was 41.56% (min 29.43% to max 48.76%) on lingual brackets and 26.52% (min 21.61% to max 32.71%) on labial brackets. the biofilm accumulation on lingual orthodontic therapy was found to be more than labial orthodontic therapy. No difference was observed in intraoral location.

6. Limitations of the Study

Even after meticulous planning and precise execution of designed study some shortcomings are inevitably anticipated. Following are some of the limitations:

1. Equal number of brackets were not collected from each quadrant of every patient.
2. There is a risk of bias in the study due to patients' efficiency in brushing of teeth.
3. Qualitative evaluation of the biofilm was not done.

6.1. Further scope

Considering the length of treatment and the number of patients receiving treatment, it is important that toothbrush manufacturers and dental professionals continue to provide specialized products for plaque removal and to improve the designs of orthodontic toothbrushes. Also, in some patients fixed orthodontic treatment takes around 24-30 months to be completed which increases the chances of burnout of oral hygiene. Hence, a long-term study can be planned to evaluate the efficacy of the two brushes in maintaining oral hygiene. Better study standardization, more studies with a low risk of bias and sufficient sample size and reporting of longer follow-ups are necessary to enrich the available evidence, increase the precision of the observed effect estimates, and unequivocally guide clinical decisions. Qualitative evaluation of the biofilm to detect the presence or absence of periodontopathogenic bacteria in the accumulated biofilm to know the effect of formed biofilm on the gingival health of the patient could be done.

7. Conclusion

It can be concluded that powered toothbrushes are more effective in removing plaque and thus reducing gingival inflammation in patients with fixed orthodontic appliances. Orthodontists should also focus on increasing patients' awareness regarding the importance of oral hygiene maintenance and professional oral prophylaxis undergoing

fixed orthodontic treatment.

8. Source of Funding

None.

9. Conflict of Interest

None.

References

1. Shankar R, Mahalakshmi K, Murali RV, Padmavathy K, Balasubramanian S. Evaluation of Streptococcus Mutans Biofilm Retention by Three Different Types of Ligations on Orthodontic Brackets: An In-Vitro Scanning Electron Microscopic Study. *IOSR J Dent Med Sci*. 2014;13(6):70–4.
2. Demling A, Heuer W, Elter C, Heidenblut T, Bach FW, Polly RS, et al. Analysis of supra- and subgingival long-term biofilm formation on orthodontic bands. *Eur J Orthod*. 2009;31(2):202–8.
3. Lindel ID, Elter C, Heuer W, Heidenblut T, Stiesch M, Polly RS, et al. Comparative analysis of long-term biofilm formation on metal and ceramic brackets. *Angle Orthod*. 2011;81(5):907–21.
4. Brandão GA, Pereira AC, Brandão AM, De Almeida H, Motta RR. Does the bracket composition material influence initial biofilm formation? *Indian J Dent Res*. 2015;26(2):148–51.
5. Garcez AS, Suzuki SS, Ribeiro MS, Mada EY, Freitas AZ, Suzuki H. Biofilm retention by 3 methods of ligation on orthodontic brackets: a microbiologic and optical coherence tomography analysis. *Am J Orthod Dentofac Orthop*. 2011;140(4):193–201.
6. Yener SB, Özsoy Ö. Quantitative analysis of biofilm formation on labial and lingual bracket surfaces. *Angle Orthod*. 2020;90(1):100–8.
7. Yaacob M, Worthington HV, Deacon SA, Deery C, Walmsley AD, Robinson PG, et al. Powered versus manual toothbrushing for oral health. *Cochrane Datab Syst Rev*. 2014;6(6):2281. doi:10.1002/14651858.CD002281.pub3.
8. Lange DE, Plagmann HC, Eenboom A, Promesberger A. Clinical methods for the objective evaluation of oral hygiene. *Deutsche zahnarztliche Zeitschrift*. 1977;32:44–51.
9. Mühlemann HR, Son S. Gingival sulcus bleeding-a leading symptom in initial gingivitis. *Helv odontol Acta*. 1971;15(2):107–20.
10. Muhlemann HR. Gingivitis in Zurich schoolchildren. *Helv Odontol Acta*. 1958;2:3–12.
11. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontol*. 1967;38(6):610–6.
12. Demling A, Elter C, Heidenblut T, Bach FW, Hahn A, Polly RS, et al. Reduction of biofilm on orthodontic brackets with the use of a polytetrafluoroethylene coating. *Eur J Orthod*. 2010;32(4):414–22.
13. Zachrisson BU. Cause and prevention of injuries to teeth and supporting structures during orthodontic treatment. . *Am J Orthod*. 1976;69:285–300.
14. Lang NP, Cumming BR, Löe H. Toothbrushing frequency as it relates to plaque development and gingival health. *J Periodontol*. 1973;44:396–405.
15. Teanpaisan R, Douglas C, Walsh TF. Characterisation of blackpigmented anaerobes isolated from diseased and healthy periodontal sites. *J Periodont Res*. 1995;30:245–51.
16. Nonnenmacher C, Mutters R, De Jacoby L. Microbiological characteristics of subgingival microbiota in adult periodontitis, localized juvenile periodontitis and rapidly progressive periodontitis subjects. *Clin Microbiol Infect*. 2001;7:213–20.
17. Paolantonio M, Girolamo GD, Pedrazzoli V, Murro CD, Picciani C, Catamo G, et al. Occurrence of Actinobacillus actinomycetemcomitans in patients wearing orthodontic appliances. A crosssectional study. *J Clin Periodontol*. 1996;23:112–20.
18. Paolantonio M, Pedrazzoli V, Murro CD, Placido GD, Picciani C, Catamo G. Clinical significance of Actinobacillus actinomycetemcomitans in young individuals during orthodontic treatment. A 3-year longitudinal study. *J Clin Periodontol*. 1997;24:610–7.
19. Saito K, Takahashi N, Horiuchi H, Yamada T. Effects of glucose on formation of cytotoxic end-products and proteolytic activity of Prevotella intermedia, Prevotella nigrescens and Porphyromonas gingivalis. *J Periodont Res*. 2001;36:355–60.
20. Clerehugh V, Williams P, Shaw WC, Worthington HV, Warren P. A practice-based randomised controlled trial of the efficacy of an electric and a manual toothbrush on gingival health in patients with fixed orthodontic appliances. *J Dent*. 1998;26(8):633–42.
21. Chapman JA, Roberts WE, Eckert GJ, Kula KS, Cabezas G. Risk factors for incidence and severity of white spot lesions during treatment with fixed orthodontic appliances. *Am J Orthod Dentofac Orthop*. 2010;138:188–94.
22. Feldens EG, Kramer PF, Feldens CA, Ferreira SH. Distribution of plaque and gingivitis and associated factors in 3- to 5-year-old Brazilian children. *J Dent Child (Chic)*. 2006;73:4–10.
23. Heasman P, Wilson Z, Macgregor I, Kelly P. Comparative study of electric and manual toothbrushes in patients with fixed orthodontic appliances. *Am J Orthod Dentofac Orthop*. 1998;114:45–54.
24. Sitenga KL. Effectiveness of an ionic toothbrush on the removal of plaque in orthodontic patients: A clinical study. *J Dent Res*. 1998;77:123.
25. Thienpont V, Dermaut LR, Maele GV. Comparative study of 2 electric and 2 manual toothbrushes in patients with fixed orthodontic appliances. *Am J Orthod Dentofac Orthop*. 2001;120(4):353–60.
26. Bilen YZ, Çokakoğlu S, Öztürk F. The short-term effects of manual and interactive powered toothbrushes on the periodontal status of orthodontic patients: A randomized clinical trial. *J World Feder Orthod*. 2021;10(1):14–23.
27. Ousehal L, Lazrak L, Es-Said R, Hamdoune H, Elquars F, Khadija A. Evaluation of dental plaque control in patients wearing fixed orthodontic appliances: a clinical study. *Int Orthod*. 2011;9(1):140–55.
28. Boyd RL, Murray P, Robertson PB. Effect of rotary electric toothbrush versus manual toothbrush on periodontal status during orthodontic treatment. *Am J Orthod Dentofac Orthop*. 1989;96(4):342–9.
29. Park SJ, Lee KH, Hwang HS. Comparison of electric and manual toothbrushes on periodontal health in fixed orthodontic patients. . *korean J Orthod*. 2005;35:286–94.
30. Ho HP, Niederman R. Effectiveness of the Sonicare sonic toothbrush on reduction of plaque, gingivitis, probing pocket depth and subgingival bacteria in adolescent orthodontic patients. *The J Clin Dent*. 1997;8:15–24.
31. Anhoury P, Nathanson D, Hughes CV, Socransky S, Feres M, Chou LL. Microbial profile on metallic and ceramic bracket materials. . *The Angle Orthod*. 2002;72:338–81.

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