Comparative Efficacy of Medium and Soft Toothbrushes in Plaque Removal and Gingivitis Control

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Background: Regularly removing dental plaque is key to good oral hygiene and gingival health promotion. This study aimed to compare the effects of using soft and medium toothbrushes using the plaque index (PI), gingival index (GI), and bleeding on probing (BOP) index.

Material/methods: A randomized parallel-group study design was used. Sixty-four participants were randomly assigned to 2 similar intervention groups (medium and soft toothbrush groups). The PI, GI, and BOP indexes were used. The median and median difference of PI, GI, and BOP were calculated. SPSS was used for data entry and analysis. Wilcoxon and Mann-Whitney U tests were used for data analysis.

Results: The median scores of GI, PI, and BOP significantly decreased from 1.8, 1.7, and 2.0, respectively, before using medium toothbrushes to 0.0, 0.1, and 0.0, respectively, after using medium toothbrushes (all P<0.0001). Similarly, the median scores of GI, PI, and BOP significantly decreased from 2.0, 1.7, and 2.0, respectively, before using soft toothbrushes to 1.1, 0.9, and 1.0, respectively, after using soft toothbrushes (all P<0.0001). The median differences in GI, PI, and BOP scores among those using medium toothbrushes were higher than the median differences among those using soft toothbrushes [(1.8 vs 0.9), (1.6 vs 0.8), and (2.0 vs 1.0), respectively]. These differences were statistically significant (P<0.0001).

Conclusions: This study concludes that medium and soft toothbrushes were effective in removing plaque and controlling gingivitis. Medium toothbrushes were more effective than soft toothbrushes in achieving these outcomes.

Keywords: Dental Plaque Index • Gingivitis • Treatment Outcome
Introduction

Periodontal disease is a prevalent oral condition, which starts with the accumulation of bacterial plaque on tooth surfaces [1]. Dental plaque is an adhesive film of bacteria that can irritate the gums and harden into tartar, resulting in gingivitis, which is swollen, bleeding gum tissue [2,3]. Regularly removing dental plaque is the most effective method to maintain good oral hygiene, reduce tooth decay, and improve gingival health [2,4]. According to World Health Organization criteria, gingivitis is defined as gingival bleeding when probing [5].

Toothbrushing is the most common method to maintain oral hygiene and is considered an effective method to remove dental plaque, thereby preventing its evolution into more pathogenic forms and reducing the risk of dental caries and gingivitis [2,6-9]. While proper brushing technique is essential, good oral hygiene relies heavily on individuals' motivation and the form of toothbrush they use for effective plaque removal [10]. Effective daily toothbrushing reduces plaque biofilm and depends on the design of the toothbrush, the skill in using the brush, and the brushing frequency and duration [4,8,11-14].

Many types of toothbrushes are available currently, with different designs, sizes, bristles, lengths, and shapes of the handle [7,15]. Regardless of the characteristics of the design of a toothbrush, a new toothbrush is more effective than a worn-out one [7]. However, individuals choose and change toothbrushes on the basis of several factors, including dentist's recommendation, appearance, feel, and cost of new toothbrushes [15]. Moreover, the effectiveness of toothbrushes usually last 2 to 3 months, but the need for replacement with a new one seems to depend more on the degree of wear than the length of use. The degradation of performance properties may occur at different times depending on the brushing force, method, hardness, and quality of the toothbrush bristles [7].

The choice of the type of toothbrush bristles is crucial for healthy teeth, and it determines the efficiency of plaque removal in the oral cavity [3,6,16]. Dental hygienists and dentists should be able to identify the type of toothbrush bristles – soft or hard – used by individuals and offer proper oral health information [17]. Toothbrushes are divided into 3 types on the basis of the softness and hardness of the bristles – soft, medium, and hard – with varying effectiveness in removing plaque [16]. Soft and medium bristles do not damage the gingiva, even with frequent brushing. However, hard bristles can lead to a condition called gingival recession [6,18].

Many studies and systematic reviews have investigated the relationship between tooth brushing frequency and duration, as well as bristles type, and periodontitis and gingivitis. Zimmermann et al and Qazi et al stated that a strong effect was documented, demonstrating that infrequent tooth brushing was associated with severe forms of periodontal disease [19,20]. Poor to fair oral hygiene increased the risk of periodontitis by 2- to 5-fold [21]. Rajapakse et al found a positive association between tooth brushing frequency and gingival disease. Other possible risk factors were duration of tooth brushing, brushing strength, frequency of switching to a new toothbrush, bristle types or hardness, and tooth brushing technique [22].

A number of published studies have investigated the effect of soft and medium bristle toothbrushes on oral hygiene, using the plaque index (PI), gingival index (GI), and bleeding on probing (BOP) index. Khalil et al [2], Himawan et al [6], Sitepu et al [16], Faisal [23], Zanatta et al [24], and Eldarita et al [25] showed that medium and soft toothbrushes were effective in removing plaque and controlling gingivitis. Khalil et al [2], Chałas et al [7], Sitepu et al [16], Faisal [23], Zanatta et al [24], and Eldarita et al [25] found that medium toothbrushes were more effective than soft toothbrushes in removing plaque.

This highlights the need for further research in this important area. This study included 64 adults and aimed to compare the effects of using soft and medium toothbrushes using the PI, GI, and BOP index. The null hypothesis was that the effectiveness of medium and soft toothbrushes in removing plaque and controlling gingivitis does not differ.

Material and Methods

Study Design and Ethical Consideration

A randomized parallel-group study design was used. This study was approved by the Ethics Committee of King Khalid University, College of Dentistry under # KKUCOD/2023-24/052 on May 30, 2024. The study was performed in accordance with the Declaration of Helsinki. All participants were informed about the aims of the study. Written informed consent was obtained from all participants before their enrollment in the study. The collected information remained anonymous. Confidentiality of data was assured and ensured.

Inclusion and Exclusion Criteria

This study included individuals diagnosed with gingivitis on the basis of the GI score ≥1, aged 16-35 years, with at least 20 teeth, and who agreed to participate. We excluded individuals aged less than 16 years old and more than 35 years old, patients with gingivitis who had systemic disease, those under radiotherapy management, pregnant women, smokers, individuals who used anti-inflammatory medications and antibiotics 2 weeks before the study, and those who did not agree to participate.
Controlling plaque using soft vs medium toothbrushes

1. Study Area and Population, Sample Size, and Sampling Technique

This study was carried out in dental clinics at a private dental clinic in Abha, Saudi Arabia, and enrolled 64 patients diagnosed with gingivitis during January-April 2024. All patients who had gingivitis were classified randomly into 2 parallel intervention groups. The first group used a medium toothbrush, whereas the second group used a soft toothbrush. A minimum sample size of 30 patients for each group was required for statistical evaluation and to estimate the quantitative variables. The sample size was increased by 5% to allow for non-respondents. The final sample size was 32 participants for each group.

A random sampling method was used to select participants in the study. The first patient who had gingivitis was enrolled randomly to 1 of the groups. The second patient was enrolled in the other group, and so on, until the required sample size was achieved. Figure 1 shows the flowchart of the study.

2. Study Procedures

Before using the assigned toothbrush, the baseline measurements were collected from all eligible participants, including the following: demographic characteristics (age, sex, education, and occupation), and GI, PI, and BOP scores. Two sites of each quadrant were selected for examination. Afterwards, the participants were randomly assigned to either the medium or soft toothbrush group. After the baseline scores were recorded, scaling and polishing were conducted for all participants in both groups.

All participants received standardized oral hygiene instructions (OHIs), including proper brushing technique 2 times a day for 2 minutes [3,7,17] by using the assigned toothbrush. Modified Stillman brushing technique was used in this study. The same brands of medium and soft toothbrushes were given to the medium and soft toothbrush groups, respectively. Moreover, the same toothpaste (brand or type) was given for all participants in both groups.

All participants were given appointments to return in the second and third weeks. At the first visit, disclosing tablets were used to determine the amount of plaque from the first week, and clinical photographs were taken for each participant. In the second and third weeks, disclosing tablets were used to assess the difference in the amount of plaque, to motivate and encourage the participants, and determine the level of their oral hygiene. At each visit, photos of staining were taken for soft brush (Figure 2A-2C) and medium brush (Figure 3A-3C) groups. In the third week, all participants were reevaluated using GI, PI, and BOP indices.

3. Quality Assurance and Control During Data Collection and Measurements

Both groups received standardized OHI and used the same brushing technique and frequency. A demonstration on cast and brush model on tooth brushing and technique was performed by a periodontal specialist. Moreover, the same brand of soft and medium manual toothbrushes (Oral-B, Procter & Gamble, United States) was used by all participants. The same brand of toothpaste (Oral-B, Procter & Gamble, United States) was given for all participants in both groups. The participants were asked not to use toothpicks and mouth washes during the study period. All scores were recorded by a periodontal specialist blinded to the assigned toothbrush group.

4. Data Collections and Scoring

A questionnaire was used to collect data at baseline and follow-up visits. It was used to collect information on the demographic characteristics of patients, gingivitis, plaque, and periodontitis by using GI, PI, and BOP.

Three indices were used to assess gingival health. The GI was used to assess gingival health. A normal gingiva (score 0) indicates healthy gingiva with a natural pink color and no inflammation. Mild inflammation (score 1) presents with slight changes in color and edema but no BOP. Moderate inflammation (score 2) shows redness, hypertrophy, edema, glazing, and BOP. Severe inflammation (score 3) shows marked redness, hypertrophy, edema, ulceration, and tendency to bleed spontaneously [2,4].

The PI was used to measure the amount of plaque buildup on teeth. A score of 0 indicates absence of microbial plaque. A score of 1 indicates a film of plaque adhering to the free
gingival margin and adjacent tooth surface. This plaque may be seen after applying a disclosing solution or using a probe on the tooth surface. A score of 2 indicates moderate accumulation of soft deposit within the gingival pocket or on the tooth surface and gingival margin, visible to the naked eye. A score of 3 indicates an abundance of soft deposit on the tooth surface and gingival margin [2,4,15].

The BOP was utilized to measure the severity of gingivitis. A score of 0 (normal) means no bleeding when the gingiva tissue around the teeth is gently probed. A score of 1 (moderate) indicates slight bleeding, and a score of 2 (severe) shows severe BOP [4].

For every participant, a total score of each index was calculated by the sum of all 8 scores. The average scores before and after OHI were calculated by dividing the total score by 8. All measurements were assessed for intra-examiner reliability, with intraclass correlation coefficient (ICC) values [26].

Statistical Analysis

SPSS version 26 was used for data entry and analysis. The Shapiro-Wilk test indicated that the data were not normally distributed (P<0.05). Therefore, the medians and interquartile ranges (IQRs) of the indices were calculated before and after OHI. The median difference between before and after OHI in the soft and medium toothbrush groups was calculated. Frequencies and percentages were used for categorical variables. Means and standard deviations (±SD) were used as additional measures.

Chi-square or Fisher’s exact tests were used to compare the sex, education, and occupation of participants between the soft and medium toothbrush groups. Fisher’s exact test was used if the expected frequency in 1 or more cells of the contingency table was less than 5; otherwise, the chi-square test was used. The Wilcoxon test was used to compare before and after OHI. The Mann-Whitney U test was used to compare medium and soft toothbrush groups. A P value <0.05 was considered statistically significant.

Results

All measurements displayed good intra-examiner reliability, with ICC values over 0.85 according to the ICC criteria. A total of 64 patients with gingivitis participated in the study. They were classified into 2 parallel intervention groups. The first group used toothbrushes with medium-stiffness bristles and the second group used soft-bristle toothbrushes. All participants completed the study, and their data were analyzed.

Characteristics of the Study Participants

Table 1 shows the characteristics of patients with gingivitis. No statistically significant differences were observed in age, sex, and occupation between the groups (P values=0.132, 0.313, and 0.429, respectively). Most participants using medium and soft toothbrushes had university education (75.0% and 50.0%, respectively).
Table 1. Characteristics of the study participants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Medium toothbrush (n=32)</th>
<th>Soft toothbrush (n=32)</th>
<th>Total (n=64)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age±SD</td>
<td>22.3 (±3.9)</td>
<td>24.6 (±5.9)</td>
<td>23.4 (±5.0)</td>
<td>0.066a</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>22.0 (21.3 and 24.0)</td>
<td>24.0 (20.3 and 29.5)</td>
<td>23.5 (21.0 and 25.0)</td>
<td>0.132b</td>
</tr>
<tr>
<td>Sex: no (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (50.0)</td>
<td>12 (37.5)</td>
<td>28 (43.8)</td>
<td>0.313c</td>
</tr>
<tr>
<td>Female</td>
<td>16 (50.0)</td>
<td>20 (62.5)</td>
<td>36 (56.3)</td>
<td></td>
</tr>
<tr>
<td>Education level: no (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>24 (75.0)</td>
<td>16 (50.0)</td>
<td>40 (62.5)</td>
<td>0.002d</td>
</tr>
<tr>
<td>Secondary</td>
<td>2 (6.3)</td>
<td>14 (43.8)</td>
<td>16 (25.0)</td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>6 (18.8)</td>
<td>2 (6.3)</td>
<td>8 (12.5)</td>
<td></td>
</tr>
<tr>
<td>Occupation status: no (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student or not working</td>
<td>26 (81.3)</td>
<td>22 (68.8)</td>
<td>48 (75.0)</td>
<td>0.429d</td>
</tr>
<tr>
<td>Housewife</td>
<td>4 (12.5)</td>
<td>8 (25.0)</td>
<td>12 (18.8)</td>
<td></td>
</tr>
<tr>
<td>Administrative</td>
<td>2 (6.2)</td>
<td>2 (6.2)</td>
<td>4 (6.2)</td>
<td></td>
</tr>
</tbody>
</table>

a independent t test, b Mann Whitney u test, c Chi square test, d Fisher exact test.

Table 2. Comparison the gingival, plaque, and BOP scores before and after using medium and soft toothbrushes.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Type of toothbrush</th>
<th>Before (n=32)</th>
<th>After (n=32)</th>
<th>Change (difference)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Median (IQR)</td>
<td>Median (IQR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gingival index</td>
<td>Medium</td>
<td>1.8 (1.7 and 2.0)</td>
<td>0.0 (0.0 and 0.1)</td>
<td>1.8 (1.4 and 2.0)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>Soft</td>
<td>2.0 (1.8 and 2.0)</td>
<td>1.1 (0.8 and 1.3)</td>
<td>0.9 (0.4 and 1.1)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.324b</td>
<td>&lt;0.0001b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaque index</td>
<td>Medium</td>
<td>1.7 (1.2 and 1.8)</td>
<td>0.1 (0.0 and 0.2)</td>
<td>1.6 (1.0 and 1.6)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>Soft</td>
<td>1.7 (1.2 and 2.0)</td>
<td>0.9 (0.5 and 1.0)</td>
<td>0.8 (0.5 and 1.0)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.550b</td>
<td>&lt;0.0001b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOP index</td>
<td>Medium</td>
<td>2.0 (2.0 and 2.0)</td>
<td>0.0 (0.0 and 0.0)</td>
<td>2.0 (2.0 and 2.0)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>Soft</td>
<td>2.0 (2.0 and 2.0)</td>
<td>1.0 (1.0 and 2.0)</td>
<td>1.0 (1.0 and 2.0)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>1.000b</td>
<td>&lt;0.0001b</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Wilcoxon test, b Mann-Whitney U test.

Comparison of Indices Before and After Using of Medium and Soft Toothbrushes

Table 2 shows the GI, PI, and BOP scores before and after using medium and soft toothbrushes. Before using these toothbrushes, the results indicated no statistically significant differences in the median scores of GI, PI, and BOP between the 2 groups (P value=0.324, 0.550, and 1.000, respectively). The median scores of GI, PI, and BOP significantly decreased from 1.8, 1.7, and 2.0, respectively, before using medium toothbrush to 0.0, 0.1, and 0.0, respectively, after using medium toothbrush (all P values <0.0001). Similarly, the median scores of GI, PI, and BOP
significantly decreased from 2.0, 1.7, and 2.0, respectively, before using soft toothbrushes to 1.1, 0.9, and 1.0, respectively, after using soft toothbrushes (all $P$ values <0.0001). Figures 4 and 5 show the mean (±SD) scores of GI, PI, and BOP before and after using the 2 types of toothbrushes.

**Table 3.** Comparison of the difference in the gingival, plaque, and BOP indices between medium and soft toothbrushes.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Medium toothbrush</th>
<th>Soft toothbrush</th>
<th>Difference between differences</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingival index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median difference (IQR)</td>
<td>1.8 (1.4 and 2.0)</td>
<td>0.9 (0.4 and 1.1)</td>
<td>0.9 (0.7 and 1.3)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Plaque index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median difference (IQR)</td>
<td>1.6 (1.0 and 1.6)</td>
<td>0.8 (0.5 and 1.0)</td>
<td>0.8 (0.3 and 0.8)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>BOP index</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median difference (IQR)</td>
<td>2.0 (2.0 and 2.0)</td>
<td>1.0 (1.0 and 2.0)</td>
<td>1.0 (0.3 and 2.0)</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

* Mann-Whitney U test.

**Comparison of the Differences Between Medium and Soft Toothbrushes**

Table 3 shows the comparison of the differences in the GI, PI, and BOP scores between the medium and soft toothbrush groups. The median differences in the GI, PI, and BOP scores among those using medium toothbrushes were higher than among those using soft toothbrushes [(1.8 vs 0.9), (1.6 vs 0.8), and (2.0 vs 1.0), respectively], and these differences were statistically significant between medium and soft toothbrushes (all $P$ values <0.0001). Figure 6 shows the mean difference (±SD) scores of GI, PI, and BOP after brushing.

**Discussion**

This study investigated the effectiveness of medium and soft toothbrushes in removing plaque and controlling gingivitis. The null hypothesis, which stated there was no difference between the medium and soft toothbrushes, was rejected. Both types of toothbrushes were significantly effective in reducing PI, GI, and BOP, but medium toothbrushes were more effective than soft toothbrushes (all $P$ values <0.0001).
We found that the age and sex of participants were comparable between the medium and soft toothbrush groups. Most participants in the 2 groups (medium and soft toothbrushes) had university education. Moreover, the occupation status did not show a significant difference between the 2 groups, with most participants being students. These findings may be attributed to the study setting where most participants came from.

No statistically significant differences were found in the median score of GI, PI, and BOP between the 2 groups before using medium and soft toothbrushes (P values=0.324, 0.550, and 1.000, respectively). This finding indicates that the scores at baseline were comparable between the medium and soft toothbrush groups.

Regarding comparisons between baseline and after using toothbrush, the study indicated that the PI, GI, and BOP scores were significantly lower after using medium and soft toothbrushes than at baseline (all P values <0.0001). The PI, GI, and BOP scores significantly decreased after using both types of toothbrushes, indicating that using medium and soft toothbrushes are effective in removing dental biofilm plaque, improving gingival health, and preventing periodontal disease. The findings of this study agree with those of Himawan et al [6], Chałas et al [7], Kalsi et al [15], Faisal [23], Zanatta et al [24], Eldarita et al [24], and Tanner et al [27], who indicated that both toothbrushes significantly reduced PI. Zimmer et al [28] found that the mean scores of bleedings and PI were reduced after using soft and medium toothbrushes. A systematic review by Langa et al concluded that soft and medium toothbrushes were effective in reducing PI and GI [29].

Regarding comparisons between medium and soft toothbrushes, the change in PI, GI, and BOP scores among those using medium toothbrush were higher than the change among those using soft toothbrushes. Statistically significant differences were found in the changes in PI, GI, and BOP scores between the medium and soft toothbrush groups (all P values <0.0001). In other words, the medium toothbrush group showed a significantly greater reduction in PI, GI, and BOP scores than the soft toothbrush group, indicating that medium toothbrushes were significantly more effective than soft toothbrushes in reducing plaque accumulation, gingival inflammation, and periodontal disease. The thicker diameter and broader surface of medium-bristled toothbrushes may explain their effectiveness. They can clean tooth surfaces and reach tight spaces more efficiently while providing a good gum massage.

Many previous studies, which found statistically significant differences in the scores of PI, GI, and BOP between medium and soft toothbrushes, support the results of the present study. Khalil et al [2], Chałas et al [7], Sitepu et al [16], Faisal [23], Zanatta et al [24], Eldarita et al [25], and Tanner et al [27] found that medium toothbrushes were significantly more effective in reducing PI [2,7,16,24,25,27] and GI than soft toothbrushes [2]. Zimmer et al showed that the mean change or reduction in bleeding and plaque [28] indices among those using medium toothbrushes was higher than those among using soft toothbrushes. Additionally, a systematic review by Langa et al [29] concluded that a toothbrush with medium bristles was more effective in reducing dental PI and GI than a toothbrush with soft bristles. Saffarzadeh et al [1] recommended toothbrushes with medium bristles for individuals with poor oral hygiene because soft-bristle toothbrushes are considered inadequate for plaque control in such people. By contrast, Himawan et al [6] found that the mean difference in PI score was higher among those using soft toothbrush bristles than that among those using medium toothbrush bristles. A robot brushing in-vitro study by Axe et al [30] showed that soft toothbrushes can achieve simulated plaque removal better than medium toothbrush.

The present study has some strengths. First, the randomized design may have minimized bias by randomly assigning participants to either the medium or soft toothbrush group, ensuring comparable groups at baseline. Second, the study controlled for some factors that could influence the results. All participants in both groups received standardized OHI and used the same brushing technique and frequency. Moreover, all participants received the same toothbrush brand and the type of toothpaste. Third, all scores were recorded by a periodontist specialist blinded to the assigned toothbrush group to avoid bias during data collection and measurements.

Our study examined the mechanical effect of different types of toothbrushes. However, a recent review on phytochemicals showed that they can influence periodontal diseases by reducing the formation of dental biofilms and plaques, thus preventing production of oral pathogens and bacterial adhesion to tooth surfaces. All of this lowered the GI, PI, and BOP and suggests a further study to compare mechanical and chemical methods, as well as assessing the effects of using recently developed types of manual toothbrushes with different types of bristles.

The relatively small sample size of our study was the main limitation, which may limit the generalizability of the findings. Additionally, the study did not assess the long-term effects of using medium or soft toothbrushes.

Conclusions

We found that medium toothbrushes were effective in removing plaque and controlling gingivitis, but medium toothbrushes were more effective than soft toothbrushes.
in achieving these outcomes. However, further research with larger sample sizes and longer follow-up periods is needed to confirm these findings.

**Institution Where Work Was Done**

This work was carried out at College of Dentistry, King Khalid University, Abha, Saudi Arabia.

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