

**Effectiveness of multipurpose toothbrushes in reducing debris, plaque and gingival inflammation**

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**Abstract**

**Introduction:** Efficient Plaque control is required in maintaining oral health. Removal of plaque using mechanical method is considered to be the gold standard. The toothbrush having multi- bristles remove plaque efficiently on free surfaces and for the proximal surfaces mechanical interdental aids like dental floss are used. The present study thus analysed three different manual toothbrushes on debris, gingival and plaque score.

**Methods and Material:** 100 patients with the age range of 18-45 years were selected for using three different toothbrushes test product I (Colgate 360<sup>0</sup> whole mouth clean) which has multifunctional bristles, test product II (Colgate 360<sup>0</sup> charcoal gold) which has charcoal spiral bristles and test product III (Colgate Superflexi, tongue

cleaner and dental floss) which has a flexible neck allocated in a sequential manner to each of the participants. Oral hygiene index simplified (Green JC and Vermillion JR), Modified gingival index (Lobene et al) and Plaque index (Ture sky Gilmore Glickman modification of Quigley-Hein) were recorded at baseline and on 14th day. A washout period of 7 days was provided between the use of each test products.

**Results:** Test product I (Colgate 360<sup>0</sup> whole mouth clean) was statistically significant in reducing debris, calculus and gingival inflammation with a p value of 0.001 as compared to test product II (Colgate 360<sup>0</sup> charcoal gold) and test product III (Colgate superflexi, dental floss and tongue cleaner).

**Conclusions:** Colgate 360<sup>0</sup> whole mouth clean was better in reducing debris, gingival inflammation when

compared to the other test products owing to its soft and flexible bristle design which penetrates in hard-to-reach area.

**Keywords:** Dental plaque, oral hygiene index, plaque index, toothbrushing

### **Introduction**

Plaque control involves regular removal of microbial plaque through various mechanical and chemical methods. Out of all the mechanical methods, plaque removal using mechanical tooth brushes is considered to be the gold standard method.<sup>1,2,3</sup> Along with toothbrushes various interdental cleaning agents which aids plaque removal are dental floss, interdental brushes, wooden picks, proxa toothbrush. Among interdental cleaning aids, dental floss if used properly is considered to be an effective way of plaque disintegration when the teeth contacts are tight.<sup>4,5,6</sup> The tongue which occupies a huge area in the oral cavity also harbours microorganisms including periodontopathic bacteria.<sup>7,8,9</sup> Therefore, to maintain an overall oral health it becomes necessary to use manual toothbrush, interdental aids and tongue cleaner as well.

A large number of long-term studies in recent years about manual tooth brushes with a novel design have been showed but their results have been somewhat unsatisfying.<sup>10,11</sup>

Hence to delineate this, the present study was conducted to evaluate the effectiveness of two multipurpose toothbrushes and a regular toothbrush along with the dental floss and a tongue cleaner in reducing plaque, gingival inflammation and bleeding.

### **Subjects and methods**

A crossover randomized clinical trail was conducted between October 2019 to March 2020 to evaluate and compare the efficacy of three different commercially available tooth brushes on plaque, gingival inflammation

and bleeding. After granting the ethical clearance for the study from the Institutional Ethical Committee, patients in the age range of 18-45 years were screened from the Out Patient Department. 105 patients were initially selected for the study, out of which 100 patients who were willing to participate in the study were explained about the research protocol and written informed consent was taken.

### **Inclusion criteria**

- Patients with good general health
- 18 to 45 years age group patients
- Minimum of twenty scorable teeth excluding 3<sup>rd</sup> molars
- Patients keen to refrain from all other oral hygiene procedures for the complete period of the study, including the use of proximal cleaning products and mouth rinses
- Patients keen to obey with the study protocol

### **Exclusion criteria**

- Orthodontic appliances or any prosthesis
- Maligned teeth
- Any physical restraint which might impede normal oral hygiene measures
- Have received antibiotic therapy within last 28 days prior to the start of the study
- Pregnancy or lactation
- Carious lesions
- Currently participating in any other trial or study of the oral cavity.

### **Procedure**

During the first visit participant's demographic data which included their age, gender, general health status and current medication usage were assessed and recorded. Dental explorer number 17/23, dental mirror number 5 and UNC 15 probe were used to assess the

periodontal status. Baseline recordings of indices was done for all the selected patients. Oral hygiene index simplified (Green JC and Vermillion JR),<sup>12</sup> Modified gingival index (Lobene et al)<sup>13</sup> and Plaque index (Ture sky Gilmore Glickman modification of Quigley-Hein)<sup>14</sup> were recorded. The draw of lot was held in the presence of two investigators. If the patient drew out the first test slip, the sequence to be followed by him/her was in the order of the toothbrush I-II-III. If the patient drew out the second slip, the sequence was in the order of II-III-I, if the patient drew out the third slip, the sequence was in the order of III-I-II.

Accordingly, three test products were allotted to the study participants (Figure 1)

**Test Product I:** toothbrush with multi functioning bristles and raised cleaning tips

**Test Product II:** toothbrush with charcoal spiral bristles

**Test Product III:** toothbrush with flexible neck, dental floss and a tongue cleaner

The test product I has multi functioning bristles which helps to clean in between teeth and along the gingival crevice. It has raised cleaning tips to reach around all the interproximal spaces.

The test product II has charcoal spiral bristles which clean and remove stains. Its bristle has antimicrobial properties which fight against the microbial growth on the brush.

The test product III has a flexible neck to clean areas which is hard to reach in the mouth.

Oral hygiene instructions were given to the patients. To achieve standardization, each participant was provided with a common dentifrice. Modified bass toothbrushing technique was demonstrated to the participants and instructed to follow the technique throughout the study period. Test products were allocated in any of the sequence (I-II-III, II-III-I, III-I-II). Clinical parameters

recorded were Oral hygiene index Simplified (Green JC and Vermillion JR), Modified gingival index (Lobene et al) and Plaque index (Ture sky Gilmore Glickman modification of Quigley-Hein). All the clinical indices were recorded at baseline i.e. before the beginning of the use of the respective Test Products(I/II/III), depending on the allocation by a trained examiner who was blinded for the toothbrush type. Once participants used the first Test Product for 14 days, the clinical parameters were recorded again on 14<sup>th</sup> day. Thereafter, a washout period of 7 days was there in which participants returned to their previously used toothbrush and toothpaste before starting with the next test product till the participant completed one round of using all the test products. (Figure 2)

## Results

The study included a total of 100 participants [36 males and 64 females] following the inclusion and exclusion criteria. The mean age of the study population was 29.16 ±7.39 and the age range was 18 to 45 years. Descriptive statistics was performed by calculating mean and standard deviation for the continuous variables. Categorical variables are presented as absolute numbers and percentage.

One-way ANOVA (Analysis of Variance) test was used for comparison of difference between mean values of more than 2 groups when the data followed normal distribution. Post-hoc Bonferroni tests were used for the inter-group comparisons. Post hoc tests attempted to control the experiment wise error rate (usually alpha = 0.05) in the same manner that the one-way ANOVA was used instead of multiple t-tests. Paired t-test was used for comparison of mean values between the groups. The p-value less than 0.05 was considered to be significant with the confidence interval of 95%.

### Oral hygiene index simplified

The baseline and 14<sup>th</sup> day scores of test product I, test product II and test product III are shown in Table 1. On intragroup comparison, a statistically significant reduction was seen in the test product I ( $p=0.001$ ) and test product II ( $p=0.018$ ), whereas test product III showed non-significant reduction ( $p=0.101$ ) in OHI-S score (Table 1). On comparing test product, I with test product II and III, a mean difference of 0.080 ( $p=0.305$ ) and 0.090 ( $p=0.202$ ) was obtained respectively. Further test product II when compared with the test product III, a mean difference of 0.0096 ( $p=1.00$ ) was obtained. However, no statistical significant values were obtained on comparison of all the 3 test products (Table 2).

### Modified gingival index

The baseline and 14<sup>th</sup> day scores of test product I, test product II and test product III are given in Table 3. On intragroup comparison a statistically significant reduction was seen in test product I ( $p=0.001$ ) & test product II ( $p=0.016$ ) whereas test product III showed non-significant reduction ( $p=0.205$ ) in MGI score (Table 3). The mean MGI scores of all the test products at baseline and 14<sup>th</sup> day showed a non-significant relation between the values ( $p=0.937$ ) and ( $p=0.330$ ) respectively. The mean difference of MGI scores of test product I, II and III from baseline to 14<sup>th</sup> day were shown in (Table 3). On intergroup comparison of test product, I with test product II and III, a mean difference of 0.0876 ( $p=0.007$ ) and 0.112 ( $p=0.001$ ) was obtained respectively. On comparing test product II with the test product III, the mean difference of 0.0244 ( $p=1.00$ ) was obtained which did not reach statistical significance (Table 4).

### Ture sky Gilmore Glickman modification of Quigley-Hein plaque index

The baseline and 14<sup>th</sup> day scores of test product I, test product II and test product III are shown in (Table 5). On intragroup comparison a statistically significant reduction was seen in test product I ( $p=0.001$ ) and non-significant results were obtained for test product II ( $p=0.065$ ) and test product III ( $p=0.105$ ) when compared between baseline to 14<sup>th</sup> day (Table 5). When test product I was compared with test product II and III, a mean difference of 0.112 ( $p=0.437$ ) and 0.112 ( $p=0.429$ ) was obtained respectively. Further test product II when compared with the test product III showed non-significant result ( $p=1.00$ ). (Table 6).

### Discussion

The present study assessed the effectiveness of the test product I which has multifunctional bristles and raised cleaning tips which provide a deep clean on both sides of the teeth and along the gumline. Test product II which has charcoal infused spiral bristles which has an antigerm properties and test product III which has a flexible neck which helps to clean hard to reach area in removing the plaque, gingival inflammation and bleeding. Along with toothbrushing, the role of dental floss and tongue cleaning is equally important as toothbrushes are unable to clean most of the interdental areas and tongue harbours bacteria which initiates in the development of gingivitis which ultimately leads to periodontitis.

In the present study cross over design was employed so that each participant could get to use all the toothbrushes to be assessed. Also a running period of 1 week was included. Maclure M 1991<sup>12</sup> stated that cross over designs yields a more efficient comparison of treatments than a parallel design and a running or washout period can diminish the impact of any carry over effects. To

compare the efficacy of these multifunctional tooth brushes, Oral hygiene index simplified (Green JC and Vermillion JR),<sup>13</sup> Modified gingival index (Lobene et al)<sup>14</sup> and Plaque index (Ture sky Gilmore Glickman modification of Quigley-Hein)<sup>15</sup> were assessed. When assessing the OHI-S, the study was in accordance to the study by Hegde et al 2011<sup>16</sup> in which the authors compared between Ther moseal ultrasoft tooth brush and plaqk off soft tooth brush and found no statistical difference between them. Rakesh KS et al 2008<sup>17</sup> compared multi angle cross bristled toothbrush, circular bristled toothbrush and z shaped bristled toothbrush and found statistical difference in gingival inflammation among the toothbrushes when assessing the modified gingival index. Similar results were obtained by Bergenholtz et al. 1984<sup>18</sup> comparing V-shaped bristles with a flat-trim toothbrush and concluded no significant differences between the toothbrushes on plaque reduction. On the contrary to our study Aravind A et al 2018<sup>19</sup> compared plaque removing efficacy on manual, electric and chewable toothbrush and found significant difference on debris and calculus scores. Cificibasi E 2014<sup>20</sup> conducted a study on manual toothbrushes with different bristle designs in terms of cleaning efficacy and potential role on gingival recession and found no statistical significant results in terms of gingival inflammation. On comparative evaluation of the three test products all the test products was found to be statistically significant on plaque reduction which is similar to the study conducted by Chakrapani et al 2014<sup>21</sup> and Supriya N et al 2007.<sup>22</sup>

In the present study test product, I (Colgate 360<sup>0</sup> whole mouth clean) was better in reducing debris, gingival inflammation and plaque due to its soft and flexible bristle design which cleanses both free surfaces of the tooth as well as penetrates in hard-to-reach area of

proximal surfaces which was followed by test product II (Colgate 360<sup>0</sup> charcoal gold). Test product III Colgate superflexi, dental floss and tongue cleaner was least effective in reducing debris, calculus, plaque and gingival inflammation. This can be justified in a way that the toothbrush was a regular type and for cleaning the interproximal areas and tongue, other oral hygiene devices requiring additional effort from the patient and further duration of time are needed. So, the compliance of patients in using many aids at one time might be the possibility and patients preferred brushing with only the toothbrush provided to them.

### **Conclusion**

Hence, it can be concluded that Colgate 360<sup>0</sup> whole mouth clean was better in reducing debris, gingival inflammation and plaque due to its soft and flexible bristle design which penetrates in hard-to-reach area. Colgate superflexi, dental floss and tongue cleaner was least effective in reducing debris, calculus, plaque and gingival inflammation. More longitudinal studies with more number of sample size are needed to substantiate the outcome of the present study.

### **Clinical relevance**

Mechanical toothbrush is commonly used among the individuals, with their wide variety of ranges in the market, there is often a dilemma between the people on choosing the toothbrush that is best suitable for their oral health. Thus, a well-designed clinical trial to test a different brush design is a primary requirement to validate the effectiveness in mechanical plaque removal. Therefore, the present clinical study was undertaken to evaluate the clinical effectiveness of multifunctional tooth brushes: Colgate 360<sup>0</sup> whole mouth clean (test product I), Colgate 360<sup>0</sup> charcoal gold (test product II) and Colgate superflexi, dental floss and tongue cleaner (test product III).

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**Legend Tables and Figures**

Table 1: Comparison of OHI-S scores of Intra and Inter test products.

OHI-S	Baseline	14 <sup>th</sup> Day	Mean Difference	SE	CI	P value of mean difference	% OHI reduction
Test Product I	0.973±0.406	0.809±0.424	0.164±0.12	0.02	0.115-0.212	0.001*	16.86
Test Product II	1.029±0.384	0.946±0.380	0.083±0.164	0.032	0.015-0.151	0.018*	8.06
Test Product III	0.957±0.425	0.883±0.339	0.074±0.217	0.043	-0.015-0.163	0.101	7.73
F	0.218	0.800	2.079				
P-value	0.805	0.453	0.133				
One way ANOVA applied, p-value significant at p<0.05 Test product I- Colgate 360 <sup>0</sup> whole mouth clean toothbrush Test product II- Colgate 360 <sup>0</sup> charcoal gold toothbrush Test product III- Colgate superflexi, dental floss and tongue cleaner				Paired t-test applied, p-value significant at p<0.05; S.D.-standard deviation, S.E.- Standard error of mean, CI- confidence interval			

Table 2: Comparison of OHI-S scores amongst various test products

Test product	Test product	Mean difference	S.E.	p-value	95% Confidence Interval	
					Lower bound	Upper bound
I	II	0.080	0.048	0.305	-0.038	0.199
	III	0.090	0.048	0.202	-0.028	0.208
II	III	0.009	0.048	1.00	-0.109	0.128
Post hoc Bonferroni applied, *p-value significant at p<0.05 Test product I- Colgate 360 <sup>0</sup> whole mouth clean toothbrush Test product II- Colgate 360 <sup>0</sup> charcoal gold toothbrush Test product III- Colgate superflexi, dental floss and tongue cleaner						

Table 3: Comparison of MGI scores of Intra and Inter test products

MGI	Baseline	14 <sup>th</sup> Day	Mean Difference	SE	CI	P value of mean difference	% MGI reduction
Test Product I	0.746±0.263	0.617±0.300	0.128±0.135	0.027	0.072-0.185	0.001*	17.16
Test Product II	0.764±0.266	0.723±0.291	0.041±0.079	0.015	0.008-0.073	0.016*	5.36
Test Product III	0.738±0.259	0.722±0.268	0.016±0.064	0.012	-0.009-0.043	0.205	2.17

III							
F	0.065	1.126	8.996				
P-value	0.937	0.330	0.001				
One way ANOVA applied, p-value significant at p<0.05 Test product I- Colgate 360 <sup>0</sup> whole mouth clean toothbrush Test product II- Colgate 360 <sup>0</sup> charcoal gold toothbrush Test product III-Colgate superflexi, dental floss and tongue cleaner				Paired t-test applied, p-value significant at p<0.05; S.D.-standard deviation, S.E.- Standard error of mean, CI- confidence interval			

Table 4: Comparison of MGI scores amongst various test products

Test product	Test product	Mean difference	S.E.	p-value	95% Confidence Interval	
					Lower bound	Upper bound
I	II	0.087	0.027	0.007*	0.019	0.155
	III	0.112	0.027	0.001*	0.043	0.180
II	III	0.024	0.027	1.00	-0.043	0.092
Post hoc Bonferroni applied, *p-value significant at p<0.05 Test product I- Colgate 360 <sup>0</sup> whole mouth clean toothbrush Test product II- Colgate 360 <sup>0</sup> charcoal gold toothbrush Test product III-Colgate superflexi, dental floss and tongue cleaner						

Table 5: Comparison of PI scores of Intra and Inter test products

PI	Baseline	14 <sup>th</sup> Day	Mean Difference	SE	CI	P value of mean difference	%PI reduction
Test Product I	2.787±0.518	2.571±0.577	0.216±0.223	0.044	0.124-0.308	0.001*	7.75%
Test Product II	2.824±0.542	2.720±0.640	0.104±0.269	0.054	-0.006-0.215	0.065	3.68%
Test Product III	2.814±0.598	2.710±0.554	0.103±0.307	0.061	-0.023-0.230	0.105	3.66%
F	0.065	0.496	1.452				
P-value	0.937	0.611	0.241				
One way ANOVA applied, p-value significant at p<0.05 Test product I- Colgate 360 <sup>0</sup> whole mouth clean toothbrush Test product II- Colgate 360 <sup>0</sup> charcoal gold toothbrush Test product III-Colgate superflexi, dental floss and tongue cleaner				Paired t-test applied, p-value significant at p<0.05; S.D.-standard deviation, S.E.- Standard error of mean, CI- confidence interval			



Table 6: Comparison of PI scores amongst various test products

Test product (I)	Test product (J)	Mean difference (I-J)	S.E.	p-value	95% Confidence Interval	
					Lower bound	Upper bound
I	II	0.112	0.076	0.437	-0.074	0.298
	III	0.112	0.076	0.429	-0.073	0.299
II	III	0.0008	0.076	1.00	-0.185	0.187

Post hoc Bonferroni applied, \*p-value significant at  $p < 0.05$

Test product I- Colgate 360<sup>0</sup> whole mouth clean toothbrush

Test product II- Colgate 360<sup>0</sup> charcoal gold toothbrush

Test product III- Colgate superflexi, dental floss and tongue cleaner



Figure 1: Test products I, II, III (from left to right)



Figure 2: Assessment of OHI-S, MGI and PI at baseline and 14<sup>th</sup> day for TP(I/II/III)