

Comparison of Effectiveness of Manual and Powered Toothbrushes in Reduction of Plaque and Gingivitis-A Randomized Controlled Trial

Kasif Ahmad^{1*}, Anand Kishore², Sudhanshu Agrawal³, Komal S Sharma⁴, Garima Singh⁴ and Aparna Srivastava⁵

¹Pg Student (JR III), Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India

²Head of Department, Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India

³Professor, Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India

⁴Associate Professor, Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India

⁵Assistant Professor, Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India

***Corresponding Author:** Kasif Ahmad, Pg Student (JR III), Department of Periodontology, Chandra Dental College and Hospital, Barabanki, India.

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Abstract

Background: Plaque is intimately related to the production and progress of dental caries and inflammatory gingival and periodontal diseases. Good plaque control facilitates the return to health for patients with gingival and periodontal diseases. Daily use of a toothbrush and other oral hygiene aids is the most dependable way to achieve oral health benefits for all patients.

Methods: A randomized clinical trial was conducted to compare the efficacy of a powered toothbrush with a manual toothbrush in controlling plaque and gingivitis over a 6-week period. The sample consisted of 60 dental students of both sexes, with ages ranging from 18 to 28 years. The samples were stratified and randomly divided into two groups of 30 by a second examiner using the coin toss method; one group used a manual toothbrush and the other group used a powered toothbrush. Each participant's gingival index, plaque index and oral hygiene index were assessed on the seventh, 14th and 45th days on the basis of the assigned toothbrush. Collected data were analyzed and different subgroups were compared using Student's t-test.

Results: A paired t-test revealed a highly significant reduction in the gingival, plaque, and oral hygiene index scores of the manual and powered groups at the first, second, and sixth weeks (P-value, 0.0001). An unpaired t-test revealed a significant reduction between the plaque index scores of the manual and powered groups at the second week (P-value, 0.05). Another unpaired t-test revealed a highly significant reduction between the plaque index scores of the manual and powered groups at the sixth week (P-value, 0.0001).

Conclusion: The subject group using the powered toothbrush demonstrated clinical and statistical improvement in overall plaque scores. Powered toothbrushes offer an individual the ability to brush the teeth in a way that is optimal in terms of removing plaque and improving gingival health, conferring good brushing technique on all who use them, irrespective of manual dexterity or training.

Keywords: Plaque Control; Oral Hygiene; Powered Toothbrush

Introduction

In man, health and disease are not static conditions but exist on a continuum. Arbitrary points or boundaries are placed on this continuum to delineate specific diseases, but these boundaries are frequently for the convenience of rapidly describing in a word or short phrase where along health - disease continuum the individual or condition exists, rather than demarcating specific entities.

Oral hygiene has ancient roots, as people of all times have given importance to oral hygiene. The first reference of recognition towards maintenance of oral hygiene by people is in the form of "Chewing sticks". As early as 3500 BC, the Babylonians used chewing sticks taken from special aromatic trees designed to clean the teeth and freshen breath. Most common device used to achieve oral hygiene in the present era is the "Toothbrush".

Numerous manual and powered toothbrushes are available to assist consumers in their oral hygiene efforts. A high degree of patient skill, compliance and motivation is required to carryout tooth brushing with a manual toothbrush to achieve satisfactory levels of plaque removal. One approach to enhance the brushing effectiveness and ensure compliance has been the development of the electric toothbrushes.

Although a true electric toothbrush was first conceived in 1800s, it was not until the 1939's when it was reliably sold in Switzerland. Claims have been made that these are more effective than manual toothbrushes, as it leaves less room for patients to brush incorrectly [4,5].

Toothbrushes were synergistically used along with an adjunct called the "Toothpaste". Many toothpaste formulations were tested and became well established because of their anti-plaque and/or anti-gingivitis properties [6]. It is claimed that toothpaste has five major purposes: minimizing the buildup of plaque, strengthening of teeth against caries, removing staining, removing food debris, and freshening the mouth [7]. Toothbrushing with toothpaste is now perceived by the general public as to provide a number of cosmetic and health benefits.

Stein and Forward [8] validate the use of toothpaste because they found that there was reduction in plaque growth after brushing with toothpaste as opposed to brushing with water.

The bulk of evidence on the effectiveness of toothpaste in reducing plaque and gingivitis derives from long-term studies where toothpaste was used under real-life conditions and usually compared to control toothpaste. In such studies, the observed plaque and gingival indices were the results of combined use of the toothbrush/toothpaste.

In this respect it is difficult to differentiate the precise contribution of each factor (toothbrush or toothpaste) on observed plaque reduction and maintenance of gingival health. Hence a study was undertaken to assess the efficacy plaque removal and maintenance of gingival health using commercially available manual and powered toothbrushes with and without toothpaste.

Aim of the Study

To evaluate the role of toothpaste in efficacy of plaque removal and maintenance of gingival health.

Objectives of the Study:

- To evaluate the efficacy of plaque removal and maintenance of gingival health using manual and powered toothbrushes with toothpaste.
- To evaluate the efficacy of plaque removal and maintenance of gingival health using manual and powered toothbrushes without toothpaste.

Methodology

The present study was a randomized, examiner-blind, parallel design clinical trial Conducted over a near about 2 year period to assess the efficacy of plaque removal and maintenance of gingival health using manual and powered toothbrushes with and without toothpaste. The study was carried out among 24-57 yr old patients from Chandra Dental College and Hospital, Safedabad, Barabanki from the year 2022 to 2023.

Prior to the start of the study, various commercially available brands of fluoridated toothpastes, manual and powered toothbrushes were obtained. Requisition letters were mailed to the respective companies for the supply or funding for the same but, the response from these companies was poor and discouraging. The products found feasible to the study were short listed bearing in mind the expenditure and the following were purchased from a retailer by the investigator of the study (Picture 1).



Picture 1

The baseline data was obtained by clinical examinations performed by an examiner other than the principal investigator of this study. A fellow dentist carried out the examination and clinical evaluation of all the study subjects to avoid bias. Clinical assessments were in the form of recording the pre-brushing levels of disclosed plaque and gingivitis through plaque and gingival indices.

The examiner was calibrated in the Department of Periodontology of Chandra Dental College and Hospital, Safedabad, Barabanki before the start of the study. This examiner was blinded to the treatment randomizations.

Plaque index always preceded the gingival index. Plaque was assessed before brushing using the Turesky, *et al.* modified Quigley Hein plaque index. All clinical examinations were carried out before brushing using incandescent light source, plane mouth mirrors and blunt probes. Plaque scores were assessed after disclosing the subjects' teeth with ALPHAPLAC, plaque disclosing agent (Bombay Burmah Trading Corp., Uttarakhand). Subjects rinsed once with 5 drops of disclosing solution in 10 ml of water for 10 seconds and then rinsed twice with 10 ml of water for 10 seconds each. Exploratory analysis was used in similar studies to assess the efficacy of plaque removal between manual and powered toothbrushes. Such an exploratory analysis assesses plaque levels in relation to their position in the mouth (Whole mouth, Buccal, and Lingual) as this gave us an advantage in identifying the extent of plaque removal and maintenance of gingival health brought about by the intervention of the study.

Qualified subjects were randomly assigned using the lottery method to one of four treatment groups labelled as Group-A, Group-B, Group-C, and Group-D with brushing assignments known only to the investigator and the subjects.

Group	Tooth Brushing Assignment
A	Use of powered toothbrush only.
B	Use of powered toothbrush with toothpaste.
C	Use of manual toothbrush only.
D	Use of manual toothbrush with toothpaste.

Table

From 400 subjects included in the study after satisfying the inclusion and exclusion criteria all the Groups received 100 subjects each.

After the randomisation of subjects into different groups, a week before commencement of the study, subjects were given brief verbal instructions on the use of powered toothbrushes and demonstrations were given. The two groups assigned to use powered toothbrushes received the toothbrushes with instructions on their usage as a part of the familiarization phase for duration of one week.

After the familiarization phase of a week all subjects received oral prophylaxis (Picture 2) and entered the experimental gingivitis phase with equally clean teeth. They were then instructed to refrain from brushing all their teeth for 21 days.



Picture 2

After a test period of 30 days, all the subjects were recalled for the final examination, with their toothpaste tubes and toothbrushes. The collected toothpaste tubes indicated that all the participants had used the allocated toothpaste. Oral soft and hard tissues were examined, any adverse events were recorded, and plaque and gingivitis levels were assessed.

Results and Discussion

With toothpaste is arguably the most common method of oral hygiene practice among individuals and as a consequence toothpaste is considered as an agent for promoting oral health benefits. A lot of attention has been focused on toothpastes to control plaque and thereby improve gingival health. The present study was a randomized, examiner-blind, parallel design trial conducted to assess the efficacy of plaque removal and maintenance of gingival health using manual and powered toothbrushes with and without toothpaste. This clinical trial was conducted over a near about 2 years period among 24 - 57 year old patients from OPD of Department of Periodontology of Chandra Dental College and Hospital, Safedabad, Barabanki.

Tooth brushing is a complex process where several factors interact: the toothpaste, with its unique formulation (chemotherapeutic agents), the toothbrush (design, force, frequency, motion and filament stiffness) and the individual (dexterity, brushing manner and motivation). It is difficult to differentiate the effect of each of those factors on plaque removal and gingival health maintenance. In the

present study, by using toothpaste with no active chemical anti-plaque or anti-gingivitis factors, any possible effects of those factors on mechanical plaque removal and reversal of gingivitis were avoided. The toothbrush related factors were controlled by providing all the subjects with the same type of manual or powered toothbrush. Furthermore, a familiarisation period was allowed for the subjects to get accustomed to the new toothbrushes. In all, the study design of the present investigation offered the possibility to evaluate the adjuvant effect of the toothpaste on plaque removal and maintenance of gingival health using both manual and powered toothbrushes.

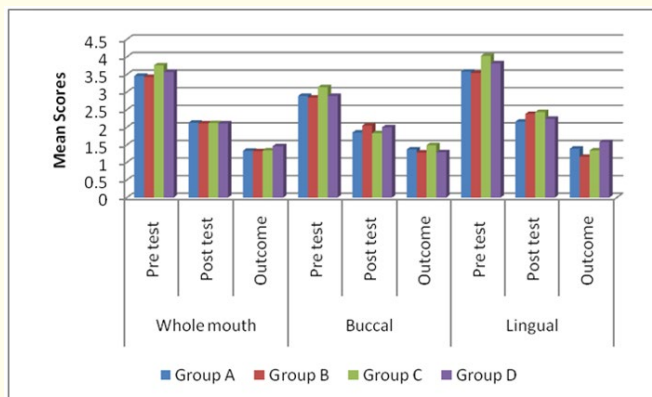
The study period was restricted for 30 days, in accordance with the regulations laid down by ADA for short term clinical trials commonly used to evaluate changes in gingivitis following use of any form of oral hygiene aids. The other factors limiting the duration of the study were availability of study subjects, examinations, holidays, academic activities of the school and limited resources like the availability of toothbrushes, toothpastes and time constraints.

A total of 400 study subjects were randomly assigned to four groups, two manual toothbrush user groups, two powered toothbrush user groups, with one group among these two groups using toothpaste and the other using the toothbrush alone.

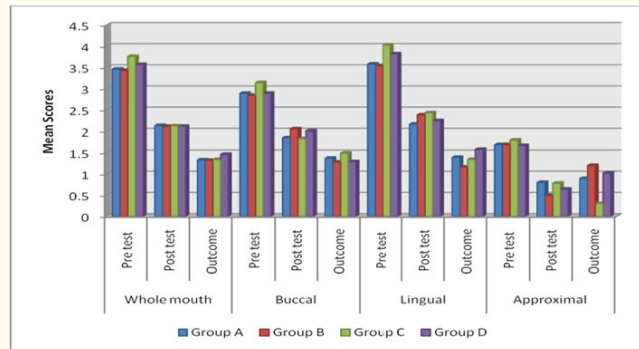
Each group consisted of 100 subjects. These study subjects were followed up for a period of 30 days.

The outcome of each intervention was analysed using the difference in index scores from the pre-intervention scores and the final examinations scores brought about by the intervention. The Plaque Index scores of the outcome after intervention were similar among all the four groups at different surfaces with no statistically significant difference. Similarly the gingival index scores did not differ much among all the four groups at the outcome after intervention of the study except between Group C (group brushing with manual toothbrush without toothpaste) and Group B (group brushing with powered toothbrush with toothpaste) for the Approximal site. Hence, further multiple group comparisons were carried out.

The present study compared the groups using powered toothbrushes without toothpaste (Group A) and manual toothbrushes without toothpaste (Group C). The results revealed that the powered toothbrush were similar to the manual toothbrush in removal of plaque when used without toothpaste and there was no statistically significant difference between the plaque index scores (P-Value = 0.967) (Graph 1). Similar results were obtained for the gingival index scores which showed no statistically significant difference (P-Value = 0.781) (Graph 2). In other words, there was no statistically significant difference brought about by the use of either powered or manual toothbrushes without toothpaste in reduction of plaque and gingivitis levels.



Graph 1: Showing the mean plaque index scores at different phases of the study.



Graph 2: Showing the mean gingival index scores at different phases of the study.

The fact that manual tooth brushing without toothpaste can remove substantial amounts of plaque was already known from previous studies. The study conducted by Paraskevas S., *et al.* indicate no role played by addition of toothpaste in plaque reduction as brushing without toothpaste resulted in 3% more overall plaque reduction than brushing with toothpaste. The study concluded that the function of the toothpaste in plaque removal can be questioned.

The present study compared a manual toothbrush with toothpaste (Group D) against powered toothbrush with toothpaste (Group B). The results revealed that Group D was 2% more efficient in plaque removal compared to Group B but, no statistically significant difference existed (p value = 0.505) between them (Graph 1 and 2).

These results were dissimilar compared to studies of Heasman., *et al.* who concluded that the powered toothbrushes were 4% more efficient in plaque removal but, the differences were not statistically significant and Deery C., *et al.* reported an 11% reduction in plaque but, no statistically significant difference except for the Oscillating/Rotating type of powered toothbrushes and also quotes that the clinical significance for this reduction is unknown.

Whereas, in the study conducted by Cronin., *et al.* it is stated that the powered toothbrushes brought about a significant reduction.

Tooth brushing (11%) of plaque compared to the manual toothbrushes. This difference is attributed to the use of Oscillating/Rotating type of powered toothbrushes in their study. Another study conducted by Stolze K and Bay L stated 41% more plaque removal using powered toothbrushes with a statistically significant difference between them. This noticed difference had been attributed to the phenomenon known as 'Hawthorne effect'. Hawthorne effect is a positive change in the behaviour of a subject as a result of the special attention and status received from the participation in an investigation. Andrew R Dentino., *et al.* also report a 8% reduction of plaque in the favour of powered toothbrushes. These powered toothbrushes of the Oscillating/Rotating type with the advantage of an automatic 2-minute timer showed increased compliance by the subjects hence the significant difference.

The results obtained in the present study for plaque removal show no difference between groups. This may be attributed to the role played by the toothbrush bristles in mechanical removal of plaque from tooth surfaces and no role played by toothpaste.

Safety assessment

Both manual and powered toothbrushes were found to be safe over 30 days of product use. Observations of the hard and soft tissues showed no abnormalities. These observations were similar to the study conducted by Andrew R Dentino., *et al.* where no abnormalities were recorded between groups for either brushes.

Conclusion

In conclusion, the results of the present study suggest that the powered toothbrushes were similar to the conventional manual toothbrushes in plaque removal and maintenance of gingival health. It is suggested that the existing powered toothbrush designs receive more rigorous testing and modification so that the powered brushes can be more effective in bacterial plaque removal as compared to that accomplished with a manual toothbrush combined with the use of an interproximal aid. Both manual and powered toothbrushes with and without toothpastes used for 30 days in the present study have shown no statistically significant reduction in plaque as well as gingivitis for all the surfaces. In the present study a statistically significant result was obtained between group B and group C. This difference is attributed to the phenomenon known as the 'Novelty effect'.

Finally it can be concluded that the use of toothpaste did not contribute to mechanical plaque removal during manual and powered tooth brushing. It seemed that the mechanical action provided by the toothbrush was the main factor in the plaque removing process and in turn maintenance of gingival health.

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