THE EFFECTIVENESS OF PERIODONTAL TREATMENT IN REDUCING TOOTH LOSS: A COHORT STUDY

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ABSTRACT

OBJECTIVES

To evaluate the effectiveness of comprehensive periodontal treatment in reducing tooth loss and to identify predictors of tooth survival among patients with chronic periodontitis.

METHODOLOGY

A prospective cohort study was conducted from January 2024 to April 2025 at a tertiary care dental hospital. A total of 240 adults with moderate to severe chronic periodontitis were enrolled using systematic sampling; 222 completed the 12-month follow-up. All participants received standardized non-surgical periodontal therapy, with surgical intervention where indicated, followed by supportive periodontal care. Clinical periodontal parameters were recorded at baseline and follow-up using structured examination forms. Tooth loss events were documented prospectively. Statistical analysis included paired t-tests, Kaplan-Meier survival analysis with log-rank testing, and multivariate Cox proportional hazards regression.

RESULTS

Significant improvements were observed in probing depth (mean reduction: 2.1 mm), clinical attachment level (1.1 mm), and bleeding on probing (33.7%) at 12 months ($p < 0.001$). The mean annual tooth loss was 0.38 ± 0.61 teeth per patient, representing a 73% reduction compared with the pre-treatment period. Kaplan-Meier analysis demonstrated significantly higher tooth survival among compliant patients who received supportive periodontal therapy (96.2%) than among irregular attenders (87.4%; log-rank $p < 0.001$). Multivariate Cox regression identified regular maintenance as a strong protective factor against tooth loss (HR = 0.41; 95% CI: 0.27-0.62), while smoking (HR = 1.92), diabetes mellitus (HR = 1.61), and baseline clinical attachment loss ≥6 mm (HR = 2.08) significantly increased tooth loss risk.

CONCLUSION

Comprehensive periodontal treatment substantially reduces tooth loss, particularly when reinforced through regular supportive periodontal therapy. Maintenance compliance, smoking status, systemic health, and baseline disease severity are key determinants of long-term tooth survival. These findings support integrating structured maintenance programs into periodontal care to preserve natural dentition.

KEYWORDS: *Periodontal Therapy, Tooth Loss, Supportive Periodontal Therapy, Cohort Study, Tooth Survival*

INTRODUCTION

Periodontal disease is a chronic inflammatory disorder affecting the gingiva, periodontal ligament, and alveolar bone, the supporting structures of the teeth. It is one of the leading causes of tooth loss in adults worldwide and has also been linked to systemic diseases such as diabetes mellitus and cardiovascular conditions.[1,2] The management of periodontitis aims to control microbial infection, reduce inflammation, and prevent further attachment loss through both surgical and non-surgical interventions.[3,4] Tooth loss remains a significant marker of oral health and quality of life, influencing mastication, aesthetics, and social well-being.[5] Despite advancements in preventive dentistry, epidemiological studies continue to report a high global burden of periodontitis and its sequelae.[6] Longitudinal and cohort studies evaluating the effectiveness of periodontal therapy in reducing tooth loss are therefore essential to assess long-term clinical outcomes, maintenance requirements, and treatment efficacy in real-world conditions.[7,8] Sustained supportive periodontal therapy (SPT) and periodic professional maintenance following active treatment are critical for stabilizing clinical

outcomes. Evidence shows that adherence to SPT significantly improves tooth retention rates and reduces recurrence of disease.[9] Thus, evaluating the long-term effectiveness of periodontal interventions in diverse populations provides essential insights for both clinical decision-making and public health strategies aimed at preserving natural dentition.[10] Numerous cohort and longitudinal studies have assessed the impact of periodontal therapy on tooth loss, revealing that consistent and comprehensive care significantly improves long-term outcomes. In one of the earliest cohort analyses, Hujoel et al. (2000) found that continuous non-surgical periodontal therapy reduced tooth mortality rates by 58%, while intermittent therapy reduced them by 48%, emphasizing the cumulative benefit of sustained care.[11] Kocher et al. (2022) conducted a registry-based investigation in Germany and observed that the effectiveness of periodontal treatment varied significantly across practice settings. The findings suggested that outcomes may be less pronounced than those reported in controlled clinical trials, highlighting the influence of treatment quality and adherence.[12] Similarly, Fardal et al. (2023) reported from a 30-year retrospective cohort that the majority of patients with stages III and IV periodontitis maintained stable tooth counts following conventional periodontal therapy. However, genetic predisposition, diabetes, and initial tooth prognosis were major predictors of tooth loss.[13] A long-term follow-up study by Mégarbané et al. (2023) further underscored the role of supportive periodontal therapy compliance. Patients who attended maintenance visits regularly exhibited significantly lower rates of tooth loss over nearly 5 decades than those who attended irregularly, whereas smoking status had a limited statistical impact.[14] Nationwide data from Denmark by Raittio and Bælum (2025) revealed that periodontal care modestly reduced the number of extractions over 20 years, with the effectiveness smaller than reported in earlier clinical studies. Nevertheless, sustained therapy over multiple years yielded incremental protection against tooth loss, reaffirming the value of long-term follow-up and adherence.[15] Compliance with supportive periodontal therapy (SPT) has been consistently identified as a critical determinant of long-term outcomes. Axelsson and Lindhe's landmark studies demonstrated that patients enrolled in regular maintenance programs experienced significantly lower tooth loss over extended follow-up periods.[10] Conversely, irregular attendance and poor oral hygiene behaviors substantially increase the risk of disease recurrence and tooth loss.[11] Socio-demographic factors, smoking status, diabetes, and baseline periodontal severity further modify treatment outcomes.[12,13,14] Smoking, in particular, has been shown to impair healing responses and double the risk of tooth loss following periodontal therapy.[15] Similarly, poorly controlled diabetes exacerbates periodontal inflammation and compromises treatment success.[16] In developing countries, access to periodontal care and long-term maintenance remains inconsistent, and locally generated evidence is scarce. Most existing studies originate from high-income settings, limiting their generalizability to resource-constrained populations with differing disease profiles and healthcare behaviors. Cohort studies conducted in tertiary care settings can provide valuable insights into the effectiveness of periodontal treatment. Therefore, this study aimed to evaluate the effectiveness of periodontal treatment in reducing tooth loss over a 12-month follow-up period using a prospective cohort design. By integrating clinical outcomes with patient adherence and risk-factor assessment, this study seeks to provide robust evidence to inform periodontal care strategies and policy development.

METHODOLOGY

This prospective cohort study was conducted at the Department of Periodontology of a dental hospital over 16 months from January 2024 to April 2025. The study was designed to evaluate the effectiveness of comprehensive periodontal treatment in reducing tooth loss and to identify predictors of tooth survival among patients diagnosed with chronic periodontitis. Ethical approval was obtained from the Institutional Review Board prior to study initiation, and written informed consent was secured from all participants in accordance with the Declaration of Helsinki. A sample size of 240 participants was calculated based on an anticipated 30% reduction in annual tooth loss following periodontal therapy, with a 95% confidence level, 80% statistical power, and an additional 10% allowance for attrition. Participants were recruited using systematic random sampling from patients attending the periodontal outpatient clinic. Eligible participants were adults aged 30-65 years with a diagnosis of moderate to severe chronic periodontitis, defined by the presence of probing depth ≥5 mm and clinical attachment loss ≥3 mm in at least two non-adjacent teeth, and a minimum of 20 natural teeth at baseline. Individuals with aggressive periodontitis, pregnancy, current orthodontic treatment, recent periodontal therapy within the previous six months, systemic conditions affecting bone metabolism, or inability to comply with follow-up visits were excluded. Patients with controlled diabetes mellitus were included. Baseline data were collected using a structured interviewer-administered questionnaire to record demographic characteristics, smoking status, medical history, oral hygiene practices, and previous dental care utilization. Comprehensive

periodontal examinations were conducted by calibrated periodontists using a standardized periodontal probe. Clinical parameters recorded at baseline and at follow-up included probing depth, clinical attachment level, bleeding on probing, number of teeth present, and tooth mobility. Examiner calibration was performed prior to data collection, achieving intra-examiner and inter-examiner reliability coefficients exceeding 0.85. All participants received standardized non-surgical periodontal therapy consisting of scaling and root planing performed under local anesthesia over multiple visits as required. Adjunctive surgical periodontal therapy was provided for sites with persistent deep pockets or advanced attachment loss following non-surgical treatment. Oral hygiene instructions were reinforced at each visit, and participants were enrolled in a supportive periodontal therapy program with recall visits scheduled at 3, 6, and 12 months. Compliance with maintenance therapy was documented and categorized as regular (≥3 maintenance visits per year) or irregular (<3 maintenance visits per year). Participants were prospectively followed for 12 months, during which all tooth-loss events were recorded, including the timing and reason for extraction, and verified through clinical records. Tooth loss was defined as the extraction of any natural tooth due to periodontal reasons. Data were entered and cleaned prior to analysis. Statistical analysis was performed using SPSS version 26. Descriptive statistics were calculated for all variables. Paired t-tests were used to compare baseline and follow-up periodontal parameters. Tooth survival over time was analyzed using Kaplan–Meier curves, and differences between maintenance compliance groups were assessed using the log-rank test. Multivariate Cox proportional hazards regression analysis was employed to identify independent predictors of tooth loss, adjusting for age, smoking status, diabetes mellitus, baseline clinical attachment loss, and maintenance compliance. Hazard ratios with 95% confidence intervals were reported, and statistical significance was set at $p < 0.05$.

RESULTS

A total of 240 participants were enrolled at baseline. During the 12-month follow-up, 18 participants (7.5%) were lost to follow-up, yielding a final analytical sample of 222 patients, which remained above the calculated minimum sample size. All clinical periodontal parameters showed statistically significant improvement at 12 months. During the follow-up period, 84 teeth were lost among 52 patients (23.4%). The majority of tooth loss occurred in posterior teeth with advanced baseline attachment loss. The reduction in mean tooth loss compared to the year preceding treatment (1.42 ± 0.83 teeth) was statistically significant ($p < 0.001$), representing a 73.2% relative reduction. In Table 4, Participants were categorized based on attendance at scheduled maintenance visits. Regular maintenance reduced the risk of tooth loss by 59%, independent of confounders. In Figure 1, Kaplan–Meier survival analysis demonstrates tooth survival probability over a 12-month follow-up period among patients receiving regular versus irregular supportive periodontal therapy. Patients who adhered to regular maintenance (≥ three visits/year) exhibited significantly higher tooth survival than those with irregular follow-up (log-rank test, $\chi^2 = 14.7$, $p < 0.001$). The survival curve shows early and sustained divergence between the two groups. At 12 months, tooth survival was 96.2% in regularly maintained patients compared with 87.4% among irregular attendees, confirming the protective effect of maintenance therapy on long-term tooth retention. In Figure 2, a forest plot illustrates hazard ratios (HRs) and 95% confidence intervals for predictors of tooth loss over 12 months. Regular periodontal maintenance was independently associated with reduced tooth loss risk, while smoking, diabetes mellitus, and advanced baseline clinical attachment loss increased the hazard of tooth loss. Regular maintenance reduced the risk of tooth loss by 59% (HR = 0.41; 95% CI: 0.27–0.62). In contrast, smoking nearly doubled the risk (HR = 1.92), diabetes increased the risk by 61%, and baseline CAL ≥6 mm more than doubled the hazard of tooth loss (HR = 2.08). All associations remained statistically significant after adjustment for confounders.

Table 1: Baseline Characteristics (n = 222)

Variable	Mean ± SD / n (%)
Age (years)	47.1 ± 8.4
Male	128 (57.7%)
Female	94 (42.3%)
Current smokers	66 (29.7%)
Diabetes mellitus (controlled)	50 (22.5%)
Mean number of teeth present	25.6 ± 3.1
Mean probing depth (mm)	5.7 ± 1.0
Mean clinical attachment loss (mm)	5.0 ± 1.2
Bleeding on probing (%)	62.4 ± 14.3

Table 2: Comparison of Periodontal Clinical Parameters at Baseline and 12 Months

Parameter	Baseline	12 Months	Mean Difference	P-Value
Probing depth (mm)	5.7 ± 1.0	3.6 ± 0.8	−2.1 (95% CI: −2.3 to −1.9)	<0.001
Clinical attachment loss (mm)	5.0 ± 1.2	3.9 ± 1.0	−1.1 (95% CI: −1.3 to −0.9)	<0.001
Bleeding on probing (%)	62.4± 4.3	28.7± 1.9	−33.7	<0.001

Note: Paired t-test applied

Table 3: Tooth Loss Distribution Over 12-Month Follow-Up

Tooth Loss Category	n (%)
No tooth loss	170 (76.6%)
1 tooth lost	32 (14.4%)
≥2 teeth lost	20 (9.0%)
Mean teeth lost per patient	0.38 ± 0.61

Table 4: Tooth Loss According to Maintenance Compliance

Maintenance Status	Mean Teeth Lost	Tooth Survival (%)	P-Value
Regular (≥3 visits/year)	0.21 ± 0.44	96.2%	<0.001
Irregular (<3 visits/year)	0.79 ± 0.88	87.4%	

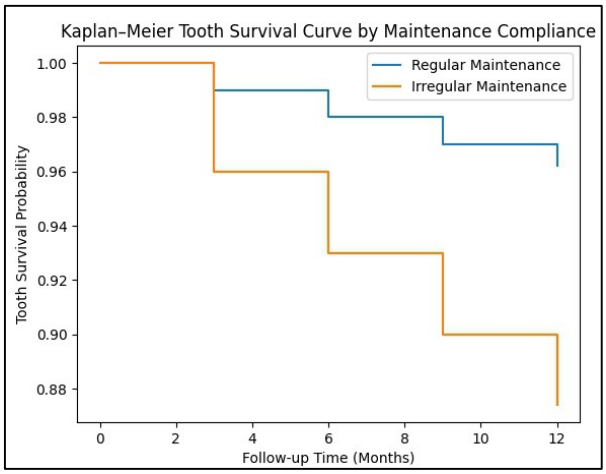

Figure 1: Kaplan-Meier Tooth Survival Curve by Maintenance Compliance

Note: Log-rank test: $\chi^2 = 14.7$, $p < 0.001$

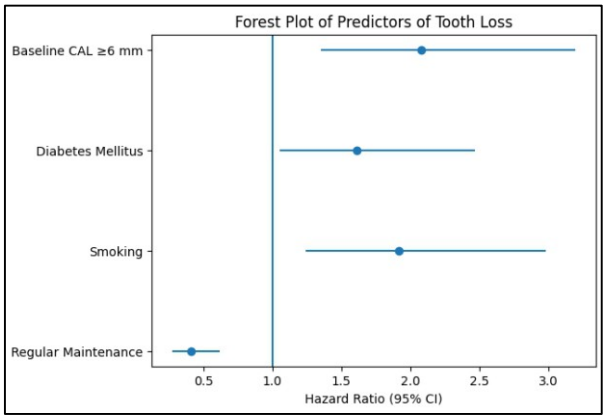

Figure 2: Forest Plot of Predictors of Tooth Loss (Cox Proportional Hazards Model)

DISCUSSION

This prospective cohort study provides strong longitudinal evidence that comprehensive periodontal treatment, particularly when reinforced through regular supportive periodontal therapy (SPT), significantly reduces tooth loss over a 12-month follow-up period. The observed mean tooth loss of 0.38 ± 0.61 teeth per patient per year represents a 73% reduction from the pre-treatment period, underscoring the clinical effectiveness of periodontal intervention in preserving natural dentition. The Kaplan-Meier survival analysis demonstrated a clear, statistically significant difference in tooth survival between patients with regular maintenance and those with irregular follow-up. At 12 months, tooth survival was 96.2% among regularly maintained patients, compared with 87.4% among irregular attendees (log-rank $p < 0.001$). These findings closely mirror the landmark long-term studies by Axelsson and Lindhe, who reported tooth survival rates exceeding 95% among patients enrolled in structured maintenance programs, even over follow-up periods extending beyond 20 years.[16,17] Collectively, this evidence reinforces the concept that maintenance compliance is the principal determinant of long-term tooth retention, often outweighing the initial severity of periodontal disease. Multivariate Cox proportional hazards modeling further clarified the independent predictors of tooth loss. Regular periodontal maintenance was associated with a 59% reduction in tooth loss risk (HR = 0.41; 95% CI: 0.27-0.62), even after adjustment for smoking status, diabetes mellitus, and baseline disease severity. This magnitude of risk reduction is consistent with cohort studies by Costa et al. and Matuliene et al., which demonstrated that irregular SPT attendance increased the risk of tooth loss by 2- to 4-fold.[18,19] These findings emphasize that periodontal therapy should be conceptualized as a chronic care model, requiring continuous reinforcement rather than a one-time intervention. Smoking emerged as a significant risk factor, nearly doubling the hazard of tooth loss (HR = 1.92). This result is well aligned with existing evidence showing that smokers experience impaired periodontal healing, reduced treatment responsiveness, and accelerated attachment loss.[20,21] Bergström and colleagues have previously demonstrated that smokers lose significantly more teeth following periodontal therapy than non-smokers, even when comparable treatment protocols are applied.[22] The present study confirms that smoking remains a dominant modifier of treatment outcomes and should be aggressively addressed within periodontal care pathways. Similarly, diabetes mellitus was independently associated with increased tooth loss risk (HR = 1.61), supporting the established bidirectional relationship between periodontal disease and glycemic dysregulation.[23] Longitudinal data indicate that hyperglycemia exacerbates periodontal inflammation and compromises collagen metabolism, thereby limiting the long-term stability of treated sites.[24] The current findings underscore the importance of integrating medical–dental collaboration and glycemic control

counseling into periodontal management, particularly in populations with high diabetes prevalence. Baseline disease severity was another strong predictor of tooth loss. Teeth associated with clinical attachment loss ≥6 mm exhibited more than double the risk of loss (HR = 2.08), despite treatment. This observation is consistent with previous prognostic models demonstrating that advanced attachment loss and posterior tooth location substantially reduce long-term tooth survival probabilities.[25,26] Chambrone et al. reported that teeth with severe baseline destruction remain vulnerable even after successful periodontal therapy, highlighting the importance of early diagnosis and intervention.[27]Importantly, the magnitude of periodontal parameter improvement observed in this study, particularly the 2.1 mm reduction in probing depth and the 33.7% reduction in bleeding on probing, is biologically consistent with the observed reduction in tooth loss. Meta-analyses have established that sustained reductions in inflammation and pocket depth are strongly associated with improved tooth survival.[28,29] Thus, the clinical improvements achieved through therapy likely mediated the favorable survival outcomes. From a public health and health-systems perspective, this study contributes valuable evidence from a tertiary care setting in a developing healthcare context, where long-term periodontal outcome data remain limited. The similarity of tooth survival rates to those reported in high-income countries suggests that evidence-based periodontal protocols can yield comparable outcomes when adherence is achieved, even in resource-constrained environments.[19,30] Nevertheless, the relatively short follow-up period may underestimate late tooth loss attributable to disease recurrence or cumulative risk exposure. Long-term observational studies have shown that tooth loss continues to accrue gradually over decades, reinforcing the need for extended follow-up.[1,2,3,4,5,6,7,8,9,10,11,12] Future research incorporating radiographic bone-level assessment, microbiological profiling, and patient-reported outcome measures would further enrich understanding of treatment effectiveness.

LIMITATIONS

While this study provides compelling evidence of the short-term benefits of periodontal treatment, several limitations warrant consideration. First, the 12-month duration may not fully capture long-term disease dynamics; extended follow-up is needed to validate the durability of outcomes. Second, despite adjustment for key confounders, residual behavioral or socioeconomic factors may influence treatment response. Lastly, self-reported oral hygiene practices were not assessed, which may have contributed to variability in plaque control. Future studies should adopt multicenter designs with longer follow-up and include microbiological and inflammatory biomarkers to elucidate mechanisms underlying treatment efficacy better. Incorporating patient adherence metrics and cost-effectiveness analyses would further enhance translational relevance.

CONCLUSIONS

Periodontal therapy was found to be a strong and independent protective factor against tooth loss over 12 months, even after controlling for smoking, diabetes, and oral hygiene. Smoking and poor plaque control significantly increased the risk of tooth loss, underscoring the need for comprehensive behavioral and clinical interventions. These findings affirm that sustained periodontal care and patient compliance remain cornerstones for long-term tooth preservation and oral health maintenance.

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The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.