



Original Research Article

Efficacy of Toothbrushing in Dental Plaque Control for the Prevention of Gingivitis.

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Abstract: Background: Dental plaque is the primary etiological factor in the development of gingivitis and remains a major cause of periodontal disease worldwide. Effective toothbrushing is the cornerstone of daily plaque control; however, its effectiveness depends on brushing frequency, duration, technique, and individual compliance. This study aimed to evaluate the efficacy of toothbrushing in dental plaque control for the prevention of gingivitis among adults aged 20–55 years. A cross-sectional study was conducted over three months among 100 participants recruited through convenience sampling from dental outpatient clinics. Dental plaque and gingival health were assessed using the Plaque Index (Silness & Loe, 1964) and the Gingival Index (Loe & Silness, 1963), while oral hygiene practices were recorded using a structured questionnaire. Data were analyzed using SPSS version 26.0, employing descriptive statistics and the Chi-square test, with statistical significance set at $p < 0.05$. Among the participants, 58% brushed twice daily, 66% brushed for at least two minutes, and 63% practiced a proper toothbrushing technique. Good plaque control was observed in 45% of participants, whereas 43% had healthy gingiva. Healthy gingival conditions were present in 72% of participants with good brushing habits. Participants who brushed at least twice daily demonstrated significantly better plaque control than those brushing once daily (78.6% vs. 26.7%, $p = 0.001$), while healthy gingiva was more common among those using a proper brushing technique than among those using an improper technique (71.4% vs. 21.6%, $p = 0.001$). These findings indicate that regular toothbrushing together with the use of fluoridated toothpaste significantly improves plaque control and reduces gingival inflammation. Promoting appropriate oral hygiene practices through regular oral health education may contribute to the prevention of gingivitis and improvement of periodontal health.

Keywords: Tooth brushing, Dental Plaque, Gingivitis, Oral Hygiene, Plaque Control, Gingival Health, Adults.

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INTRODUCTION

Good oral health is critical to good overall health, both physical and mental, as it allows everyday functions,

including eating, talking, and smiling, as well as important social functions. Gingivitis, which can lead to the more serious and widespread periodontitis, is one of

the most common oral diseases and one of the most serious public health issues at all ages (Kinane et al., 2017). As the gum tissues are inflamed due to plaque build-up, gingivitis causes edema and inflammation.

Though the condition is periodontal, destruction is irreversible. Progressive gingivitis may lead to tooth loss (Papapanou et al., 2018).

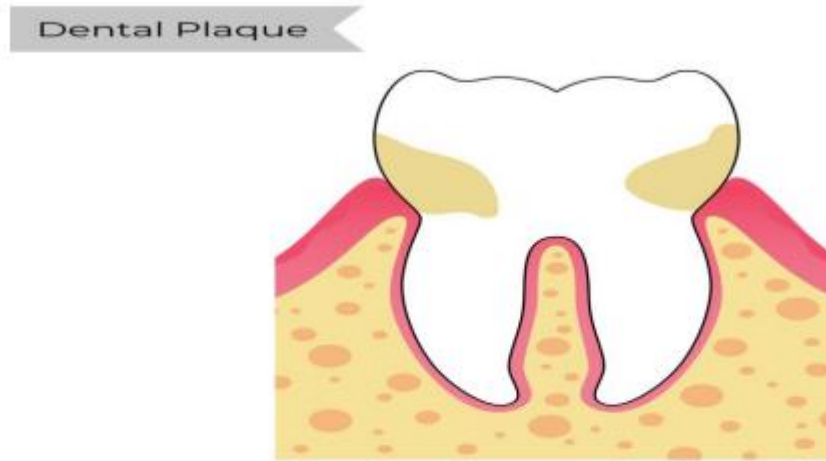


Figure 1.1: Schematic representation of dental plaque biofilm accumulation at the tooth surface.. Source: Pikovit44 / Getty Images

Plaque is a biofilm of multiple microbes and an extramatrix that forms a plaque on the teeth. Continuous plaque leads to gum inflammation caused by an immune response to the bacteria. Plaque has been shown to be the leading cause of gingivitis, and other periodontal diseases have been shown to be caused by the ineffective management of plaque. As such, the management of plaque is the most important preventative measure against other periodontal diseases (Marsh, 2006).

Tooth brushing is the best way to remove dental plaque and maintain good oral hygiene. It is quick, inexpensive, and convenient. Prompt daily brushing disrupts the formation of microbial plaque and prevents the development of a pathogenic biofilm that causes inflammation of the gums. It is recommended by various international oral health associations that tooth brushing be done twice a day. It is also recommended that brushing be done along with the use of a fluorinated toothpaste to optimize plaque control and ensure good gum health (Chapple et al., 2015).

There are several factors regarding tooth brushing that influence the retention of plaque, and these include the frequency and duration of brushing, the technique, the toothbrush and its bristles, personal motivation, and

compliance. Brushing is ineffective if it does not remove plaque from all tooth surfaces. Insufficient duration and poor technique of brushing lead to retained plaque, which increases the risk of gingivitis, even with regular brushing (Slot et al., 2012).

The frequency of brushing significantly impacts plaque accumulation. Research has found that brushing twice a day correlates to lower plaque accumulation and healthier gums as compared to once a day. In addition, brushing for a minimum of two minutes makes the process more effective, as it is more likely that all surfaces of the teeth will be cleaned. This has become part of the public health response to improve oral health and has been incorporated into the standards of preventive dentistry (Van der Weijden & Slot, 2015).

The demographics of people, such as age, gender, education, socioeconomic standing, and area of residence, can also impact oral health. For example, people of higher or more recent generations of education have been found to have better oral health and an increased likelihood to follow oral hygiene recommendations. Socioeconomic standing can impact the availability of oral healthcare and the availability of oral hygiene products. Because of this, there are disparities in oral health and controlling plaque (Watt et al., 2019). Despite guidelines to prevent gingivitis,

many adults have gingivitis and it is due to a lack of motivation, inconsistent brushing, or a lack of knowledge of oral health practices. This has led to an increased burden on the healthcare system in

developing countries where there are limited resources to educate the public on preventive oral health practices (Peres et al., 2019).



Figure 1.2: Anatomical transition showing healthy gingival tissues compared to plaque-induced gingivitis.. Source: wowwa / Getty Images

It is vastly more cost-efficient to focus on the prevention of gingivitis than on the treatment of more advanced forms of periodontal disease. The combination of regular tooth brushing, professional oral health education, and regular dental checkups leads to significantly lower levels of dental plaque, less inflammation of the gums, and more favorable long-term outcomes for the individual's oral health. Therefore, the development of community-oriented plans for the improvement of oral health will greatly benefit from the understanding of the relationship between tooth brushing and the condition of the gums. (Chapple et al. 2015)

The purpose of the present study was to determine the role of tooth brushing in the control of dental plaque and the prevention of gingivitis in the adult population of 20 to 55 years of age. In particular, the study sought to determine the effect of tooth brushing on the level of dental plaque and the condition of the gums in relation to the frequency, duration, and method of brushing. It is expected that the results of this study will provide the basis for the implementation of more preventive oral health policies and will positively impact the promotion of better periodontal health.

METHODOLOGY

Study Design: The present study used a quantitative cross-sectional study design to determine the role of

tooth brushing in the control of dental plaque and the prevention of gingivitis. A cross-sectional design was used to describe the state of oral hygiene and the health of gums at a single point in time, and to describe the relationships that may exist between the behaviors of tooth brushing and the health of gums and the dental health of gums and dental plaque may have.

Study Setting: The study was carried out in the Dental Outpatient Department (Dental OPD) of Sir Syed College of Medical Sciences, Karachi. Potential participants were patients who attended the Dental OPD for routine dental check-ups or minor dental procedures. Clinical examination and administration of the questionnaire were conducted in the Dental OPD under standardized conditions to ensure consistency and uniformity during data collection.

Study Duration: This study was completed within three months. During this time, the recruitment of participants, obtaining of informed consent, completion of the questionnaire, clinical examination, entry of data, and the subsequent analysis of data and interpretation of findings were all completed as per the study protocol.

Study Population: The adult population targeted for this study were those aged between 20 and 55 years, who were clients of some selected outpatient dental clinics. Male and female, participants with various

educational and socioeconomic statuses were targeted to ensure a heterogeneous adult population with varying dental hygiene and gingival health.

Sample Size: 100 participants were included in this study. This sample size was adequate to determine the relation of gingival health and plaque in this study with the limited time and resources available. The sample size was calculated using OpenEpi (Version 3.01), an open-source epidemiological statistics software. Assuming a 95% confidence level, a 5% margin of error, and an anticipated prevalence based on previous literature, the minimum required sample size was calculated.

Sampling Technique: Convenience sampling was employed to select study participants. Eligible individuals visiting the selected dental clinics were invited to participate in the study until the sample size of 100 was reached.

Inclusion and Exclusion Criteria: The sample consisted of individuals between the ages of 20 to 55 who had at least 20 remaining natural teeth and were able to brush teeth unaided. People who received any form of periodontal therapy or professional dental cleaning during the last three months, were undergoing active orthodontic treatment, were completely edentulous, were wearing complete removable dentures, were pregnant, had systemic diseases that would be considered major and would likely affect the status of periodontal disease (e.g., uncontrolled diabetes or other diseases that would compromise the immune system), who are on drugs that cause gingival hyperplasia, and those who were unable to complete the survey and the clinical assessment were all excluded from the study.

Data Collection Instruments: Two standardized instruments were used to collect data. The first was a structured questionnaire that was used to gather data on participants' demographics and a number of potentially relevant factors on the status of periodontal disease, namely participants' oral hygiene. Oral hygiene was operationalized to include brushing frequency, brushing duration, brushing technique, how often the toothbrush was replaced, the presence of a fluoridated toothpaste, and the presence of dental floss and mouthwash. The second instrument was a standardized clinical

assessment form that was used to record the Plaque Index (Silness and Loe, 1964) and the Gingival Index (Loe and Silness, 1963). The Plaque Index measured the amount of plaque that accumulated at the gingival margin and the assessment for the Gingival Index measured the level of gingival inflammation that was assessed by the presence of changes in color and/or the degree of swelling and bleeding after the probing was done.

Data Collection Procedure: After obtaining approval from the institutional ethics committee, eligible participants were recruited from the dental outpatient departments to explain the study purpose and procedures. The participants were asked to sign the study in the consent form after reading it. Data were collected by one trained principal investigator who administered the structured questionnaire and conducted all clinical examinations to ensure consistency throughout the study. Before the commencement of the study, the examiner underwent calibration and reliability assessment on 10 participants who were not included in the final sample.

Clinical examinations were repeated after 48 hours, and intra-examiner reliability for the Plaque Index (Silness and Loe, 1964) and Gingival Index (Loe and Silness, 1963) was assessed using Cohen's Kappa statistic, yielding a Kappa value of 0.86, indicating excellent agreement. The questionnaire was administered face-to-face, followed by an intraoral examination using a mouth mirror, WHO periodontal probe, cotton rolls, and adequate illumination under standard infection control procedures. All findings were recorded immediately on standardized data collection forms to minimize recording errors and maintain data quality.

Study Variables: The independent variables were identified as age, gender, educational status, socioeconomic status, frequency of tooth brushing, duration of tooth brushing, technique of tooth brushing, frequency of toothbrush replacement, usage of fluoridated toothpaste, and usage of additional aids of oral hygiene. The dependent variables were accumulation of dental plaque assessed by the Plaque Index and gingival health Status assessed by the Gingival Index.

Study Methodology & Data Collection Flow

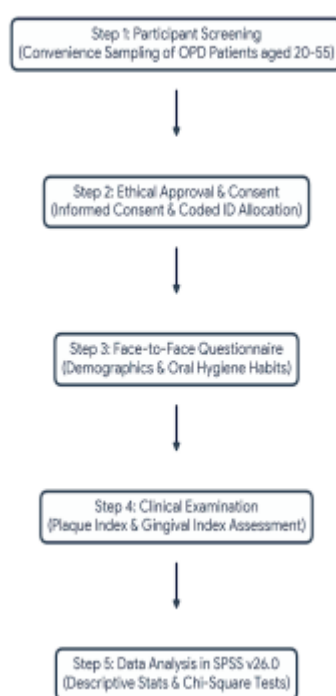


Figure 3: Flow diagram illustrating the step-by-step research methodology, participant screening, and data collection process.

Ethical Considerations: Participation in the study was voluntary. The researcher obtained the signed informed consent from each study participant. The participants' personal information was kept confidential by the use of coded identification. The participants were made aware that they could withdraw from the study without a diminishment of the dental services provided to them. The study followed the ethical principles of the Declaration of Helsinki concerning studies with human participants.

Data Analysis: SPSS version 26.0 was employed for data entry, data cleaning, coding and analysis. Descriptive statistics (frequencies, percentages, means and standard deviations) were generated for participants' demographics, oral hygiene practices, plaque scores, and gingival health status. The associations between tooth brushing practices and clinical outcomes were analyzed using inferential statistics (Chi-square test). A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1. Demographic Characteristics of the Participants (N = 100)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	20–30	35	35.0
	31–40	30	30.0
	41–55	35	35.0
Gender	Male	46	46.0
	Female	54	54.0
Educational Status	Primary	15	15.0
	Secondary	32	32.0
	Graduate	38	38.0
	Postgraduate	15	15.0
Socioeconomic Status	Low	30	30.0
	Middle	50	50.0
	High	20	20.0

35% of respondents were either 20 to 30 years old or 41 to 55 years old. There was a slight majority of females at 54%,

as well as a slight graduation majority at 38%, and a majority of the middle socioeconomic class at 50%.

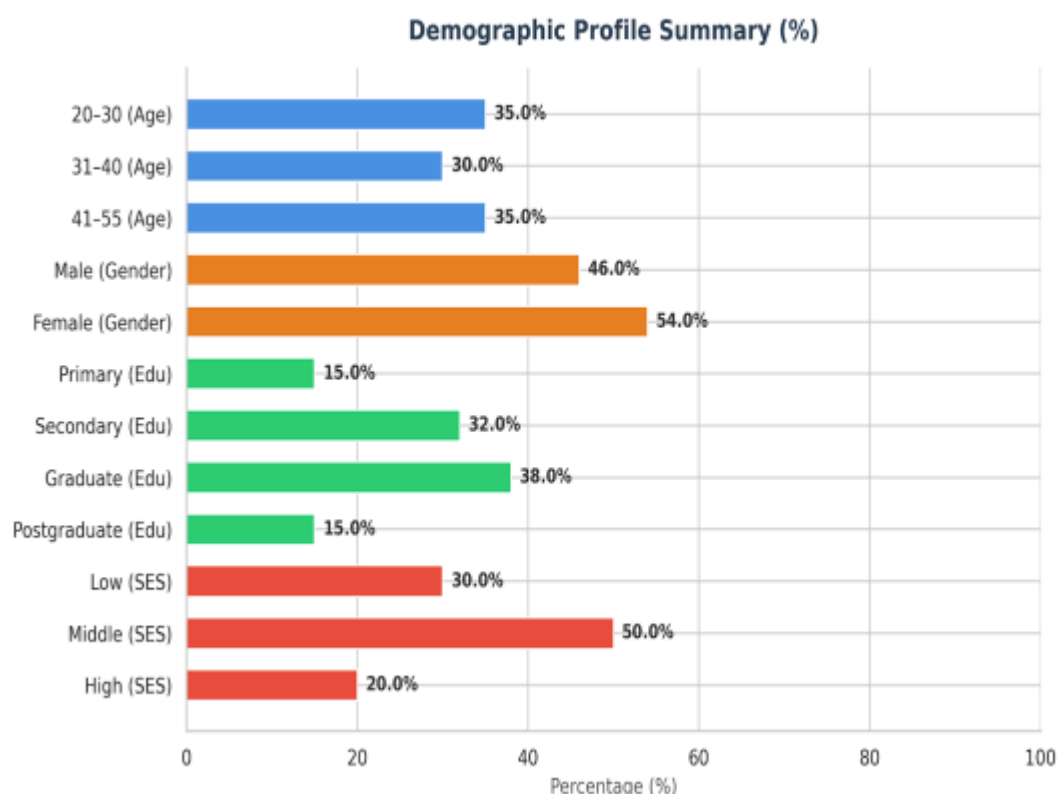


Table 2. Toothbrushing Habits Among Participants (N = 100)

Variable	Category	Frequency (n)	Percentage (%)
Brushing Frequency	Once daily	30	30.0
	Twice daily	58	58.0
	More than twice daily	12	12.0
Brushing Duration	<2 minutes	34	34.0
	≥2 minutes	66	66.0
Type of dentifrice	Toothpaste (Fluoride)	63	63.0
	Manjan/powder (herbal)	37	37.0

Most participants (58%) brushed their teeth twice each day. Only 66% brushed their teeth for at least 2 minutes, and 63% were able to brush their teeth with proper technique.

Table 3. Distribution of Plaque Index Scores (N = 100)

Plaque Index Category	Frequency (n)	Percentage (%)
Good (0.0–0.9)	45	45.0
Fair (1.0–1.9)	38	38.0
Poor (2.0–3.0)	17	17.0

Good plaque control was exhibited by almost half the study participants (45%) and was rated as poor by 17% of the participants.

Table 4. Distribution of Gingival Index Scores (N = 100)

Gingival Condition	Frequency (n)	Percentage (%)
Healthy Gingiva	43	43.0
Mild Gingivitis	36	36.0
Moderate Gingivitis	17	17.0
Severe Gingivitis	4	4.0

Healthy gingiva was noted in 43% of the population and the rest (57%) had reported cases of gingivitis of one degree or another.

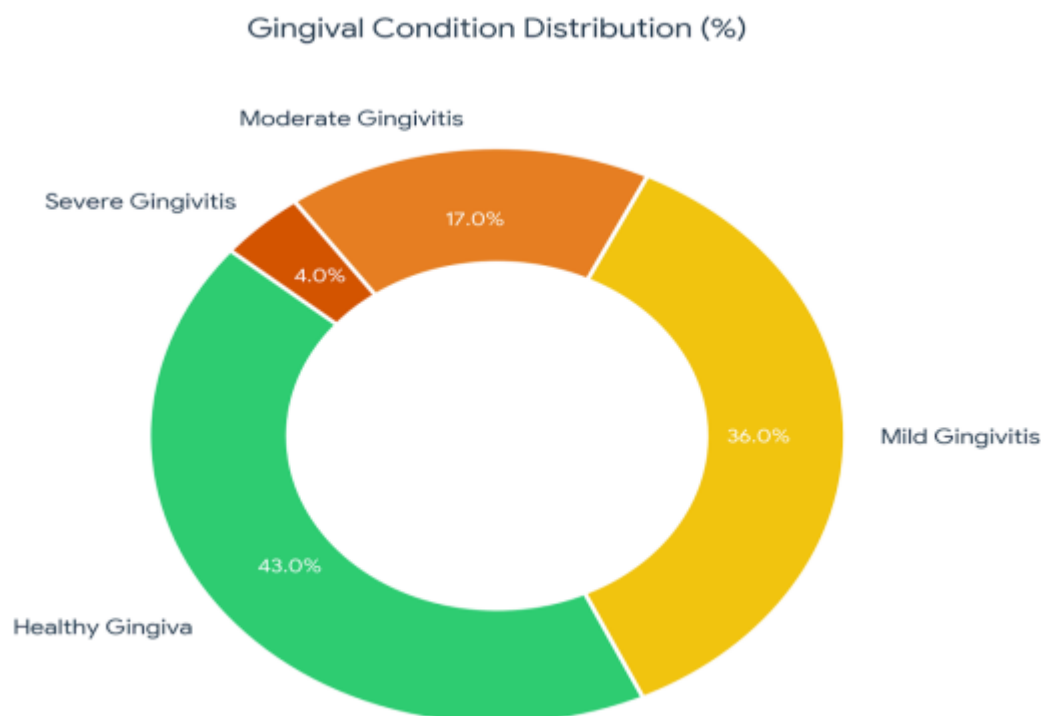


Table 5. Association Between Brushing Frequency and Plaque Control (N = 100)

Brushing Frequency	Good Plaque Control n (%)	Fair/Poor Plaque Control n (%)	Total
Once daily	8 (26.7)	22 (73.3)	30
Twice or More Daily	55 (78.6)	15 (21.4)	70
Chi-square			p = 0.001

Individuals who brushed their teeth at least twice a day were found to better control plaque than those who brushed at least once a day ($p = 0.001$).

Table 6. Association Between type of Dentifrice usage and Gingival Health (N = 100)

Dentifrice	Healthy Gingiva n (%)	Gingivitis n (%)	Total
Toothpaste (Fluoride)	45 (71.4)	18 (28.6)	63
Manjan/powder (herbal)	8 (21.6)	29 (78.4)	37
Chi-square			p = 0.001

Individuals who brushed teeth using a fluoridated toothpaste had healthier gums than individuals using a herbal Manjan ($p = 0.001$).

DISCUSSION

The current study examined the role of tooth brushing in controlling dental plaque to assess the prevention of gingivitis for adults aged between 20 and 55 years. The results found that the absence of plaque and the condition of the gums improved with tooth brushing in the following situations: brushing was done at least twice a day, brushing was done for at least 2 minutes, and brushing was done with proper tooth brushing technique using a toothpaste. Participants with better oral hygiene habits had better Plaque Index and

Gingival Index scores compared to participants with poor brushing habits. This shows that the daily removal of mechanical plaque is the most important factor in the prevention of gingivitis.

Demographic findings showed that in the study, participants from different age groups, different educational attainment levels, and from different socioeconomic groups participated, with females being the more dominant participants. Gingivitis was present

among participants in all the demographics, however, better oral hygiene and better conditions of the gums were present among participants with higher educational attainment. Albandar and Rams (2002) reported the same findings when they said that better education enhances the awareness of better oral hygiene and preventive behavior. This was reported by Petersen and Ogawa (2012) when they said that the condition of oral hygiene and the health of the gums is affected by socioeconomic status and educational attainment.

The study observed that only 30% of participants brushed their teeth once a day while 58% brushed twice a day. Those who brushed their teeth twice or more times a day had better plaque control compared to those who brushed once a day ($p = 0.001$). These results go hand in hand with the study by Yaacob et al. (2014). According to their systematic review, brushing teeth at least twice a day leads to lower plaque levels and lower gingival inflammation, compared to brushing once a day or less.

Toothbrushing using a fluoridated toothpaste had a significantly higher level of plaque and gingivitis control than with toothbrushing using Herbal Manjan/powder, $p=0.001$. This coincides with the results derived by Gupta et al (2012). They studied the effects of different dentifrices on the microbes, concluding that the effects of fluoridated toothpastes were superior in reducing pathogens when compared to herbal Manjan/powders. Shah et al. (2018) also showed significant differences between toothpaste-toothbrush users and other traditional oral hygiene practices on gingival bleeding, which correlates with the observed data.

The present study shows that poor plaque control was related to moderate and severe gingivitis. This strengthens the already known correlation of plaque accumulation and gingival inflammation. Trombelli et al. (2018) reported plaque as the leading cause of gingivitis and that the removal of plaque improves gingival health. Murakami et al. (2018) pointed out the importance of plaque control in the progression of gingivitis to periodontitis.

The control of plaque was also linked to the duration of tooth brushing. It was found that participants who brushed for a minimum of two minutes had a lower plaque score compared to those brushed for less than two minutes. This study also supported the suggestion made by Creeth et al. (2009), that a longer brushing duration improved the removal of plaque.

The current findings provide compelling evidence for the need to promote effective toothbrushing, but some limitations should be noted. The cross-sectional design restricts the ability to link toothbrushing behaviors to causative factors for poor gingival health. The use of self-reported oral hygiene practices may suffer from the

effects of recall bias and social desirability bias. The use of standardized clinical indices of gingival health with direct oral examinations, however, increased the reliability of the data collected. It is suggested that future research be conducted in the gerontological population using larger sample sizes, and be designed as longitudinal and/or randomized clinical studies to assess the impact and/or effectiveness of various toothbrushing techniques and prevention-oriented strategies of oral hygiene.

Generally, the results of the present study coincide with findings and recommendations of current periodontal research. This research continues to identify effective toothbrushing as one of the most economical and pragmatic strategies for the prevention of the formation of dental plaque and gingivitis. Enhanced brushing techniques included in oral health education programs may provide a fundamental improvement in the overall adult population's oral health by reducing the incidence of gingival diseases.

CONCLUSION

The present study provides evidence that adult populations (20–55 years) who practice effective toothbrushing are able to prevent the formation of gingivitis. Those participants who brushed at least twice a day, had an adequate brushing time, and utilized proper brushing techniques with fluoridated toothpaste had healthier gingival tissues and less plaque. The burden of oral health and periodontal disease will be reduced with the incorporation of effective toothbrushing practice education combined with frequent preventive clinical dental care.

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