

# Plaque Removal Efficacy of Two Types of Toothbrush in Patients Undergoing Orthodontic Treatment with Fixed Appliance - A Comparative Study

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**Abstract:** *The purpose of this study was to investigate whether orthodontic toothbrushes were superior to classical toothbrushes in the elimination of microbial dental plaque on teeth and brackets and in the maintenance of periodontal tissue health in patients, aged 15 to 25 years, with fixed orthodontic appliances. Forty patients undergoing orthodontic treatment with fixed appliances and brushing with the Bass technique were included in the study. Twenty patients used the Orthodontic toothbrushes, whereas the remaining twenty patients used the conventional manual toothbrushes. Plaque Index (Turesky-Gilmore-Glickman) and Gingival Index (Loe H and Silness P) were recorded for all the subjects. Records were taken at the beginning of the study and at 1 month and 2 months after fixed orthodontic appliance was bonded. No statistically significant difference was found for Plaque Index and Gingival Index between Orthodontic toothbrush group and conventional manual toothbrush group when measurements were compared. This short-term study concluded that the Orthodontic toothbrush is not superior to the conventional manual toothbrush.*

**Keywords:** Orthodontic toothbrush, Conventional manual tooth brush, Plaque index, Gingival index, Modified Bass technique

## 1. Introduction

Patients undergoing orthodontic treatment with fixed appliances face a challenging oral hygiene situation. Orthodontic bands, brackets, and wires are impediments to brushing and flossing, thus facilitating the accumulation of plaque and compromising gingival health. It is well documented that orthodontic treatment with fixed appliances is accompanied by an increased risk of caries<sup>1,2</sup> and gingivitis<sup>3,4</sup>. Microbiological changes after the insertion of orthodontic appliances have been demonstrated. Increasing numbers of *Streptococcus mutans* and lactobacilli after bonding of fixed appliances have been described<sup>5</sup>. Other reports revealed statistically significant increases in suspected periodontal pathogens such as spirochetes, motile rods, and other gram-negative organisms<sup>6</sup>.

It is well established that dental plaque is an essential etiologic factor of caries and gingivitis. Bacterial plaque initiates an inflammatory process in the supporting structures of the tooth and, if allowed to continue, ultimately may lead to the loss of the teeth in most individuals.<sup>7</sup>

Applications of fluoride and/or antibacterial agents are recommended to reduce these unwanted side-effects<sup>8</sup>. Such measures are, however, dependent on either frequent professional oral hygiene or patient compliance. Sealing of

the enamel surface with resin-based bonding agents or even the application of veneers have been proposed to protect enamel against demineralization<sup>9,10</sup>.

Effective brushing of teeth is, however, still the most important preventive measure. Numerous types of toothbrushes have been designed and promoted for orthodontic patients. For preventing plaque accumulation side effects, oral hygiene performance by patients, especially adolescents who are the main part of orthodontic patients, is necessary. The aim of this study was to evaluate the efficacy of orthodontic toothbrush on oral hygiene indices in patients treated with fixed orthodontic appliances.

An important part of motivating the orthodontic patient is choosing oral hygiene tools that will best meet the individual's needs. Innovations in this field present numerous alternatives for the clinician<sup>11, 12, 13,14</sup>. These include electric toothbrushes<sup>11,13</sup>, orthodontic toothbrushes (OTs) with different brush head designs, oral irrigators<sup>15,16</sup>, dental flosses, and interproximal toothbrushes (ITs). Numerous studies have evaluated and compared these oral hygiene tools. A recent meta-analysis revealed that powered toothbrushes with a rotation oscillation action reduced plaque and gingivitis more than manual toothbrushing<sup>17</sup>. In particular, studies comparing manual with electric toothbrushes have presented conflicting results in orthodontic patients. While some studies suggest that

electric toothbrushes are superior to manual toothbrushes<sup>11,13,14</sup>, others report equal effectiveness in plaque removal<sup>18,19,20</sup>. In India, since powered toothbrushes are considered expensive, an alternative tool to good oral hygiene during orthodontic treatment is the orthodontic toothbrush.

Here a comparison is done on the plaque removal efficacy of conventional manual Colgate toothbrush and Colgate orthodontic toothbrush.

## 2. Review of Literature

**Heintze SD, Jost-Brinkmann PG, Loundos J [1996]** studied the effectiveness of three different types of electric toothbrushes compared with a manual technique in orthodontic patients. Wilcoxon rank testing for aggregated surfaces revealed statistically significantly lower plaque scores for Rota-dent than for the manual technique ( $p < 0.01$ ). For all other toothbrushes, no differences were found in comparison to the manual technique. For Plaque Indices of specific sites, statistical analysis revealed all electric toothbrushes to be equal to the manual technique. No differences in Gingival Bleeding Indices were found after 4 weeks with either toothbrush. Patients with poor oral hygiene who used Rota-dent and Braun Oral-B Plaque Remover OD5 had statistically significantly lower plaque scores compared with the manual technique ( $p < 0.01$ ;  $p < 0.05$ ); for patients with good oral hygiene, these differences were neutralized. It may be concluded that electric toothbrushes of the new generation are a real alternative to the often laborious manual tooth cleaning procedures used during active appliance therapy. Patients with poor oral hygiene may benefit from them especially because plaque removal can be achieved easier and faster.

**Hülya Kiliçoğlu, Melek Yildirim, Hülya Polater [1997]** compared the effectiveness of two types of toothbrushes on the oral hygiene of patients undergoing orthodontic treatment with fixed appliances. Quigley-Hein plaque index, bonded bracket index, sulcus bleeding index, and periodontal pocket depth measurements were made at the beginning of the study and a month later. No statistically significant difference was found for plaque, sulcus bleeding, and periodontal pocket depth between Oral B Ortho and Plus 35 groups when the preinvestigatory and postinvestigatory measurements for the vestibular and proximal surfaces of upper and lower teeth were compared. This short-term study concluded that the Ortho-type toothbrush is not superior to the Plus 35-type toothbrush.

**Trimpeneers LM, Wijgaerts IA, Grogard NA, Dermaut LR, Adriaens PA [1997]** compared the effectiveness of three different types of electric toothbrushes, i.e., Interplak, Philips, and Rotadent, with a manual multitufted toothbrush (Blend-a-Med), in removing supragingival plaque and in preventing the development of gingivitis in adolescent patients with fixed orthodontic appliances. The results demonstrated, in essence, for all parameters that the manual toothbrush was the most effective. Of the three electric toothbrushes tested, the Philips toothbrush seemed to give slightly better results than the Interplak toothbrush, whereas Rotadent very clearly gave results inferior to all others.

Personal preference on the four toothbrushes used revealed that the group as a whole least preferred a manual brush.

**Laher A, Kroon J, Booyens SJ [2003]** conducted a study to find out the effectiveness of four manual toothbrushes in a cohort of patients undergoing fixed orthodontic treatment in an academic training hospital. PI and GI values were relatively low at baseline as well as after the use of the toothbrushes. General linear model procedure showed no statistical difference between the Mean Plaque Index (MPI) before and after use of each toothbrush as well as the Difference in Mean Plaque Index (DMPI). There was a slight difference in the Difference in Mean Gingival Index (DMGI) between the Colgate Precision and Aquafresh toothbrush. For all the other comparisons general linear model procedure showed no difference between the Mean Gingival Index before and after use of each brush. There was no correlation between the toothbrush preferred by the patient and oral cleanliness as measured by DMPI and DMGI.

**Christoph Kossack and Paul-Georg Jost-Brinkmann [2005]** compared toothbrushes and interdental cleaning aids for reducing Plaque and Gingivitis in patients undergoing orthodontic treatment with fixed appliances. They concluded that Plaque and gingivitis can be reduced especially in patients with poor oral hygiene by using an interdental cleaning aid. In the long run, the Flosser FL-110 is more effective than multi-floss 3-phase dental floss.

**Marc Schätzle, Thomas Imfeld, Beatrice Senerand Patrick R. Schmidlin [2009]** studied the *in vitro* tooth cleaning efficacy of manual toothbrushes around brackets. In the most critical area of 2 mm around the brackets, there was no statistically significant difference between the different toothbrushes evaluated. Staged and v-shaped brush designs resulted in superior cleaning efficacy of teeth with fixed orthodontic attachments than toothbrushes with a planar bristle field. None of the tested toothbrushes showed a consistent, significantly higher cleaning efficacy than the others in this *in vitro* experiment.

**SyedAli Banihashemrad, Arezoo Jahanbin, Habibollah Esmaili, Minoosanaee Moghadam [2009]** studied the effect of the electrical versus manual toothbrush on oral hygiene indices in patients treated with fixed orthodontic appliances. The result of our study showed that electric toothbrush had no significant advantage over manual toothbrush. Manual brushing was even more effective than cross action power tooth brush in BPI reduction.

**Cunha LDD, Peruzzo DC, Costa LA, Pereira ALP, Benatti BB [2018]** studied effect of a single-tufted toothbrush on the control of dental biofilm in orthodontic patients. The results of the study showed that combination of single-tufted and conventional toothbrushes was effective for controlling dental biofilm formation in orthodontic patients.

**Terrana A, Rinchuse D, Zullo T, Marrone M [2019]** studied the plaque removal ability of a triple-headed tooth brush versus a conventional manual toothbrush in adolescents with fixed orthodontic appliances. The results

showed that the triple-headed toothbrush leads to a significantly lower plaque index compared to the conventional manual toothbrush post-brushing.

### 3. Aims and Objectives

- 1) To study the oral hygiene status of patients after starting fixed orthodontic treatment.
- 2) To compare the Plaque Index and Gingival Index of patients using Orthodontic toothbrush and Conventional manual toothbrush after bonding fixed orthodontic appliance.
- 3) To compare the plaque removal efficacy of Orthodontic toothbrush and Conventional manual toothbrush in patients with fixed orthodontic appliance.

### 4. Materials and Methods

The subjects for the study were selected from the patients seeking orthodontic treatment in Sinhgad Dental College and Hospital. The patients were assessed daily, over a period of two weeks, for their ability to follow oral hygiene instructions and maintain oral hygiene. Only those subjects who followed the instructions meticulously were included in the study.

Forty patients (18 males and 22 females) in the age group between 15 and 25 years participated in this study. Prior to the study, information about the study design was given to the subjects and informed consent was obtained. The patients were randomly divided into two groups comprising of 20 subjects each. One group received Colgate Orthodontic toothbrushes [Colgate-Palmolive (India) Ltd.] and the other group received conventional manual Colgate toothbrush.

A double-blind type of study was carried out. The subject and the doctor were unaware of the type of toothbrush used. A structured form was designed to collect demographic and dental variables, including patient's age, sex, type of toothbrush, plaque index and gingival index. Two indices mirroring the oral hygiene of the subjects were recorded i.e. Plaque Index (PI) and Gingival Index (GI). The same examiner carried out the indices for all patients.

Scaling and polishing of the teeth was done for all subjects. Baseline recording (0 months) of PI and GI was made for all patients just before strapping them up with fixed orthodontic appliance (0.022 MBT Gemini 3M). The patients were given oral hygiene instructions and method of toothbrush brushing on the same day of bonding. Clinical parameters of PI and GI for all subjects were recorded at 1 month and 2 months after strapping.

Group 1: Subjects were given Orthodontic toothbrush  
Group 2: Subjects were given conventional manual tooth brush.

Inclusion criteria consisted of subjects:

- 1) With good general health,
- 2) Without any systematic diseases,
- 3) Without disease known to affect oral tissues,

- 4) Who had not received any periodontal therapy for past 3 months,
- 5) Who had not taken any antibiotics or antiseptic mouthwashes since last one month prior to study,
- 6) With full complement of teeth, except third molars,
- 7) With ability to attend hospital at recall intervals.

Exclusion criteria consisted of subjects:

- 1) With orthodontic appliances,
- 2) Using any other supplemental plaque control methods,
- 3) With five or more carious teeth requiring immediate treatment,
- 4) With mucogingival problems like high frenal attachment,
- 5) With manual dexterity conditions,
- 6) Who were taking drugs that could affect state of gingival tissues including corticosteroids and nonsteroidal anti-inflammatory drugs.

#### Dentifrice used:

One brand of dentifrice Colgate Total ® was used throughout the experimental study.

#### Oral hygiene instructions

Standardized oral hygiene instructions were given to all subjects by the same clinical investigator at baseline and all subsequent visits. The subjects were advised to brush for 3 minutes in the morning and 3 minutes in the evening. The specific verbal instructions for each type of toothbrush were followed by a demonstration on a clinical model. The subjects were instructed to make ten strokes each on the labial, lingual and occlusal surfaces.

All patients were told to refrain from using dental floss, interproximal brushes, or other hygiene aids during the entire course of the study. They were not allowed to receive topical fluoride applications, neither to rinse with fluoride solutions nor any oral antiseptics.

#### Plaque Index (Turesky - Gilmore – Glickman 1970, Modification of Quigley-Hein plaque index)<sup>27</sup>

**Materials:** mouth mirror  
light source  
disclosing agent

#### Method

Plaque is assessed on the labial, buccal and lingual surfaces of all the teeth after using disclosing agent.

#### Scoring Criteria

This index is based on a numerical scale of 0 to 5.

Score	Criteria
0	No plaque
1	Separate flecks of plaque at the cervical margin of the tooth
2	A thin continuous band of plaque (upto 1 mm) at the cervical margin of the tooth
3	A band of plaque wider than 1 mm but covering less than one third of the crown of the tooth
4	Plaque covering at least one third but less than two thirds of the crown of the tooth
5	Plaque covering two thirds or more of the crown of the tooth

**Calculation:**

Index = Total score / number of surfaces examined

**Gingival Index (Loe H and Silness J)<sup>28</sup>**

**Materials:** mouth mirror

light source

probe.

**Method**

The severity of gingivitis is scored on all surfaces of all teeth. The teeth and gingivae were dried lightly by a blast of air and/or cotton rolls. The gingival tissues around each tooth were divided into four scoring units: distal-facial papilla, facial margin, mesial-facial papilla and the entire lingual gingival margin. A blunt instrument such as the periodontal pocket probe was used to assess the bleeding potential of the tissues.

Each of the four gingival units was assessed according to the following criteria:

Score	Criteria
0	Absence of inflammation/ Normal gingivae
1	Mild inflammation, slight change in colour, slight edema; no bleeding on probing
2	Moderate inflammation, moderate glazing, redness, edema and hypertrophy; bleeding on probing
3	Severe inflammation, marked redness and hypertrophy and ulceration; tendency of spontaneous bleeding

**Calculation:**

Gingival index: Totaling all scores per tooth/ Number of teeth examined. The numerical scores of the gingival index may be associated with varying degrees of clinical gingivitis as follows:

Gingival scores	Condition
0.1-1.0	Mild gingivitis
1.1-2.0	Moderate gingivitis
2.1-3.0	Severe gingivitis

**Biostatistical Analysis**

The biostatistical analysis was done using SPSS version 21. The test applied for comparison between group 1 and group 2 is unpaired t-test. The intragroup comparison for gingival and plaque index at M<sub>0</sub>, M<sub>1</sub>, M<sub>2</sub> was done using ANOVA (Analysis of variance) and Post Hoc were done using Tuskey HSD.

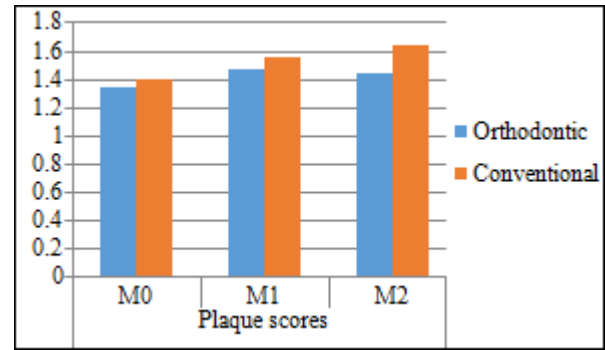
**5. Results and Discussion**

1) For Plaque Index

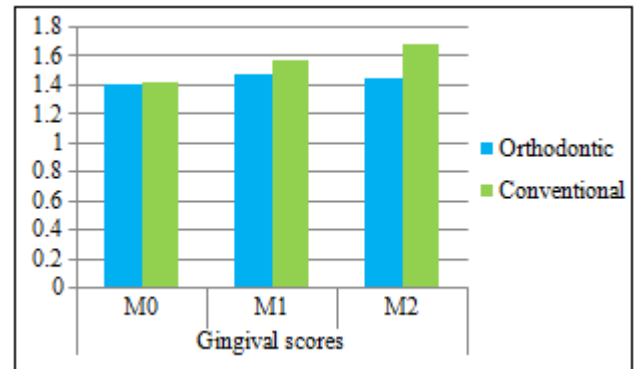
Type of Tooth Brush	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	P Value (Significant Value)
Orthodontic Tooth Brush	1.35	1.49	1.46	0.416
Conventional Tooth Brush	1.41	1.57	1.65	0.416
P Value (Significant Value)	0.543	0.434	0.138	

2) For Gingival Index

Type of Tooth Brush	M <sub>0</sub>	M <sub>1</sub>	M <sub>2</sub>	P Value (Significant Value)
Orthodontic Tooth Brush	1.41	1.48	1.45	0.838
Conventional Tooth Brush	1.43	1.58	1.69	0.838
P Value (Significant Value)	0.857	0.412	0.032	



Graph 1: Comparison of Plaque Index



Graph 2: Comparison of Gingival Index

The gingival index of M<sub>2</sub> was found to be significant with p<0.05 indicating reduced in plaque accumulation and decreased gingivitis.

The average Plaque Index of patients using Colgate Orthodontic toothbrush before fixed orthodontic appliance was bonded was 1.35, 1 month after bonding was 1.49 and 2 months after bonding was 1.46. The average Plaque Index of patients using conventional Colgate toothbrush before fixed orthodontic appliance was bonded was 1.41, 1 month after bonding was 1.57 and 2 months after bonding was 1.65.

The average Gingival Index of patients using Colgate Orthodontic toothbrush before fixed orthodontic appliance was bonded was 1.41, 1 month after bonding was 1.48 and 2 months after bonding was 1.45. The average Gingival Index of patients using conventional Colgate toothbrush before fixed orthodontic appliance was bonded was 1.43, 1 month after bonding was 1.58 and 2 months after bonding was 1.69.

A high standard of oral hygiene is essential for patients undergoing orthodontic treatment. Without good oral hygiene, plaque accumulates around the appliance, causing gingivitis and decalcification of the enamel. To avoid such problems, the orthodontist has a double obligation: to advise the patient about methods of plaque control and, at routine visits, to monitor the effectiveness of the oral-hygiene regime.

Patients with an orthodontic appliance are more susceptible to gingival inflammation and enamel decalcification. In particular, appliances increase the number of plaque retention areas. The only effective method of control is oral hygiene. Advice on hygiene, given to the patient undergoing appliance therapy, has three objectives: to prevent enamel

decalcification, to reduce gingival inflammation, and to reduce appliance breakage. Fixed orthodontic appliances can prevent both effective tooth brushing and the mechanical cleaning action of mastication, leading to plaque accumulation. Taking into consideration the long treatment times, emphasis must be placed on routine hygiene for the orthodontic patient, including professional tooth cleaning and home care instructions. Efficient mechanical removal of plaque has been shown to be the best means of plaque control (Basker, 1993). However, despite receiving appropriate advice, many patients undergoing orthodontic treatment fail to maintain an adequate standard of plaque control: they suffer from gingival inflammation and enamel decalcification.

In this study, the plaque removal efficacy of two commonly available and prescribed toothbrushes was tested. A double-blind type of study was done so as to prevent bias. The Group I patients did not know that they were given some special toothbrush (orthodontic toothbrush), so that they would not change the amount and method of brushing. The examiner noting the indices also did not know which patient had used which specific toothbrush to avoid a bias in recording the Plaque Index and Gingival Index.

The age group selected was between 15- 25 years so that they could follow the instructions given meticulously and the periodontium would be in relatively good health.

Patients were asked to brush twice daily, i.e., in the morning and in the evening. According to the literature, the efficacy of plaque removal differs for each toothbrush. However, for each individual toothbrush, the plaque removing efficacy increases with the brushing time. The major part of the plaque removing effect is reached after 30 seconds of brushing per quadrant. Other investigators standardized the duration of tooth brushing to 2 minutes. Because of the increased plaque retention, oral hygiene is even more time-consuming when fixed orthodontic appliances are in place. The brushing time in this study was arbitrarily set at 3 minutes.

Mouthwashes may be helpful to reduce dental plaque formation, although the application of topical fluorides is one of the most effective caries preventive methods. Therefore all patients were told to refrain from using dental floss, interproximal brushes, or other hygiene aids during the entire course of the study to maintain uniformity. They were not allowed to receive topical fluoride applications, neither to rinse with F-solutions nor any oral antiseptics.

Tooth brushing technique has a significant effect on plaque removal, but it is very difficult to influence personal tooth brushing behavior to maximize efficacy. A simple scrubbing technique is most commonly used consistently during brushing. Most people brush their teeth for a shorter than optimal period, many of them using techniques that are inadequate to remove plaque from the gingival margins and proximal surfaces, areas that are important in maintaining periodontal health. Given these constraints, a practical approach to improving dental health is to develop a more effective toothbrush, one that has the potential to remove plaque more completely from tooth surfaces.

Different studies comparing the plaque-removing efficacy of different tooth brushing methods have shown small or no differences<sup>44</sup>. In an attempt to facilitate plaque control in orthodontic patients, however, specially designed manual toothbrushes have been developed. Brushes with v-shaped longitudinal grooves trimmed into the bristle field were manufactured to improve brushing around brackets and arch wires, although their effectiveness in reducing gingivitis compared with conventional brushes is questionable. Such staged brushes showed significantly superior cleaning efficacy independent of the bracket area size in in-vitro experiment. The findings confirm the results of a previous in vitro study which showed that different bristle arrangements, such as lowered bristles in the middle of the brush field, have improved cleaning efficacy than planar bristle fields. Toothbrushes with a flat profile proved to be unsatisfactory for the cleaning of teeth with brackets. It has, however, also been shown that certain toothbrushes have different cleaning effects when used with varying degrees of force application. At high load, soft or fine bristles may become twisted resulting in a lower cleaning efficacy. With low force, interaction with the tooth surfaces increases, since soft bristles allow penetration into the interproximal and interbracket area.

The Turesky-Gilmore-Glickman modification of the Quigley-Hein Plaque Index (1970) is unique among the indices used for assessment of plaque because it is a reliable index for measuring plaque, using an estimate of the area of the tooth covered by plaque.

The Gingival Index was developed by Loe H and Silness J in 1963. It was developed solely for the purpose of assessing the severity of gingivitis and its location in four possible areas by examining only the qualitative changes of the gingival soft tissue. The GI is one of the most widely accepted and used gingival index due to its documented validity, reliability and ease of use.

## 6. Conclusion

This study found no difference in efficacy among Orthodontic toothbrush and the conventional manual toothbrush of patients in the age group 15-25 years undergoing fixed orthodontic treatment.

Therefore, orthodontists should focus on enhancing their patient's dental awareness and oral hygiene along with professional prophylaxis and fluoride applications.

Also the study will be more effective if the sample size selected was greater and the follow-up of the patients in the study was for over approximately 2 years.

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