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Original Research Article

Evaluation of Plaque Control Measures in Reducing Plaque-Induced Chronic Inflammatory Gingival Enlargement

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Abstract: ***Background*:** Plaque-induced chronic inflammatory gingival enlargement is a reversible consequence of prolonged bacterial plaque accumulation and poor oral hygiene that may impair aesthetics, comfort and masticatory function if untreated. Although its association with plaque is well established, comparative clinical evidence on the effectiveness of routine plaque control in community dental settings, particularly among South Asian populations, remains limited. This study evaluated the effectiveness of structured plaque control measures in reducing plaque-induced chronic inflammatory gingival enlargement. ***Methods*:** This prospective quasi-experimental study was conducted by the Department of Dental Public Health, Outpatients Department of Pioneer Dental College and Hospital, Dhaka, Bangladesh, from August 2025 to February 2026. A total of 50 adult outpatients with clinical evidence of plaque-induced chronic inflammatory gingival enlargement were enrolled and followed for twelve weeks after a structured plaque control intervention. Participants received oral hygiene instruction, professional scaling and reinforced brushing guidance and were assessed at baseline and 12 weeks using the Gingival Index, Modified Plaque Index and gingival enlargement score. Data were analyzed using SPSS version 25.0. ***Results*:** Following intervention, the mean Gingival Index reduced from 2.14 to 0.68, Modified Plaque Index from 2.31 to 0.72 and gingival enlargement score from 2.85 mm to 1.10 mm, corresponding to reductions of 68.2%, 68.8% and 61.4% respectively ($p<0.001$ for all). Severe enlargement fell from 42.0% to 4.0%, while participants with no enlargement rose from 4.0% to 36.0%. Improvement was consistent across all oral hygiene habit subgroups. ***Conclusion*:** Structured plaque control measures produced substantial and statistically significant improvement in gingival health and enlargement severity within twelve weeks, strongly supporting their integration into routine preventive periodontal care protocols.

Keywords: Gingival Enlargement, Dental Plaque, Oral Hygiene, Gingivitis, Plaque Control.

INTRODUCTION

Gingival health depends on a delicate balance between the host immune response and the bacterial biofilm that continuously forms on tooth surfaces. When this balance is disturbed by the accumulation of dental plaque, the gingival tissues respond with an inflammatory reaction that, if allowed to persist, can manifest clinically as gingival enlargement [1]. Dental plaque-induced gingival conditions are characterized by inflammation confined to the gingiva, reversibility once the bacterial biofilm is removed and a strong dependence on the quantity and duration of plaque accumulation at the gingival margin [1, 2]. Chronic inflammatory gingival enlargement, the most common form of gingival overgrowth encountered in clinical practice, arises when long-standing plaque-induced inflammation leads to fibrous and oedematous tissue changes that increase gingival bulk, disrupt normal contour and interfere with effective oral hygiene practices, thereby perpetuating a self-sustaining cycle of plaque retention and further enlargement [2].

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Globally, periodontal diseases including gingivitis remain among the most prevalent chronic conditions affecting adults, with estimates suggesting that a considerable proportion of the world population experiences some form of plaque-related gingival inflammation during their lifetime [3, 4]. Reports from Bangladesh similarly indicate a high burden of periodontal disease, with community-based assessments identifying poor oral hygiene practices, limited access to preventive dental services and low oral health literacy as key contributing factors among both urban and marginalized populations [5]. Given this burden, primary prevention strategies centered on effective plaque control have consistently been recommended as the cornerstone of gingivitis management, since removal or disruption of the causative biofilm reliably reduces inflammation and halts further tissue enlargement [2-6].

A wide range of plaque control measures have been evaluated in the literature, spanning professional mechanical debridement, individualized oral hygiene instruction, adjunctive chemical agents and traditional cleaning aids such as toothbrush and paste combinations or chewing sticks. Systematic reviews have demonstrated that mechanical toothbrushing remains the mainstay of self-performed plaque removal, with interdental aids providing additional benefit where indicated [7,8]. Adjunctive chemical agents incorporated into mouth rinses and dentifrices have likewise shown measurable reductions in plaque and gingival indices when used alongside mechanical methods [9]. Structured oral hygiene education delivered through demonstration-based or reinforcement techniques has been shown to significantly improve gingival health outcomes in diverse population groups, including adolescents and individuals with special needs [10]. In regions where traditional oral hygiene practices persist, chewing sticks such as miswak, as well as herbal dentifrices derived from similar plant sources, have been reported to produce clinical improvements in plaque and gingival indices comparable to conventional toothbrushing, particularly when used as an adjunct [11, 12].

Despite this evidence, few prospective studies from Bangladesh have quantified the effectiveness of routine, clinic-based plaque control measures specifically on chronic inflammatory gingival enlargement using standardized indices before and after a defined intervention period, limiting practitioners' ability to plan preventive interventions in resource-limited settings. This study was therefore designed to evaluate structured plaque control measures, encompassing professional scaling, oral hygiene instruction and reinforced brushing practices, in reducing plaque accumulation, gingival inflammation and enlargement severity among adult patients over twelve weeks, with additional exploration of outcomes across baseline oral hygiene habits.

MATERIALS AND METHODS

This prospective quasi-experimental study was conducted by the Department of Dental Public Health, Outpatients Department of Pioneer Dental College and Hospital, Dhaka, Bangladesh, from August 2025 to February 2026. The study population comprised adult outpatients with clinical evidence of plaque-induced chronic inflammatory gingival enlargement. A total of 50 participants were enrolled by consecutive sampling and followed for twelve weeks after a structured plaque control intervention.

Selection Criteria

Inclusion Criteria

- Adults aged 18 to 45 years of either sex
- Presence of clinically diagnosed plaque-induced chronic inflammatory gingival enlargement
- Presence of at least 20 natural teeth
- Willingness to comply with the twelve-week follow-up protocol
- Provision of written informed consent

Exclusion Criteria

- Gingival enlargement attributable to systemic disease, hormonal conditions, or drug-induced causes
- History of periodontal surgery or scaling within the preceding six months
- Presence of chronic periodontitis with attachment loss
- Pregnant or lactating women
- Use of antibiotics or anti-inflammatory medication within the preceding one month
- Known systemic illness affecting periodontal status, such as uncontrolled diabetes mellitus

Data Collection Procedure

Data collection followed a structured, sequential protocol to ensure accuracy and reproducibility. At enrolment, each participant underwent an intraoral clinical examination under adequate illumination using a mouth mirror, community periodontal probe and explorer, with all instruments sterilized prior to use. Sociodemographic information, including age, sex, education level and habitual oral hygiene practices, was recorded using a pretested structured questionnaire administered through direct interview. Baseline clinical measurements, comprising the Gingival Index, Modified Plaque Index and gingival enlargement score in millimetres, were recorded by a single calibrated examiner to minimize inter-examiner variability, with periodic duplicate examinations performed to verify intra-examiner reliability. Following baseline assessment, participants received professional plaque control intervention consisting of thorough scaling to remove supragingival and subgingival deposits, followed by individualized, demonstration-based oral hygiene instruction tailored to each participant's existing brushing technique and habitual

cleaning aid, with reinforcement provided at scheduled intervals. Reassessment using identical clinical indices was performed at twelve weeks under the same examination conditions. All data were recorded on standardized case report forms and entered into a secure, password-protected electronic database accessible only to the research team. Participant identity was protected through coded identification numbers and all information was kept strictly confidential in accordance with institutional ethical guidelines, after obtaining written informed consent from every participant.

Statistical Analysis

Data were entered and analyzed using SPSS version 25.0. Descriptive statistics, including frequencies, percentages, means and standard deviations, summarized demographic and clinical variables. The paired t-test compared baseline and twelve-week Gingival Index, Modified Plaque Index and gingival enlargement scores, while one-way ANOVA assessed within-group reductions across oral hygiene habit subgroups. A p-value below 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Distribution of Study Participants (N=50)

Variable	Category	Frequency (n)	Percentage (%)
Age (Years)	18–25	14	28.0
	26–35	21	42.0
	36–45	15	30.0
Sex	Male	26	52.0
	Female	24	48.0
Education Level	Primary / Secondary	12	24.0
	Higher Secondary	18	36.0
	Graduate / Postgraduate	20	40.0
Oral Hygiene Habit	Toothbrush only	18	36.0
	Toothbrush + Paste	22	44.0
	Miswak / Traditional	10	20.0

Table 1 shows the demographic distribution of the study participants. Of the 50 participants, 26 (52.0%) were male and 24 (48.0%) were female. The largest age group was 26–35 years, comprising 21 participants (42.0%), followed by 36–45 years (15, 30.0%) and 18–25 years (14, 28.0%). Regarding education, 20 participants (40.0%) had graduate or postgraduate qualifications, 18 (36.0%) had higher secondary education and 12 (24.0%) had primary or secondary education. With respect to oral hygiene habits, 22 participants (44.0%) used a toothbrush with paste, 18 (36.0%) used a toothbrush only and 10 (20.0%) used miswak or a traditional cleaning method.

Table 2: Comparison of Clinical Indices at Baseline and 12 Weeks (N=50)

Clinical Index	Baseline (Mean ± SD)	12 Weeks (Mean ± SD)	Mean Reduction	% Improvement	p-value
Gingival Index (GI)	2.14 ± 0.42	0.68 ± 0.31	1.46	0.682	< 0.001
Modified Plaque Index (MPI)	2.31 ± 0.38	0.72 ± 0.29	1.59	0.688	< 0.001
Gingival Enlargement Score (mm)	2.85 ± 0.61	1.10 ± 0.45	1.75	0.614	< 0.001

Table 2 compares clinical indices at baseline and at 12 weeks. The mean Gingival Index reduced from 2.14 ± 0.42 at baseline to 0.68 ± 0.31 at 12 weeks, a mean reduction of 1.46 corresponding to a 68.2% improvement. The Modified Plaque Index reduced from 2.31 ± 0.38 to 0.72 ± 0.29, a mean reduction of 1.59 representing a 68.8% improvement. The Gingival Enlargement Score decreased from 2.85 ± 0.61 mm to 1.10 ± 0.45 mm, a mean reduction of 1.75 mm equivalent to a 61.4% improvement. All three reductions were statistically significant ($p<0.001$).

Table 3: Frequency Distribution of Gingival Enlargement Severity (Before vs. After Intervention)

Severity of Gingival Enlargement	Baseline n (%)	12 Weeks n (%)
None (0 mm)	2 (4.0)	18 (36.0)
Mild (0.1–1.0 mm)	8 (16.0)	22 (44.0)
Moderate (1.1–2.5 mm)	19 (38.0)	8 (16)
Severe (> 2.5 mm)	21 (42.0)	2 (4)
Total	**50**	**50**

Table 3 presents the frequency distribution of gingival enlargement severity before and after the intervention. At baseline, 21 participants (42.0%) had severe enlargement and 19 (38.0%) had moderate enlargement, while only 2 (4.0%) had no enlargement and 8 (16.0%) had mild enlargement. At 12 weeks, this distribution shifted markedly, with 18 participants (36.0%) showing no enlargement and 22 (44.0%) showing mild enlargement, while only 8 (16.0%) remained in the moderate category and 2 (4.0%) remained severe.

Table 4: Subgroup Analysis of Response to Plaque Control by Baseline Oral Hygiene Habit

Baseline Oral Hygiene Habit	n	Baseline GI (Mean)	12 Weeks GI (Mean)	Mean GI Reduction	% Reduction	p-value (Within Group)
Toothbrush only	18	2.21	0.75	1.46	0.661	< 0.001
Toothbrush + Paste	22	2.1	0.62	1.48	0.705	< 0.001
Miswak / Traditional	10	2.18	0.7	1.48	0.683	< 0.001
Overall (All Groups)	50	2.14	0.68	1.46	0.682	< 0.001

Table 4 presents the subgroup analysis of response to plaque control according to baseline oral hygiene habit. Participants using a toothbrush with paste (n=22) showed a mean Gingival Index reduction from 2.10 to 0.62, a 70.5% reduction. Participants using a toothbrush only (n=18) showed a reduction from 2.21 to 0.75, a 66.1% reduction, while participants using miswak or a traditional method (n=10) showed a reduction from 2.18 to 0.70, a 68.3% reduction. The overall Gingival Index reduction across all groups was 68.2%. Each subgroup demonstrated a statistically significant within-group reduction ($p<0.001$).

DISCUSSION

The present study demonstrated that a twelve-week structured plaque control intervention produced a substantial and statistically significant reduction in gingival inflammation, plaque accumulation and the severity of chronic inflammatory gingival enlargement among adult participants. The mean Gingival Index reduced from 2.14 to 0.68, a 68.2% improvement, closely reflecting the magnitude of change reported in comparable trials. Findings from Kumar *et al*., show that structured oral hygiene education incorporating visual reinforcement techniques produced a 58.7% reduction in gingival scores among adolescents over a comparable follow-up period, a slightly smaller but directionally consistent improvement, likely reflecting differences in participant age and the added benefit of professional scaling in the present protocol [10]. Similarly, the substantial reduction in Modified Plaque Index observed here, from 2.31 to 0.72, aligns with the conclusion of Sälzer *et al*., that toothbrushing combined with individually tailored instruction remains the most consistently effective approach for mechanical plaque control, regardless of the specific device used [7]. This is further reinforced by Slot *et al*., who, in a network meta-analysis of mechanical plaque removal, reported no clinically meaningful superiority of powered over manual toothbrushes, suggesting that the quality of technique and consistency of use, rather than the device itself, primarily determine clinical outcomes [8].

The marked shift in gingival enlargement severity observed in the present study, with severe cases falling from 42.0% to 4.0% and enlargement-free participants rising from 4.0% to 36.0%, is consistent with the established understanding that chronic inflammatory gingival enlargement is largely reversible once the causative plaque biofilm is controlled. Murakami *et al*., describe plaque-induced gingival conditions as inherently reversible provided that bacterial biofilm is adequately disrupted, a principle strongly supported by the magnitude of enlargement reduction observed in the present cohort [1]. Tan and Yan similarly emphasize that combined plaque and inflammation control forms the foundation of non-surgical management for gingival hypertrophy, noting that fibrotic components not responding to conservative therapy may require surgical intervention, which was not necessary for any participant in the present study given the favourable early response to non-surgical measures [13].

The subgroup analysis by baseline oral hygiene habit revealed comparable improvement across toothbrush-only, toothbrush-with-paste and miswak or traditional-method users, with Gingival Index reductions of 66.1%, 70.5% and 68.3% respectively. This finding is consistent with Rifaey *et al*., who reported that miswak chewing sticks, when combined with toothbrushing, produced significant improvement in gingival and plaque indices comparable to toothbrushing alone, supporting the acceptability of traditional cleaning aids as effective adjuncts within structured plaque control programmes [11]. Likewise, Azizan *et al*., found no statistically significant difference in plaque and gingivitis control between a Salvadora persica chewing stick and a standard toothbrush, reinforcing the observation in the present study that the specific cleaning aid mattered less than the consistency of professional reinforcement and follow-up [14]. Garg *et al*., similarly demonstrated that both herbal and non-herbal dentifrices produced significant reductions in plaque and gingival scores over a comparable timeframe, further supporting the present finding that the type of product used was less influential than adherence to a structured hygiene regimen [15].

The overall improvement observed also compares favourably with the findings of Zaheer *et al*., who reported a high burden of periodontal disease in Bangladeshi populations with limited access to preventive oral healthcare, underscoring the value of structured, supervised plaque control in similar community settings [5]. Nazir *et al*., likewise highlighted the disproportionate burden of periodontal disease in low- and middle-income countries, a context in which the present findings suggest that simple, low-cost interventions comprising scaling and reinforced oral hygiene instruction can achieve meaningful improvement within a short timeframe [3]. Trombelli *et al*., further note that a gingivitis case can be reliably identified through bleeding-based criteria, supporting the use of standardized indices such as those applied in the present study to objectively track treatment response over time [2]. Serrano *et al.,* additionally reported that adjunctive chemical plaque control agents can enhance outcomes when mechanical hygiene alone is insufficient, an option that may be considered for participants demonstrating slower resolution in future extensions of this work [9]. Taken together, these findings affirm that consistent mechanical plaque control, irrespective of the specific cleaning modality, remains the most reliable determinant of resolution in plaque-induced chronic inflammatory gingival enlargement and that structured reinforcement of oral hygiene behaviour, rather than reliance on any single device or product, should form the basis of preventive dental public health strategies in similar populations.

Limitations and Recommendations

This single-center study had a modest sample size and lacked a control group. Future multicenter randomized controlled trials with longer follow-up are recommended to strengthen the generalizability of these findings.

CONCLUSION

This study demonstrated that structured plaque control measures, comprising professional scaling and reinforced oral hygiene instruction, significantly reduced plaque accumulation, gingival inflammation and enlargement severity over twelve weeks. Improvement was consistent across baseline oral hygiene habits, confirming that routine mechanical plaque control effectively reverses early plaque-induced gingival changes. These findings support integrating structured, supervised plaque control programmes into dental public health practice, particularly within resource-limited community settings, to reduce the preventable burden of gingival disease.

Conflicts of Interest: There are no conflicts of interest.

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