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Systematic Review Article

Association between Periodontal Disease and Diabetes Mellitus: A Systematic review

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ABSTRACT

Background: Periodontal disease and diabetes mellitus are chronic inflammatory conditions that frequently coexist and may influence each other through shared pathogenic mechanisms. Growing evidence suggests a bidirectional relationship, with potential implications for glycaemic control, periodontal outcomes, and diabetes-related complications. This systematic review aimed to synthesize recent evidence on the association between periodontal disease and diabetes mellitus, including therapeutic, complication-related, mechanistic, and Indian population-based data.

Material and methods: A systematic review was conducted in accordance with PRISMA 2020 guidelines. Electronic searches of PubMed/MEDLINE, Scopus, and Web of Science, supplemented by manual reference screening, identified eligible studies published up to June 2025. Studies were included if they evaluated the association between periodontal disease and diabetes, the effect of periodontal therapy on metabolic outcomes, diabetes-related complications, or mechanistic and population-based evidence. Sixteen studies meeting predefined eligibility criteria were included and categorized into four evidence domains. Data were synthesized narratively.

Results: Longitudinal and population-based studies demonstrated a bidirectional association between periodontal disease and diabetes mellitus, indicating increased risk of each condition in the presence of the other. Interventional and synthesis-level evidence showed that non-surgical periodontal therapy was associated with improvements in periodontal parameters and glycaemic control, with adjunctive therapies providing additional benefit in some studies. Evidence from cohort and meta-analytic studies linked periodontitis with a higher risk of diabetes-related complications, particularly microvascular outcomes. Mechanistic studies supported biological plausibility through shared inflammatory and immune pathways, while Indian population-based studies consistently reported a higher prevalence and severity of periodontal disease among individuals with diabetes.

Conclusion: The available evidence supports a clinically meaningful, bidirectional association between periodontal disease and diabetes mellitus. Integrating periodontal care into diabetes management may contribute to improved metabolic control and reduced complication risk.

Keywords*: Periodontal disease; Diabetes mellitus; Glycaemic control; Periodontitis; Systematic review.*

INTRODUCTION

Periodontal disease, particularly periodontitis, is a chronic biofilm-driven inflammatory condition that results in progressive destruction of tooth-supporting tissues. Diabetes mellitus, most commonly type 2 diabetes mellitus (T2DM), is a widespread metabolic disorder characterized by chronic hyperglycaemia and systemic inflammatory dysregulation. These conditions frequently coexist and share several risk determinants, including ageing, smoking, obesity, and socioeconomic factors. However, contemporary consensus has moved beyond a shared-risk framework and recognizes periodontitis as independently associated with diabetes and other systemic outcomes, with implications for integrated medical–dental care [1].

Biologically, periodontal inflammation may contribute to impaired glycaemic regulation through sustained systemic inflammatory burden, recurrent bacteraemia, and dissemination of microbial products, promoting insulin resistance and adverse metabolic profiles. Conversely, hyperglycaemia exacerbates periodontal tissue breakdown via altered immune responses, impaired collagen metabolism, microvascular dysfunction, and amplified inflammatory signaling. Consequently, periodontitis and diabetes are now conceptualized as interacting chronic conditions rather than isolated diseases managed independently [2].

Clinically, this interaction is relevant even before overt diabetes is diagnosed. Evidence synthesis has shown that individuals with periodontitis, despite not having diabetes, tend to exhibit higher HbA1c levels compared with periodontally healthy individuals, suggesting a link between periodontal inflammation and early metabolic dysregulation and supporting the potential role of dental settings in opportunistic glycaemic screening [3]. Interventional studies in non-diabetic populations further indicate that non-surgical periodontal therapy may be associated with modest HbA1c reductions, although outcomes vary according to baseline metabolic risk and study design [4].

In patients with established diabetes, the contribution of periodontal therapy to metabolic control has been extensively evaluated. A Cochrane review concluded that periodontal treatment improves periodontal outcomes and may result in modest improvements in glycaemic control, while highlighting heterogeneity and methodological limitations across trials [5]. Umbrella reviews summarizing multiple systematic reviews have similarly reported short- to medium-term reductions in HbA1c following non-surgical periodontal therapy, with variability related to adjunctive interventions, diabetes duration, and baseline glycaemic status [6]. More recent meta-analyses restricted to randomized trials with standardized follow-up have strengthened the interpretability of these findings, demonstrating statistically significant but clinically modest HbA1c reductions, reinforcing periodontal therapy as an adjunct rather than a substitute for medical diabetes management [7].

While global evidence is substantial, the relevance of these findings to specific health systems depends on population characteristics, access to periodontal care, and diabetes detection practices. In India, the concurrent high burden of diabetes and periodontal disease, coupled with variable oral health awareness and access to care, underscores the need for context-specific evidence synthesis. Accordingly, the present systematic review evaluates the association between periodontal disease and diabetes mellitus, with particular emphasis on recent evidence and Indian population-based studies, to inform integrated screening and management strategies relevant to clinical practice.

MATERIAL AND METHODS

Study Design and Reporting Framework: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review protocol was developed a priori, defining the research question, eligibility criteria, outcomes of interest, and methods for study selection and data synthesis.

Eligibility Criteria: Eligibility criteria were defined using a PECO/PICO-based framework, tailored to the scope of the included studies and stratified according to the four predefined evidence domains represented in Tables 1–4.

Population: Studies were eligible if they included:

- Adults diagnosed with **diabetes mellitus** (type 1, type 2, or prediabetes), or
- Adult populations assessed for **periodontal disease** with documented diabetes status

No restrictions were placed on sex, ethnicity, or geographic location.

Exposure / Intervention:

- Presence of **periodontal disease**, defined clinically using established periodontal indices, or
- **Non-surgical periodontal therapy**, with or without adjunctive interventions, in interventional studies

Comparators:

- Individuals without periodontal disease or without diabetes
- Baseline measurements prior to periodontal intervention
- Standard medical care without periodontal treatment (where applicable)

Outcomes: Primary and secondary outcomes were defined according to study category:

- **Association outcomes**: incidence or prevalence of diabetes or periodontal disease
- **Therapeutic outcomes**: changes in glycaemic control (e.g., HbA1c), periodontal clinical parameters, and inflammatory biomarkers
- **Complication outcomes**: diabetes-related microvascular or macrovascular complications
- **Mechanistic outcomes**: genetic associations, molecular pathways, or population-level prevalence data

Study Designs: The following study designs were included:

- Systematic reviews and meta-analyses
- Cohort and register-based studies

- Randomized controlled trials and clinical interventional studies
- Cross-sectional and case–control studies
- Mendelian randomization and bioinformatic analyses

Editorials, narrative reviews, case reports, animal studies, and in vitro studies were excluded.

Information Sources and Search Strategy: A comprehensive literature search was conducted using PubMed/MEDLINE, Scopus, and Web of Science to identify relevant articles published up to June 2025. The search strategy combined controlled vocabulary and free-text terms related to *periodontal disease*, *diabetes mellitus*, *glycaemic control*, and *diabetes complications*. In addition, manual screening of reference lists from relevant reviews and key articles was performed to identify additional eligible studies. Indian population-based studies were further identified through targeted searches and citation tracking. Only peer-reviewed full-text articles published in English were considered.

Study Selection: All retrieved records were screened in two stages:

1. **Title and abstract screening** to exclude clearly irrelevant studies
2. **Full-text review** to assess eligibility against predefined criteria

Study selection was conducted independently by reviewers, with discrepancies resolved through discussion.

Data Extraction: Data were extracted using a standardized form designed prior to review commencement. The following information was collected:

- Author(s) and year of publication
- Study design and setting
- Population characteristics
- Exposure/intervention and comparator details
- Outcome measures assessed
- Principal findings relevant to the review objectives

Extracted data were synthesized narratively and organized into four thematic tables reflecting study type and outcome focus.

Study Grouping and Evidence Classification: Included studies were categorized into four evidence domains:

1. Bidirectional association between periodontal disease and diabetes (Table 1)
2. Effects of periodontal therapy on glycaemic and inflammatory outcomes (Table 2)
3. Association between periodontal disease and diabetes-related complications (Table 3)
4. Mechanistic and Indian population-based evidence (Table 4)

This stratification enabled structured synthesis while minimizing methodological heterogeneity across analyses.

Risk of Bias Assessment: Risk of bias was assessed using design-specific tools:

- **AMSTAR 2** for systematic reviews and meta-analyses
- **Cochrane Risk of Bias 2 tool** for randomized controlled trials
- **Newcastle–Ottawa Scale** for cohort and observational studies
- **Joanna Briggs Institute checklist** for cross-sectional studies

Risk of bias assessments were used to inform qualitative interpretation of findings but did not serve as exclusion criteria.

Data Synthesis

Given the heterogeneity in study design, populations, and outcomes, a narrative synthesis approach was adopted. Findings were summarized by evidence domain, emphasizing consistency of direction and strength of associations rather than pooled quantitative estimates. Results were reported in accordance with PRISMA recommendations without duplication of tabulated data.

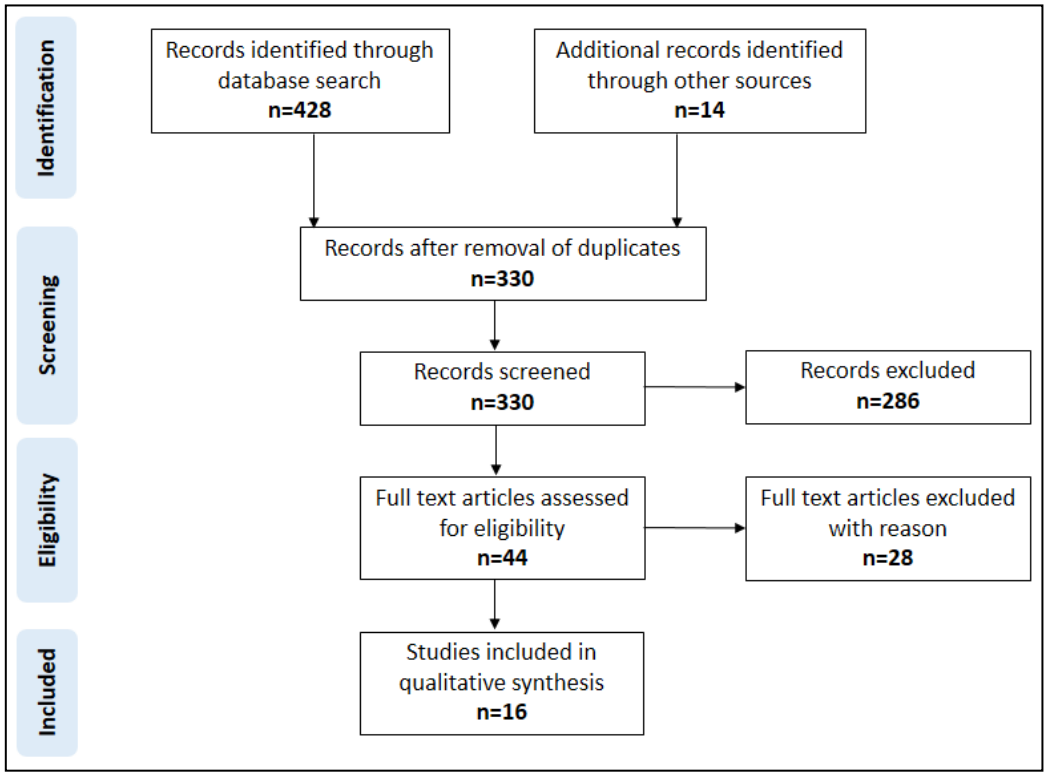

Figure 1: PRISMA flow diagram

A comprehensive electronic search of PubMed/MEDLINE, Scopus, and Web of Science identified 428 records related to the association between periodontal disease and diabetes mellitus. An additional 14 records were identified through manual searching of reference lists and citation tracking, resulting in a total of 442 records. After removal of 112 duplicate records, 330 unique records remained for title and abstract screening. During this stage, 286 records were excluded due to irrelevance to the review question, including studies not involving periodontal disease or diabetes mellitus, animal or in vitro studies, case reports, editorials, and narrative reviews. The full texts of 44 articles were assessed for eligibility. Of these, 28 articles were excluded for the following reasons: inappropriate study design (n = 11), absence of relevant periodontal or diabetes-related outcomes (n = 9), duplicate or overlapping study populations (n = 4), and insufficient methodological detail or unavailable full text (n = 4). Ultimately, 16 studies met the predefined inclusion criteria and were included in the qualitative synthesis. These studies were categorized into four predefined evidence domains: bidirectional association studies, periodontal intervention studies, diabetes-related complication studies, and mechanistic or Indian population-based studies.

RESULTS

Evidence from longitudinal and population-based studies consistently demonstrated a bidirectional relationship between periodontal disease and diabetes mellitus (Table 1). Cohort-level synthesis indicated that individuals with periodontal disease had a higher likelihood of developing diabetes over time, while patients with diabetes exhibited an increased risk of incident periodontitis. Register-based and population-level analyses further reinforced this association by showing that periodontitis was more prevalent among individuals with diabetes and that its presence was linked to a higher burden of diabetes-related complications. Collectively, these findings support a reciprocal interaction between the two conditions rather than a unidirectional association.

Across systematic reviews, randomized clinical trials, and interventional studies, periodontal therapy was associated with improvements in both periodontal parameters and glycaemic outcomes in patients with diabetes or prediabetes (Table 2). Evidence synthesis suggested that non-surgical periodontal treatment contributed to clinically meaningful improvements in glycaemic control, with effects observed alongside standard medical therapy. Randomized trials further indicated that adjunctive approaches, such as the use of hyaluronic acid, enhanced periodontal healing and were accompanied by favorable metabolic responses. Biomarker-based monitoring also demonstrated reductions in inflammatory activity following periodontal intervention, supporting a biological link between periodontal inflammation control and metabolic regulation.

Findings addressing diabetes-related complications consistently indicated that periodontal disease was associated with an increased risk of microvascular outcomes (Table 3). Meta-analytic evidence showed a significant association between periodontitis and diabetic retinopathy, while large-scale cohort data demonstrated higher incidence of multiple diabetes-related complications among individuals with periodontal disease. These associations persisted after adjustment for

relevant confounders, suggesting that periodontal disease may contribute to the progression or severity of diabetes complications rather than acting solely as a coincidental comorbidity.

Genetic, bioinformatic, and population-based studies provided supportive evidence for biological plausibility and population relevance (Table 4). Mendelian randomization analyses suggested a causal role of hyperglycaemia in the development of periodontitis, while bioinformatic investigations identified shared inflammatory and immune-related pathways between periodontitis and type 2 diabetes. Indian observational studies consistently reported a higher prevalence and greater severity of periodontal disease among individuals with diabetes across diverse settings and age groups. These studies also highlighted gaps in oral health awareness among diabetic populations, underscoring the public health relevance of the association in low- and middle-income country contexts.

Table 1. Bidirectional Association between Periodontal Disease and Diabetes Mellitus

Citation	Study Design	Outcome Measures	Key Findings
Stöhr et al., 2021 [8]	Systematic review and meta-analysis of cohort studies	Incidence of diabetes in periodontitis; incidence of periodontitis in diabetes	Periodontal disease was associated with a higher risk of incident diabetes, and diabetes was independently associated with increased risk of periodontitis, supporting a bidirectional relationship
Trullenque-Eriksson et al., 2024 [9]	Register-based cohort study	Periodontitis prevalence; diabetes-related complications	Patients with diabetes had higher prevalence of periodontitis, which was associated with increased risk of microvascular diabetes-related complications
Bitencourt et al., 2024 [10]	Population-based cohort study	Diabetes complications (retinopathy, nephropathy); periodontitis status	Periodontitis was associated with increased risk of diabetes-related complications independent of major confounders

Table 2. Effect of Periodontal Therapy on Glycaemic Control and Inflammatory Outcomes

Citation	Study Design	Outcome Measures	Key Findings
Umezaki et al., 2025 [11]	Systematic review and meta-analysis	HbA1c reduction; adjunctive effect vs medication	Periodontal treatment resulted in a modest but significant reduction in HbA1c, comparable to some pharmacologic interventions
López-Valverde et al., 2024 [12]	Review of systematic reviews with meta-analyses	HbA1c; periodontal parameters	Consistent evidence that non-surgical periodontal therapy improves glycaemic control in patients with diabetes
Olszewska-Czyz et al., 2024 [13]	Randomized clinical trial	Periodontal indices; HbA1c	Adjunctive hyaluronic acid with non-surgical therapy improved periodontal outcomes and showed favorable effects on glycaemic control
Al-Abbadi et al., 2025 [14]	Randomized controlled trial	Probing depth; clinical attachment loss; HbA1c	Non-surgical periodontal therapy improved periodontal parameters, with additional benefit observed using adjunctive hyaluronic acid
Umeizudike et al., 2025 [15]	Clinical interventional study	HbA1c; active-MMP-8 levels	Periodontal therapy improved glycaemic control and reduced inflammatory biomarker levels in prediabetes and diabetes patients

Table 3. Periodontal Disease and Diabetes-Related Complications

Citation	Study Design	Outcome Measures	Key Findings
Anil et al., 2025 [16]	Systematic review and meta-analysis	Diabetic retinopathy; periodontitis	Periodontitis was associated with significantly increased odds of diabetic retinopathy
Trullenque-Eriksson et al., 2024 [9]	Register-based cohort study	Retinopathy; nephropathy; cardiovascular outcomes	Periodontitis was associated with higher incidence of multiple diabetes-related complications
Bitencourt et al., 2024 [10]	Population-based cohort study	Microvascular complications	Presence of periodontitis increased risk of microvascular diabetes complications

Table 4. Mechanistic and Indian Population-Based Evidence

	Study Design	Outcome Measures	Key Findings
Wang et al., 2022 [17]	Mendelian randomization study	Genetic proxies of fasting glucose; periodontitis	Genetic evidence supported a causal role of elevated fasting glucose in periodontitis development

Wei et al., 2024 [18]	Bioinformatic analysis	Gene expression pathways	Shared inflammatory and immune-regulatory pathways were identified between periodontitis and type 2 diabetes
Agrawal et al., 2025 [19]	Cross-sectional observational study (India)	Periodontitis prevalence; awareness	High prevalence of periodontitis among diabetic patients with low awareness of the diabetes–periodontitis link
Bajaj et al., 2025 [20]	Cross-sectional study (India)	Periodontal disease prevalence	Periodontal disease prevalence was higher among individuals with type 2 diabetes
Jitender et al., 2025 [21]	Comparative cross-sectional study (India)	Periodontal status	Diabetic patients showed significantly worse periodontal health compared with non-diabetic controls
Patil et al., 2025 [22]	Case–control study (India)	Periodontal indices	Diabetes was associated with poorer periodontal health compared with hypertensive and healthy controls
Shaw & Khan, 2025 [23]	Population-based cross-sectional study (India)	Dental caries; periodontal disease	Diabetes was associated with increased risk of periodontal disease among older adults in India

DISCUSSION

This systematic review synthesizes recent evidence indicating a clinically meaningful interrelationship between periodontal disease and diabetes mellitus across multiple evidence domains (Tables 1–4). Overall, the direction of findings was consistent: periodontitis and diabetes appear to influence each other, periodontal treatment is generally associated with improved metabolic and inflammatory profiles, and periodontal inflammation is linked to a higher burden of diabetes-related complications. These observations align with a broader shift in the literature toward viewing periodontitis as a modifiable inflammatory exposure with systemic relevance, particularly in individuals with dysglycaemia.

Biological plausibility for bidirectionality is supported by converging mechanistic frameworks. Contemporary mechanistic work highlights that oral dysbiosis and periodontal inflammation can contribute to systemic inflammatory signalling pathways relevant to insulin resistance, whereas hyperglycaemia can amplify periodontal tissue breakdown through immune and microvascular dysfunction. Such models support an "inflammation-amplification loop" that can operate bi-directionally and may help explain why periodontal status correlates with metabolic trajectories over time (Table 4). Mechanistic syntheses also emphasize that causality is unlikely to be attributable to a single pathway; rather, host response dysregulation, microbial ecology, and shared cardiometabolic risk factors likely interact to produce the observed clinical associations. These contemporary interpretations are concordant with our finding that genetic and pathway-level analyses complement—but do not replace—clinical and epidemiological evidence (Table 4) [24,25].

From an interventional standpoint, the overall pattern of evidence in our review suggests that controlling periodontal inflammation may yield modest improvements in glycaemic indices and inflammatory activity (Table 2). These findings are consistent with external meta-analytic evidence indicating that periodontal treatment is more likely to demonstrate metabolic benefit when baseline dysglycaemia is present and when follow-up is sufficient to capture systemic effects. At the same time, prior multicenter randomized evidence has reported null glycaemic effects in some settings, underscoring that treatment response may be heterogeneous and influenced by factors such as baseline HbA1c, adherence, concurrent medication intensification, periodontal disease severity, and trial methodology. Accordingly, periodontal therapy should be interpreted as an adjunctive strategy that may contribute to metabolic optimization in selected patients, rather than a substitute for guideline-based diabetes care [26,27].

The observed association between periodontitis and diabetes-related complications (Table 3) is clinically important because even small improvements in glycaemic control or systemic inflammation could plausibly translate into meaningful long-term risk reduction at a population level. Beyond glycaemia, periodontitis may contribute to endothelial dysfunction, oxidative stress, and persistent low-grade inflammation—pathways implicated in microvascular disease progression. While residual confounding remains a concern in observational designs, the consistency of associations across different populations and study approaches supports the need for clinicians to treat periodontal disease as a relevant comorbidity in diabetes risk stratification and complication prevention frameworks [24,28].

The Indian context warrants specific consideration. India bears a substantial and growing burden of diabetes and metabolic non-communicable diseases, with large-scale national and population studies reporting high prevalence alongside gaps in awareness and control. In such settings, periodontal disease may represent an under-recognized inflammatory comorbidity that intersects with limited access to preventive dental care and fragmented medical–dental referral pathways. Our synthesis of Indian population-based and clinic-based studies (Table 4) is directionally aligned with these broader epidemiologic realities, reinforcing the value of integrated, opportunistic approaches—such as diabetes risk screening in dental settings and periodontal screening in diabetes clinics—tailored to local care delivery constraints [29,30].

The public health implications extend beyond clinical dentistry. Evidence from integrated-care interventions suggests that combining diabetes and periodontal self-management strategies may improve outcomes more effectively than siloed care, although implementation feasibility and sustainability remain major barriers, particularly in low- and middle-income settings. Similarly, recent reviews of integrated care pathways emphasize structural determinants (workforce, reimbursement, health system design) that limit routine collaboration between medical and dental services. These findings reinforce the need for pragmatic implementation studies that evaluate referral workflows, shared-care models, and cost-effectiveness in real-world practice [31,32].

Several limitations should be acknowledged when interpreting this review. First, the included body of evidence is heterogeneous in design and outcome definition, which limits quantitative pooling and necessitates narrative synthesis (Tables 1–4). Second, observational studies remain vulnerable to residual confounding and misclassification of both diabetes status and periodontal case definitions. Third, interventional studies vary in treatment protocols, follow-up periods, and co-interventions, which may partly explain variability in metabolic outcomes. Finally, mechanistic and causal inference studies provide supportive biological context but should not be over-weighted relative to clinical outcomes evidence when formulating practice recommendations.

Future research should prioritize well-designed pragmatic trials in diverse settings, including India, with standardized periodontal and metabolic endpoints, adequate follow-up duration, and explicit accounting for medication adjustments and baseline glycaemic status. In parallel, implementation research should test scalable integrated-care pathways capable of reducing both periodontal inflammatory burden and diabetes-related risk in routine healthcare delivery.

CONCLUSION

The evidence synthesized in this systematic review demonstrates a consistent and clinically relevant association between periodontal disease and diabetes mellitus, supporting a bidirectional relationship in which each condition may adversely influence the onset, progression, and outcomes of the other. Longitudinal and population-based studies indicate that diabetes is associated with increased risk and severity of periodontitis, while periodontal disease is linked to poorer glycaemic control and a higher burden of diabetes-related complications. Interventional evidence further suggests that non-surgical periodontal therapy contributes to improvements in metabolic and inflammatory parameters, reinforcing the biological plausibility of this relationship. Findings from mechanistic analyses and Indian population-based studies extend the relevance of this association across diverse settings and populations. Collectively, these results underscore the importance of integrating periodontal assessment and management into comprehensive diabetes care strategies and highlight the need for coordinated medical–dental approaches to improve long-term metabolic and oral health outcomes.

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