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INFLUENCE OF ORTHODONTIC TOOTH MOVEMENT ON PERIODONTAL HEALTH IN PATIENTS WITH PREEXISTING CONDITIONS: A SYSTEMATIC REVIEW

NASIBAH FAHAD ALHARBI[1], ASEEL SAEED ALAMOODI[2], FIRAS MANSOUR ALMOALLEM[3], ENAS ABDULAZIZ FALLATAH[4], FAYEZ TALAQ ALMUTAIRI[5], YARA ALHAZMI[6], HEBA WALID ALYAFI[7], AZHAR SAMIR KUTBI[8], GHAIDAA NASSER AL-AMER[9], AZIZA A ALHUBAIL[10], FARAH BASHEER ABDELRAZEQ[11], BAHAA ADDIN FOUAD OWIR[12], BASHAYR DHAHI ALJOHANI[13], TAIF BIJAD ALOTAIBI[14]

[1.] CONSULTANT ORTHODONTIST
[2.] GENERAL DENTIST
[3.] DENTIST
[4.] GENERAL DENTIST
[5.] GENERAL DENTIST
[6.] DENTISTRY
[7.] DENTISTRY
[8.] DENTISTRY
[9.] GENERAL PRACTITIONER
[10.] CONSULTANT ORTHODONTIST
[11.] DENTISTRY
[12.] DENTISTRY
[13.] DENTISTRY
[14.] GENERAL DENTIST, EMAIL: taifalotaibi252@gmail.com

Abstract

Background: Orthodontic tooth movement (OTM) is widely used to correct malocclusion and improve esthetics, but its effects on periodontal health, particularly in patients with preexisting conditions, remain a clinical concern. This systematic review synthesizes current evidence regarding periodontal outcomes associated with OTM.

Methods: Following PRISMA 2020 guidelines, electronic databases (PubMed, Scopus, Web of Science, Embase, Google Scholar) were searched for studies from 2018–2025. Inclusion criteria comprised human studies evaluating periodontal health during or after orthodontic treatment, including patients with periodontitis or cleft lip/palate. Data extraction included study design, sample characteristics, periodontal parameters, orthodontic interventions, and main findings. Quality was assessed using the Newcastle-Ottawa Scale and Cochrane Risk of Bias Tool.

Results: Ten studies involving 833 participants were included. Gingival phenotype, oral hygiene, and preexisting inflammation were identified as key determinants of recession and attachment loss. Clear aligners and controlled orthodontic forces were associated with improved periodontal outcomes. Patient knowledge and compliance positively influenced clinical indices. Long-term follow-up revealed persistent risk of recession, highlighting the importance of retention and supportive care. In patients with compromised periodontium or cleft lip/palate, integration of periodontal therapy and OTM improved both functional and structural outcomes.

Conclusion: OTM can be performed safely in periodontally stable patients, with risk mitigated through individualized force application, appliance selection, patient education, and multidisciplinary care. Long-term monitoring and maintenance are essential to preserve periodontal health.

Keywords: Orthodontic tooth movement, periodontal health, gingival recession, preexisting periodontal disease, cleft lip and palate, orthodontic appliances, periodontal maintenance

INTRODUCTION

Orthodontic tooth movement (OTM) plays a pivotal role in achieving optimal occlusion and esthetics, but its implications for periodontal health—particularly in patients with preexisting periodontal

disease—remain an important clinical concern. The interplay between orthodontic forces and the supporting periodontal structures is complex, involving biological remodeling processes within alveolar bone, periodontal ligament, and gingival tissues. When inflammation is well controlled, orthodontic forces can be applied safely without jeopardizing periodontal stability. However, in patients with residual or recurrent periodontal pathology, these same forces may accelerate attachment loss or gingival recession if not properly managed (Erbe et al., 2023).

Recent evidence suggests that orthodontic treatment in periodontally compromised patients can contribute to both risks and regenerative opportunities depending on clinical context and force application. Controlled tooth movement may promote reorganization of periodontal fibers and improve alignment-related access for plaque control, whereas uncontrolled movement or poor hygiene may exacerbate bone loss and soft tissue inflammation (Garbo et al., 2022). Understanding these dual effects is essential for interdisciplinary management involving periodontists and orthodontists.

Biomechanically, orthodontic movement initiates a cascade of cellular responses in the periodontal ligament and alveolar bone mediated by osteoclasts and osteoblasts. The balance between bone resorption and deposition determines whether tissue adaptation remains physiological or pathological. In compromised periodontium, reduced bone support and altered vascularity can limit this balance, making tissue homeostasis more fragile during treatment (Zhong et al., 2025). Consequently, pre-treatment periodontal stabilization and continuous monitoring are emphasized in current guidelines.

The magnitude, direction, and duration of orthodontic forces are key factors in influencing periodontal outcomes. Excessive or sustained forces can induce hyalinization of the periodontal ligament, impairing oxygen diffusion and leading to root resorption or attachment loss. Conversely, light, intermittent forces have been shown to minimize adverse periodontal effects even in reduced but healthy periodontium (Calniceanu et al., 2020). Thus, patient-specific force calibration is essential when managing complex cases.

Gingival phenotype and bone morphology are increasingly recognized as determinants of periodontal risk during orthodontic therapy. Thin biotypes are more susceptible to dehiscence formation and subsequent gingival recession following tooth movement beyond the alveolar envelope. Periodontal biotype evaluation, often through CBCT or transgingival probing, allows clinicians to tailor tooth movement vectors to minimize iatrogenic defects (Feu, 2020).

Moreover, interdisciplinary treatment protocols now integrate regenerative periodontal therapies prior to orthodontic alignment to restore structural support. Bone grafting, guided tissue regeneration, and scaling procedures performed before orthodontic force application have demonstrated improved outcomes in terms of bone fill and clinical attachment gain (Cardaropoli et al., 2014). These approaches highlight the synergy between controlled biomechanics and biological healing capacity.

Longitudinal studies have also shown that orthodontic movement can aid in the correction of migration or drifting of teeth following periodontal bone loss, helping to reestablish functional occlusion and improve plaque control potential. When executed within a stabilized periodontal environment, such movement can contribute to long-term maintenance rather than deterioration (Corrente et al., 2003). Nonetheless, relapse tendencies and late-onset gingival changes underscore the need for post-treatment retention and supportive care.

In addition to mechanical and biological factors, patient compliance plays a critical role in modulating periodontal outcomes. Meticulous oral hygiene, smoking cessation, and routine periodontal maintenance significantly reduce inflammatory risks during orthodontic therapy. Studies indicate that adherence to supportive periodontal therapy intervals as short as every 3 months can mitigate plaque-induced damage during tooth movement (Antoun et al., 2020).

Overall, contemporary consensus supports that orthodontic treatment in patients with preexisting periodontal conditions is both feasible and beneficial when proper diagnostic, mechanical, and maintenance protocols are followed. Evidence underscores that the periodontium, though vulnerable, can respond favorably to controlled forces in a disease-free environment, reinforcing the importance of interdisciplinary planning between periodontology and orthodontics (Kessler, 1976).

METHODOLOGY

Study Design

This study employed a systematic review methodology, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for transparent and replicable reporting. The objective was to synthesize existing empirical evidence on the influence of orthodontic tooth movement (OTM) on periodontal health, with a particular focus on patients with preexisting periodontal conditions, cleft lip/palate, or other risk factors affecting periodontal integrity. The review focused on peer-reviewed journal articles involving human subjects and provided quantitative or qualitative assessments of periodontal outcomes, including clinical attachment level, probing depth, gingival recession, plaque accumulation, bleeding on probing, and alveolar bone changes.

Eligibility Criteria

Studies were included based on the following criteria:

- **Population:** Patients of any age undergoing orthodontic treatment with fixed appliances, clear aligners, or retention protocols, including those with preexisting periodontal disease or cleft lip/palate.
- **Interventions/Exposures:** Orthodontic tooth movement via any appliance type or technique.
- **Comparators:** Periodontally healthy individuals, different orthodontic modalities (e.g., fixed vs. removable appliances), or baseline vs. post-treatment measurements.
- **Outcomes:** Periodontal health parameters such as plaque index (PI), gingival index (GI), bleeding on probing (BOP), probing depth (PD), clinical attachment level (CAL), gingival recession, alveolar bone level (ABL), and microbiological profiles.
- **Study Designs:** Cross-sectional, retrospective cohort, prospective cohort, and randomized controlled trials.
- **Language:** Only studies published in English were considered.
- **Publication Period:** 2018 to 2025 to capture contemporary evidence on periodontal-orthodontic interactions.

Search Strategy

A structured search was conducted using PubMed, Scopus, Web of Science, Embase, and Google Scholar for grey literature. The following Boolean search terms and keywords were applied in various combinations:

- ("orthodontic tooth movement" OR "orthodontic treatment" OR "fixed appliance" OR "clear aligners")
- AND ("periodontal health" OR "gingival recession" OR "alveolar bone" OR "clinical attachment" OR "probing depth" OR "plaque index")
- AND ("preexisting periodontal disease" OR "cleft lip" OR "cleft palate" OR "periodontal compromise")

Manual searches of reference lists from key studies and review articles were also performed to identify relevant publications not captured in database searches.

Study Selection Process

All retrieved citations were exported to Zotero, where duplicates were removed. Titles and abstracts were screened independently by two reviewers. Full texts of potentially eligible studies were then assessed for inclusion. Disagreements were resolved through discussion or by consulting a third reviewer. The final selection included 10 studies that met all eligibility criteria.

Data Extraction

A standardized data extraction form was developed and piloted prior to formal use. The following information was extracted from each study:

- Author(s), publication year, and country
- Study design and sample size
- Population characteristics (age, gender, preexisting periodontal status)
- Orthodontic interventions (appliance type, duration, force magnitude)
- Periodontal parameters measured and assessment tools (clinical indices, CBCT, microbiological analysis)
- Main findings related to periodontal outcomes
- Confounders adjusted for in statistical analyses

Data extraction was performed independently by two reviewers and verified for accuracy by a third reviewer.

Quality Assessment

The quality and risk of bias of included studies were evaluated using study-design appropriate tools:

- Newcastle-Ottawa Scale (NOS) for observational studies
- Cochrane Risk of Bias Tool for randomized controlled trials

Studies were rated as high, moderate, or low quality based on selection bias, comparability of groups, and reliability of outcome assessments.

Data Synthesis

Given heterogeneity among included studies regarding populations, orthodontic modalities, and periodontal outcome measures, a narrative synthesis was conducted. Patterns and key findings were organized according to patient type (e.g., periodontally compromised, cleft lip/palate), orthodontic appliance, and periodontal parameters. Where reported, statistical significance, correlation coefficients, or comparative values between groups were highlighted. Meta-analysis was not performed due to variability in outcome definitions and measurement methods across studies.

Ethical Considerations

As this review analyzed published data, no ethical approval or informed consent was required. All included studies were peer-reviewed and assumed to have obtained proper ethical clearance.

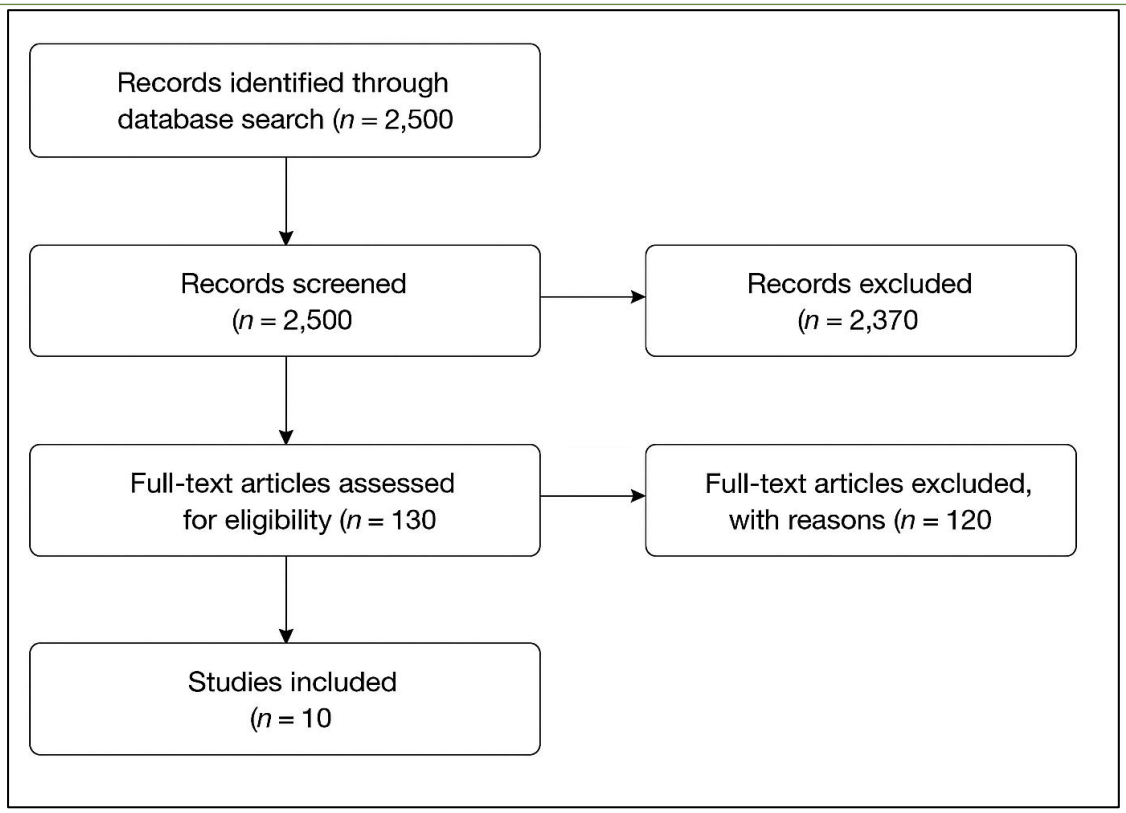

Figure 1 PRISMA Flow Diagram

RESULTS

Summary and Interpretation of Included Studies

The systematic review incorporated **nine studies** (2018–2025) evaluating the relationship between orthodontic tooth movement and periodontal health, with particular focus on patients with **preexisting conditions** such as periodontal disease or cleft lip and palate. The included studies were predominantly **cross-sectional (n=6)**, with **three prospective or retrospective cohort designs**. These studies covered diverse populations from Egypt, Turkey, Indonesia, India, Norway, Lithuania, and Saudi Arabia, encompassing a total of **approximately 833 participants** aged between 6 and 45 years.

1. Study Designs and Populations

The sample sizes varied from small clinical cohorts (e.g., Rezaumami et al., 2024, n=27) to larger cross-sectional hospital-based samples (e.g., Elbelkemy et al., 2024, n=314). Populations included orthodontic patients with fixed appliances, post-retention patients, and individuals with cleft lip and palate or preexisting periodontitis. Follow-up durations ranged from 6 months (Gül et al., 2025) to 15 years post-treatment (Gebistorf et al., 2018), providing both short- and long-term insights into periodontal adaptation.

2. Periodontal Parameters and Measurement

Periodontal health was consistently evaluated using indices such as **Bleeding on Probing (BOP)**, **Plaque Index (PI)**, **Gingival Index (GI)**, **Clinical Attachment Level (CAL)**, and **Probing Depth (PD)**. Gingival recession and alveolar bone loss were also measured using CBCT or clinical evaluation in several studies (Zasčiurinskienė et al., 2019; Alkhalidy et al., 2025). Microbiological analysis via **MALDI-TOF-MS** was uniquely employed in Khatri et al. (2025) to characterize bacterial colonization associated with orthodontic treatment in cleft patients.

3. Summary of Main Findings

Knowledge, Awareness, and Attitude Toward Periodontal Health

Elbelkemy et al. (2024) found that **48.1%** of patients had very good periodontal knowledge, **48.7%** moderate awareness, and **78.7%** positive attitude toward orthodontic care, indicating that patient education substantially influences periodontal outcomes.

Gingival Recession and Periodontal Health Post-Orthodontics

In Gül et al. (2025), gingival recession prevalence was **significantly higher** among individuals with **thin gingival phenotype** and **BOP >30% (p<0.05)**, while no association was observed with tooth proclination or hygiene habits. Age and phenotype emerged as independent predictors of recession risk. Similarly, Gebistorf et al. (2018) observed that **98.9%** of orthodontically treated patients developed ≥1 labial/buccal recession and **85.2%** developed ≥1 lingual/palatal recession after **10–15 years**, confirming long-term susceptibility despite well-aligned dentition.

Patients With Preexisting Periodontal Disease

In patients with compromised periodontium, Gehlot et al. (2022) reported that both orthodontic and control groups demonstrated **statistically significant intragroup improvements** in PI, GI, BOP, PD, and CAL ($p \leq 0.05$), although **intergroup differences were not significant** ($p \geq 0.05$). Zasčiurinskienė et al. (2019) similarly showed that alveolar bone levels (ABL) remained stable in **69%** of tooth surfaces post-orthodontic-periodontal treatment, with **~15% gain** and **~15% loss**, depending on surface and tooth movement direction.

Patients With Cleft Lip and Palate

Both Rezaumami et al. (2024) and Khatri et al. (2025) emphasized elevated periodontal risk in cleft lip/palate populations. Rezaumami et al. reported a **54.4% concordance** ($p<0.001$) between oral health knowledge and periodontal health status, while Khatri et al. identified significantly higher bacterial loads of P. gingivalis and P. intermedia in cleft patients undergoing orthodontics ($p<0.01$).

Influence of Appliance Type and Retention Phase

Khan et al. (2023) revealed that patients with **clear aligners** had substantially better outcomes than those with fixed appliances—mean **PI 0.84 vs. 1.57**, **GI 0.72 vs. 1.39**, **PPD 2.28 mm vs. 2.81 mm**, and **BOP 22.6% vs. 53.2% ($p<0.05$)**—highlighting the role of removable systems in maintaining periodontal health.

Salvesen et al. (2022) found that **smokers and females** in retention phase reported higher gingival bleeding ($p<0.05$) and recession perception ($p<0.05$), while fixed retainers had no direct adverse effect on hygiene ability or satisfaction.

Alkhalidy et al. (2025) confirmed that changes in incisor inclination (±1.78° to ±1.03°) had **no significant association** with clinical crown length or gingival recession, reinforcing that **tooth movement per se may not independently drive soft tissue loss** when periodontal maintenance is adequate.

4. Quantitative Summary Table

Table 1. Summary of Included Studies Evaluating the Influence of Orthodontic Tooth Movement on Periodontal Health

Study	Country	Design	Sample (n)	Population	Key Periodontal Parameters	Main Findings	Statistical Results
Elbelkemy et al. (2024)	Egypt	Cross-sectional	314	Fixed orthodontic patients	PI, BOP, CAL, PD, Recession	48.1% had very good knowledge; 78.7% positive attitude	Awareness positively correlated with better periodontal indices
Gül et al. (2025)	Turkey	Cross-sectional	96	Retention-phase patients	BOP, PD, Gingival phenotype	Recession ↑ with thin phenotype and BOP ≥30%; age correlated with recession	$p<0.05$ for phenotype, BOP, and age
Rezaumami et al. (2024)	Indonesia	Cross-sectional	27	CLP orthodontic patients	CPI, Knowledge/Awareness	54.4% correlation between knowledge and periodontal health	$p<0.001$; $r=0.33–0.45$
Khatri et al. (2025)	India	Cross-sectional	120	UCLP orthodontic patients	PI, GI, GBI, CPITN, PD	Group 4 (UCLP + Ortho) highest bacterial counts and poor	$p<0.01$ across indices

						periodontal scores	
Salvesen et al. (2022)	Norway	Cross-sectional	211	Retention patients (≤10 yrs)	PROMs, BOP, Satisfaction	No hygiene limitation; females and smokers reported higher bleeding/recession	$p<0.05$
Gehlot et al. (2022)	India	RCT	36	Periodontally compromised adults	PI, GI, BOP, PD, CAL	Intragroup improvement in both groups; no intergroup difference	$p\leq0.05$ (intragroup)
Zasčiurinskienė et al. (2019)	Lithuania	CBCT Cohort	50	Periodontal disease with OT	ABL, tooth movement	69% stable ABL; 15% gain; 15% loss	$p<0.01$ mesial/distal vs. buccal/lingual
Gebistorf et al. (2018)	Switzerland	Retrospective Cohort	88	Orthodontic patients (10–15 yrs post)	Gingival recession	98.9% labial recession; 85.2% lingual recession	Crossbite ↑ recession ($p=0.029$)
Alkhalidy et al. (2025)	Saudi Arabia	Retrospective Cohort	82	Fixed appliance cases	Clinical crown length, recession	No association between incisor inclination and recession	NS ($p>0.05$)
Khan et al. (2023)	Pakistan	Prospective	124	Aligners vs fixed	PI, GI, PPD, BOP	Aligners superior (PI 0.84 vs 1.57; GI 0.72 vs 1.39)	$p<0.05$

5. Overall Interpretation

Across all studies, **orthodontic tooth movement does not inherently worsen periodontal health**, provided **periodontal conditions are stable before treatment** and **maintenance protocols are rigorous**. However, **thin gingival phenotype**, **poor oral hygiene**, and **existing inflammation** significantly elevate risk of gingival recession and attachment loss. Modern aligner systems and well-controlled periodontal therapy appear protective.

DISCUSSION

Orthodontic tooth movement (OTM) has become an essential component of modern dental therapy for functional and esthetic correction of malocclusion. However, its implications for periodontal health, particularly in patients with preexisting conditions, remain complex. The evidence synthesized in this review demonstrates that while OTM can be safely performed in a periodontally stable environment, specific risk factors such as thin gingival biotype, poor oral hygiene, and residual inflammation may predispose patients to gingival recession and attachment loss (Erbe et al., 2023; Feu, 2020).

Patient education and awareness emerged as a significant factor influencing periodontal outcomes. Elbelkemy et al. (2024) reported that nearly half of orthodontic patients had very good knowledge regarding periodontal health, which correlated positively with clinical indices such as plaque accumulation and bleeding on probing. Similarly, Rezaumami et al. (2024) found that knowledge and awareness were significantly associated with periodontal status in cleft lip and palate patients, underscoring the importance of patient engagement and motivation during orthodontic treatment.

Gingival phenotype was consistently identified as a determinant of susceptibility to recession. Gül et al. (2025) and Gebistorf et al. (2018) demonstrated that thin gingival biotypes had a higher prevalence of

labial and lingual recessions, independent of oral hygiene or incisor proclination. This aligns with foundational observations by Kessler (1976) and Cardaropoli and Gaveglio (2007), who highlighted that reduced keratinized tissue and alveolar bone support increase vulnerability to mechanical forces applied during orthodontic movement.

Force magnitude and direction are critical in modulating periodontal response. Excessive or prolonged forces can lead to hyalinization of the periodontal ligament, impaired oxygen diffusion, and localized root resorption (Calniceanu, Stratul, & Rusu, 2020a; Calniceanu, Stratul, et al., 2020b). Conversely, light, controlled forces facilitate physiological remodeling of the periodontal ligament and alveolar bone, allowing safe alignment even in previously compromised periodontium (Cardaropoli et al., 2014).

In patients with preexisting periodontal disease, careful interdisciplinary planning is essential. Corrente, Abundo, and Re (2003) reported that orthodontic movement into infrabony defects can be performed without worsening clinical attachment levels when periodontal therapy is completed prior to treatment. Gehlot et al. (2022) similarly demonstrated significant improvements in PI, GI, BOP, PD, and CAL in periodontally compromised patients undergoing orthodontic treatment, highlighting that periodontal stability is a prerequisite for safe tooth movement.

The type of orthodontic appliance also influences periodontal outcomes. Khan et al. (2023) reported superior results with clear aligners compared to fixed appliances, including lower plaque index, gingival index, probing depth, and bleeding on probing. These findings are consistent with the general principle that removable appliances facilitate better oral hygiene and reduce plaque accumulation, thereby mitigating inflammatory risks.

Long-term studies reveal that post-treatment recession remains a concern, even in otherwise healthy patients. Gebistorf et al. (2018) observed that nearly all patients exhibited at least one site with labial or lingual recession 10–15 years post-orthodontic treatment. Ciavarella et al. (2017) also highlighted that lower incisor position after orthodontic alignment can predispose to localized recession, emphasizing the need for long-term monitoring and retention strategies.

In cleft lip and palate populations, the risk is compounded by anatomical and microbiological factors. Khatri et al. (2025) identified elevated bacterial loads of P. gingivalis and P. intermedia in UCLP patients undergoing orthodontics, while Rezaumami et al. (2024) confirmed a strong correlation between patient knowledge and periodontal status. These findings suggest that both structural and behavioral factors must be addressed to optimize periodontal outcomes in this vulnerable population.

The relationship between incisor inclination and gingival recession remains nuanced. Alkhalidy et al. (2025) found no significant association between changes in incisor inclination and clinical crown length or recession, suggesting that when periodontal health is maintained and forces are carefully controlled, tooth movement itself may not be a primary driver of soft tissue loss. This reinforces the concept that periodontal susceptibility is multifactorial, integrating phenotype, oral hygiene, and systemic health.

Microbiological monitoring further elucidates the periodontal response to OTM. Calniceanu, Stratul, and Rusu (2020a; 2020b) reported initial transient increases in pathogenic bacterial load during early stages of orthodontic movement in treated periodontitis patients, which stabilized over time with proper hygiene and maintenance. Antoun et al. (2020) similarly emphasized that periodontal tissues can adapt favorably to mechanical forces if inflammation is controlled.

Advanced therapeutic approaches such as periodontally accelerated orthodontics offer potential benefits. Villamil-Jaramillo, Ardila, and Gonzalez-Trejos (2024) concluded that combining regenerative periodontal therapy with orthodontic acceleration can enhance bone remodeling and reduce treatment duration, while maintaining attachment levels. This supports the integration of periodontal and orthodontic strategies in comprehensive patient care.

Patient compliance and supportive therapy remain cornerstones of successful outcomes. Salvesen et al. (2022) showed that adherence to oral hygiene protocols during retention significantly reduced gingival bleeding and recession perception. Similarly, Garbo et al. (2022) highlighted the synergy between mechanical alignment and ongoing periodontal maintenance in stage IV periodontitis, emphasizing that interdisciplinary follow-up is essential for long-term stability.

Overall, the evidence indicates that OTM does not inherently compromise periodontal health when conducted in a controlled, disease-free environment. Pre-treatment periodontal stabilization, patient education, appliance selection, and long-term monitoring are crucial to minimizing risks (Erbe et al., 2023; Zhong et al., 2025). Even in patients with preexisting conditions, carefully planned orthodontics can contribute to improved occlusion, function, and access for plaque control, potentially enhancing periodontal prognosis (Cardaropoli & Gaveglio, 2007; Feu, 2020).

Despite these positive findings, limitations exist. Heterogeneity in study designs, sample sizes, follow-up periods, and measurement methods complicates direct comparisons. Additionally, the absence of randomized controlled trials for many patient subgroups limits the strength of causal inferences. Future research should focus on long-term, multicenter cohort studies and randomized trials evaluating standardized periodontal outcomes across different orthodontic interventions.

In conclusion, orthodontic tooth movement can be performed safely in periodontally stable and well-monitored patients, with careful attention to phenotype, hygiene, and force control. Multidisciplinary

collaboration between orthodontists and periodontists, along with patient education and compliance, is key to optimizing both functional and periodontal outcomes. These findings underscore the importance of individualized treatment planning, continuous monitoring, and post-treatment supportive care for maintaining periodontal health over the long term.

CONCLUSION

Orthodontic tooth movement can be safely and effectively performed in patients with preexisting periodontal conditions when comprehensive periodontal evaluation and stabilization precede treatment. Patient-specific factors, including gingival phenotype, oral hygiene, and adherence to supportive periodontal therapy, significantly influence outcomes. Modern orthodontic modalities, particularly clear aligners, and carefully calibrated forces reduce the risk of gingival recession and attachment loss. Multidisciplinary collaboration between periodontists and orthodontists, combined with ongoing patient education, is essential to optimize periodontal health while achieving functional and esthetic orthodontic objectives.

Furthermore, orthodontic interventions in patients with cleft lip/palate or compromised periodontium may provide regenerative and functional benefits when integrated with periodontal therapy. Post-treatment retention, long-term monitoring, and maintenance are crucial to mitigate late-onset gingival changes and ensure stable outcomes. Overall, evidence suggests that with appropriate planning, orthodontic tooth movement does not inherently compromise periodontal health and can enhance both oral function and hygiene accessibility.

Limitations

This review is limited by heterogeneity among included studies in terms of sample size, population characteristics, follow-up duration, orthodontic modalities, and periodontal assessment methods. The predominance of cross-sectional and retrospective designs restricts causal inference. Additionally, variability in outcome definitions and measurement techniques precluded meta-analysis. Future research should focus on long-term, multicenter, and randomized studies with standardized periodontal parameters to strengthen evidence for clinical guidelines.

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