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## Original Article

# Managing Periodontitis in Orthodontics: Tailored Approaches Based on the 2017 Classification

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## Abstract

The 2017 classification of periodontal diseases provides a structured system for staging and grading periodontitis to guide diagnosis and therapy. Orthodontic care has increasingly been applied alongside periodontal treatment to manage malocclusion, drifting teeth, and bite instability. Yet, there is still limited literature that directly matches this updated classification. This systematic review aims to assess how orthodontic intervention affects periodontal health in patients categorized as Stage III and IV under the 2017 system. Following PRISMA 2020 guidelines, a systematic review was carried out. Databases screened included PubMed, Web of Science, Scopus, and Google Scholar. Publications from 2012–2024 were considered. After selection, 17 studies met the inclusion standards. Key outcomes were changes in clinical attachment level (CAL), reductions in probing depth (PD), and radiographic indicators of bone repair. When orthodontic therapy was combined with periodontal management, there was a substantial gain in CAL (4.35–5.96 mm on average), a marked reduction in PD (3.1–6.3 mm), and measurable vertical bone fill (mean: 4.89 mm). The most pronounced benefits were reported in Stage IV Grade C patients, particularly when orthodontics followed regenerative procedures early on. Follow-ups lasting as long as 10 years supported the durability of these improvements. Adding orthodontics to conventional periodontal therapy enhances outcomes in advanced disease, especially in Stage III and IV periodontitis. These findings reinforce the value of coordinated, multidisciplinary care and the necessity for clear treatment pathways that integrate orthodontics into periodontal protocols.

**Key words:** Orthodontics, 2017 classification, Stage III/IV periodontitis, Multidisciplinary care, Bone regeneration, Guided tissue regeneration

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## Introduction

Periodontitis remains one of the most common oral health conditions worldwide and is a leading contributor to tooth loss, characterized by progressive inflammation and destruction of supporting structures [1]. Beyond dental implications, it has established links with systemic conditions such as diabetes and cardiovascular disease, highlighting the urgency for effective



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treatment [2]. In advanced stages, the disease causes major functional disturbances, including tooth migration and malocclusion, that severely impair quality of life [3]. Orthodontic intervention has recently been proposed as a supportive therapy, not only restoring occlusal balance and esthetics but also contributing to the long-term stability of periodontal results [4]. Despite this, standardized integration of orthodontics into periodontal care is still lacking, especially for severe cases that require a comprehensive, multifaceted approach [5].

The 2017 Classification of Periodontal and Peri-Implant Conditions introduced a revised diagnostic framework, organizing disease by stage (severity and complexity of treatment) and grade (progression rate and systemic risk factors such as smoking and diabetes) [6]. This system has improved diagnostic clarity, yet relatively few investigations have aligned orthodontic applications with the updated categories [7].

Within this framework, the combined use of orthodontics and periodontics represents a modern interdisciplinary strategy for addressing advanced disease [8]. Unlike previous models, the 2017 classification allows a systematic view of disease progression, facilitating collaboration between specialties [9, 10]. A key feature is its inclusion of systemic and behavioral risk factors into treatment planning [6]. For example, orthodontic forces can be adjusted to prevent further tissue breakdown, while regenerative approaches simultaneously repair bone and attachment loss. This synergy—targeting both alignment and regeneration—positions interdisciplinary therapy as a central component of present-day periodontal management [11].

Collaboration among specialists is a key element of this model. By applying the 2017 classification, orthodontists and periodontists can coordinate their roles more effectively, resulting in improved treatment predictability and greater stability over time [5].

A major limitation in the literature is the lack of clear recommendations or strong clinical evidence regarding orthodontic management across different stages and grades of periodontitis. As a result, clinicians still depend largely on conclusions drawn from research based on older diagnostic systems [9,10]. This creates uncertainty, particularly when deciding on orthodontic therapy for patients placed in Stage III or IV, Grade C under the 2017 scheme [6]. The current review was therefore designed to address this shortcoming by assessing studies that either explicitly adopted the 2017 framework or could be retrospectively classified according to their reported findings. In addition, the review seeks to clarify how orthodontics can be applied in advanced disease, what outcomes can be expected, and what barriers may arise—especially in cases where secondary malocclusion or occlusal overload must be corrected. The evidence gathered may provide a platform for future interdisciplinary protocols and emphasize the need for customized orthodontic approaches at different stages and grades of periodontitis.

## Methodology

### *Research question (PICO)*

For patients diagnosed with periodontitis at different severities and progression levels (Population), what influence does orthodontic therapy (Intervention) have on periodontal status and orthodontic success (Outcome), when compared across stage and grade categories (Comparison)?

### *Literature search*

This review was formally registered with PROSPERO (ID: CRD42025630425), ensuring open access to the methodology and compliance with international standards. Once approved, the full protocol will be viewable in the registry. The process followed the PRISMA 2020 reporting criteria [12].

Electronic searches were performed in PubMed, Scopus, Web of Science, and Google Scholar, covering studies from January 1, 2017, to December 14, 2024. This window was selected to capture publications appearing after the introduction of the 2017 Classification of Periodontal and Peri-Implant Diseases and Conditions. Earlier work was also considered if it documented cases of severe, aggressive, or chronic periodontitis with sufficient details (e.g., attachment loss, bone destruction, radiographs) that allowed cases to be retrospectively reclassified as Stage III/IV and Grade B/C [6]. The feasibility of such reclassification has been confirmed by Raza *et al.* (2024), who demonstrated that radiographic bone loss (RBL), probing pocket depth (PPD), and clinical attachment level (CAL) can reliably support reassignment to the 2017

categories [13]. In this review, the same criteria were applied to standardize older case reports. Typically, aggressive forms corresponded to Stage III or IV Grade C, while chronic cases were reassigned to Stage II/III, Grades B or C. Subgroup analyses suggested that reclassification had little effect on outcomes, reinforcing the strength of the 2017 system for unifying diagnosis and treatment assessment.

The search strategy used both MeSH terms and free keywords to ensure broad coverage.

- In PubMed, the query combined Periodontitis [Mesh] with (Orthodontics [Mesh] OR Orthodontic Treatment [Mesh] OR Periodontal Disease Classification 2017 [Mesh]) AND (Staging [Mesh] OR Grading [Mesh]).
  - In Scopus, it was structured as: KEY (periodontitis) OR KEY (periodontal AND disease) OR KEY (periodontal AND therapy) AND KEY (orthodontics) OR KEY (orthodontic AND treatment) OR KEY (periodontal AND disease AND classification) AND KEY (staging) OR KEY (grading).
  - For Web of Science, the formula was: AK = (Periodontitis OR Periodontal AND disease OR Periodontal AND therapy) AND AK = (Orthodontics OR Orthodontic AND treatment OR Periodontal AND disease AND classification) AND AK = (Staging OR Grading).
  - For Google Scholar, the keywords were: “Periodontitis” OR “Periodontal disease” OR “Periodontal therapy” AND “Orthodontics” OR “Orthodontic treatment” OR “Periodontal disease classification 2017” AND “Staging” OR “Grading.”
- The Google Scholar search was conducted through *Publish or Perish* software, capped at the 500 most relevant results. This ensured a comprehensive yet focused pool of studies addressing orthodontic treatment in periodontitis patients classified according to the 2017 system (**Table 1**).

**Table 1.** Search strategy for systematic review

| Database       | Query Keywords                                                                                                                                                               | Search Constraints                         | Articles Found |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------|
| PubMed         | (“Periodontitis”[MeSH] AND (“Orthodontics”[MeSH] OR “Orthodontic Treatment”[MeSH]) AND “Periodontal Disease Classification 2017”[MeSH]) AND (Staging[MeSH] OR Grading[MeSH]) | English, 2017–2024, Full-text access       | 25             |
| Scopus         | KEY(“Periodontitis” OR “Periodontal Disease” AND “Orthodontics” OR “Orthodontic Treatment” AND “Periodontal Disease Classification 2017”) AND (“Staging” OR “Grading”)       | English, Peer-reviewed journals only       | 18             |
| Web of Science | AK = (“Periodontitis” OR “Periodontal Therapy” AND “Orthodontics” OR “Orthodontic Treatment” AND “Periodontal Disease Classification 2017” AND “Staging” OR “Grading”)       | English, 2017–2024, Peer-reviewed articles | 20             |
| Google Scholar | “Periodontitis” OR “Periodontal Disease” AND “Orthodontics” OR “Orthodontic Treatment” OR “Periodontal Disease Classification 2017” AND “Staging” OR “Grading”               | Top 500 results, English language          | 13             |

To extend coverage, a snowballing approach was used—checking references of included articles and locating newer studies that cited them via Google Scholar. Only English-language publications were accepted. To minimize bias, the authors did not restrict study design, allowing data from different methodologies to be incorporated. The search process was performed independently by N.T.H. and S.P.D., who applied the same search terms. The inclusion criteria were agreed upon by all authors, and N.T.H. and S.P.D. subsequently extracted the data jointly for consistency.

### *Selection of studies*

This review focused on orthodontic treatment in patients diagnosed with periodontitis, classified according to the 2017 periodontal disease system. The main objective was to assess how treatment outcomes are influenced by the stage and grade of disease, and to compare results between different categories. The central hypothesis assumed that tailoring orthodontic therapy to disease severity and grade would lead to better periodontal condition and treatment stability.

Clear inclusion rules were set to capture only studies relevant to the research purpose. Eligible papers had to involve adult participants with periodontitis identified by the 2017 classification, and they needed to present measurable outcomes linked to orthodontic procedures. Outcomes considered included gains in clinical attachment level (CAL), reduction of probing depth (PD), and radiographic evidence of bone recovery. Only investigations carried out in cooperation between orthodontists

and periodontists were accepted. To maintain consistency, studies had to be full-text, peer-reviewed, and written in English. Earlier publications (before 2017) were also taken into account if their clinical or radiographic information allowed retrospective classification into the updated staging and grading system. This ensured valuable older evidence could still contribute, provided it matched the new criteria. Excluded were works lacking methodological strength or relevance, such as case reports, case series, narrative and systematic reviews, meta-analyses, animal experiments, or studies of patients younger than 18. Papers without measurable periodontal/orthodontic results or with insufficient data for retrospective application of the 2017 framework were also omitted (**Table 2**).

**Table 2.** Criteria for selecting studies included in the systematic review

| Inclusion Requirements                                                                                                                                                                            | Exclusion Requirements                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Access to full-text articles                                                                                                                                                                      | Case reports or case series                                      |
| Articles in English                                                                                                                                                                               | Systematic literature reviews                                    |
| Adult patients diagnosed with periodontitis                                                                                                                                                       | Meta-analytic studies                                            |
| Research addressing orthodontic treatment customized to periodontitis staging and grading                                                                                                         | Historical literature reviews                                    |
| Studies reporting specific periodontal health and orthodontic outcomes                                                                                                                            | Conference proceedings                                           |
| Use of the 2017 periodontitis classification framework                                                                                                                                            | Editorial letters                                                |
| Collaborative approaches involving orthodontists and periodontists                                                                                                                                | Studies on animal models                                         |
| Articles published in peer-reviewed sources                                                                                                                                                       | Patients under 11 years old                                      |
| Minimum follow-up duration to evaluate clinical outcomes                                                                                                                                          | Research lacking quantifiable orthodontic or periodontal results |
| Emphasis on the interplay between orthodontic and periodontal management                                                                                                                          |                                                                  |
| Pre-2017 studies included if they provide detailed clinical data (e.g., extent of attachment loss and bone destruction) enabling retrospective application of the 2017 staging and grading system |                                                                  |

#### *Risk of bias in individual studies*

For the first stage of selection, each reviewer independently screened titles and abstracts to minimize bias. Agreement between reviewers was tested with Cohen's  $\kappa$  statistic, providing a structured measure of consistency [14]. Any disagreements about inclusion were settled through detailed discussion until consensus was reached, thereby ensuring impartiality in the decision process.

#### *Sample selection*

Two reviewers (N.T.H. and S.P.D.) independently selected study samples to maintain objectivity. Quality assessment relied on criteria such as clarity of inclusion/exclusion rules, proper distribution of participants across stages and grades, and adequate reporting of methods used to evaluate orthodontic outcomes. Studies were included if they examined the link between orthodontic intervention and periodontitis progression under the 2017 system. Pre-2017 research was eligible only if it contained detailed information (e.g., attachment loss, bone destruction, radiographic records) that allowed for accurate retrospective staging and grading. This approach made it possible to include cases of advanced or aggressive disease, or chronic periodontitis with severe tissue loss, properly categorized by the revised classification. Reviewers also confirmed that sample features were clearly defined and that outcome measures for both periodontal and orthodontic effects were reliable.

#### *Risk of bias in sample selection*

Bias assessment was undertaken according to study design. Randomized controlled trials (RCTs) were examined with the Cochrane ROB 2 tool [14], which considers randomization quality, deviations from assigned therapy, missing results, assessment reliability, and reporting practices. Retrospective cohort studies were judged using ROBINS-I, with focus on confounding factors, participant selection, intervention classification, data loss, and measurement of outcomes. Case-control research was reviewed using the Newcastle-Ottawa Scale, concentrating on participant recruitment, comparability between groups, and outcome/exposure evaluation. Cross-sectional studies were checked against the Joanna Briggs Institute (JBI) checklist, addressing recruitment method, measurement accuracy, management of missing data, and reporting bias [15].

### Data extraction

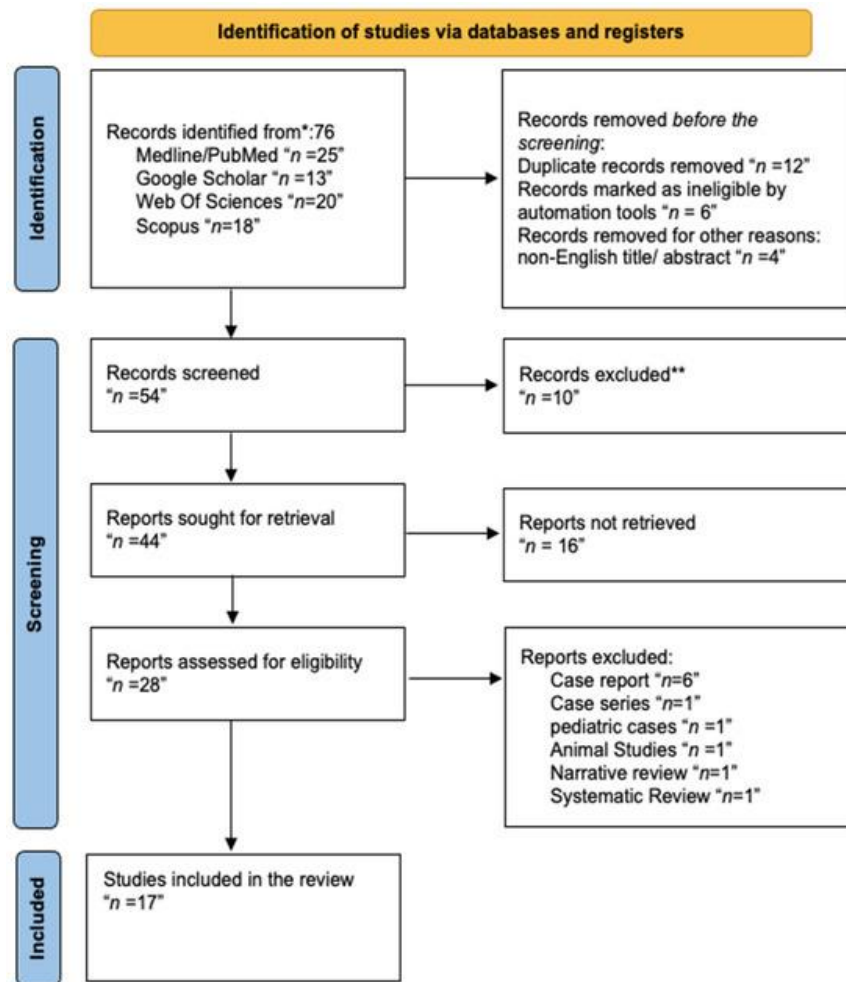
Once inclusion decisions were finalized, both reviewers extracted information. Extracted data included:

- Bibliographic details (author and year)
- Type of design
- Intervention and control descriptions
- Diagnostic system used
- Clinical parameters measured
- Reported findings
- Duration of follow-up
- Number of participants and sample size calculations
- Age range with standard deviation
- Gender distribution

### Results

#### Study selection

The PRISMA flow diagram for study screening is shown in **Figure 1** [12].



**Figure 1.** PRISMA flowchart of study identification and selection. All screening steps were performed manually, with no automated tools involved

### Database search and study selection

A targeted search of the literature was carried out using the terms Orthodontics, Periodontology, staging, grading, periodontal disease classification, aggressive periodontitis, interdisciplinary collaboration, and treatment outcomes. In total, 76 papers were retrieved: 25 from PubMed, 18 from Scopus, 20 from Web of Science, and 13 from Google Scholar.

After eliminating duplicates, 54 articles remained for title/abstract screening. Of these, 28 were read in full, and following detailed review, 20 studies met the inclusion requirements. These papers focused on orthodontic management in patients diagnosed under the 2017 Periodontal Classification, particularly those with Stage III–IV, Grade C disease. Pre-2017 investigations were also considered if their clinical/radiographic records (e.g., bone loss, attachment levels, disease severity) allowed them to be retrospectively assigned to the 2017 staging and grading system. The included literature, published between 2010 and 2023, encompassed diverse research methodologies, patient populations, and multidisciplinary treatment strategies.

Of the 28 full-texts assessed, 11 were excluded [16–26]. Exclusions were based on: pediatric focus (1 study [20]), case reports (6 studies [16–19, 23, 24]), a case series (1 study [25]), one narrative review, one systematic review [22, 26], and an animal experiment (1 study [21]). These designs were excluded due to their limited generalizability or lack of applicable clinical data. The final dataset for analysis included 17 studies (**Table 3**).

**Table 3.** Excluded studies and justification for exclusion

| Study Name                                                                                       | Basis for Exclusion   | Citation |
|--------------------------------------------------------------------------------------------------|-----------------------|----------|
| Orthodontic Management of Generalized Aggressive Periodontitis                                   | Single Case Study     | [16]     |
| Digital Orthodontic Planning and Clear Aligners for Adult Periodontitis Patients                 | Single Case Study     | [17]     |
| Combined Therapy for Severe Periodontitis with Angle Class II Division 1 Malocclusion            | Single Case Study     | [18]     |
| Aggressive Periodontitis Following Prior Orthodontic Treatment                                   | Single Case Study     | [19]     |
| One-Year Monitoring of a 4-Year-Old Girl with Stage IV Grade C Localized Periodontitis           | Pediatric Case Study  | [20]     |
| Periodontal Effects of Orthodontic Movement in Diabetic Rat Models                               | Animal-Based Research | [21]     |
| Periodontal Response to Orthodontic Forces After Regeneration of Infrabony Defects               | Descriptive Review    | [22]     |
| Periodontal Care for Localized Severe Periodontitis in a Fixed Orthodontic Patient               | Single Case Study     | [23]     |
| Multidisciplinary Management of Severe Tooth Migration Due to Localized Aggressive Periodontitis | Single Case Study     | [24]     |
| Orthodontic Therapy Post-Periodontal Regeneration in Deep Infrabony Defects                      | Case Series Study     | [25]     |
| Orthodontic Management of Severe (Stage IV) Periodontitis Cases                                  | Comprehensive Review  | [26]     |

### Risk of bias assessment

To appraise methodological quality, each included study was assessed according to its design. The following standardized tools were used: ROBINS-I for retrospective cohort studies, Newcastle–Ottawa Scale for case-control research, Joanna Briggs Institute (JBI) checklist for cross-sectional studies, and Cochrane Risk of Bias 2 (ROB 2) for randomized controlled trials [15]. A full summary is presented in **Table 4**.

**Table 4.** Risk of bias evaluation of the 17 included studies

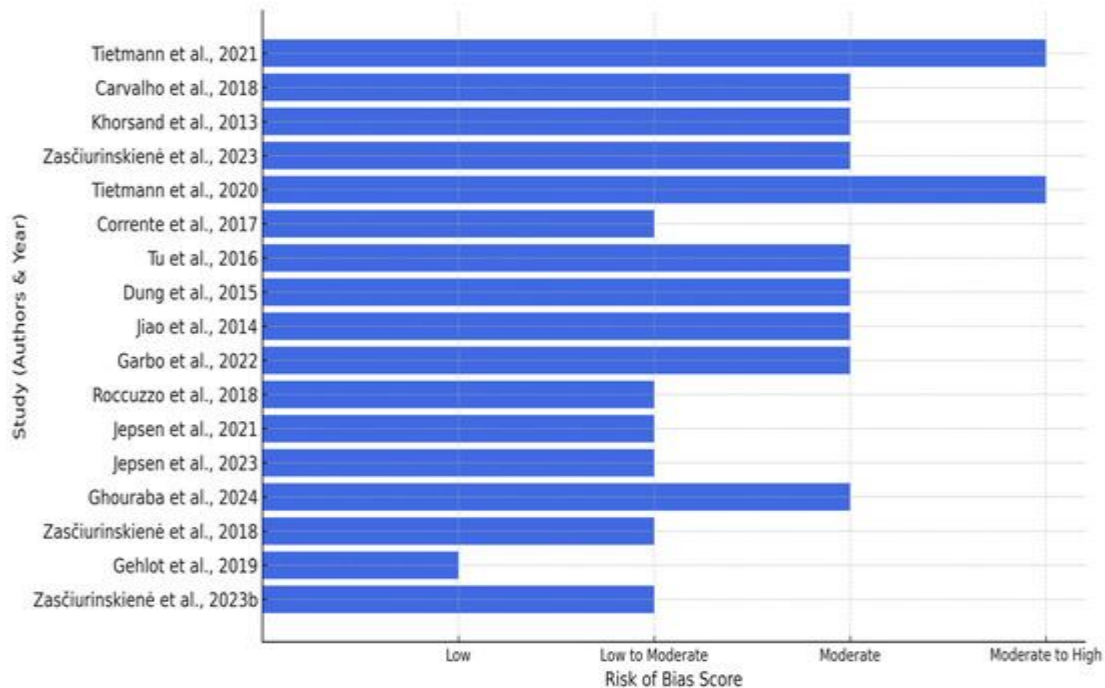
| Study Name                                                                                  | Research Design              | Assessment Tool            | Evaluated Aspects                                                          | Bias Level      |
|---------------------------------------------------------------------------------------------|------------------------------|----------------------------|----------------------------------------------------------------------------|-----------------|
| Treatment Outcomes for Angular Bone Defects [27]                                            | Controlled Clinical Study    | Newcastle-Ottawa Framework | Subject enrollment, result standardization, monitoring quality             | Moderate        |
| Post-Orthodontic Periodontal Health Assessment [28]                                         | Exploratory Study            | Newcastle-Ottawa Framework | Enrollment bias, procedure uniformity, data omissions, small cohort        | Moderate        |
| Orthodontic Tooth Movement in Severe Periodontal Defects [29]                               | Prospective Monitoring Study | Newcastle-Ottawa Framework | Subject selection, outcome reliability, treatment consistency              | Low to Moderate |
| Perceptions and Interest in Orthodontic Care Among Stage III–IV Periodontitis Patients [30] | Cross-Sectional Survey       | JBI Evaluation Tool        | Recruitment accuracy, measurement validity, data gaps, selective reporting | Moderate        |

|                                                                                           |                                    |                            |                                                                                        |                  |
|-------------------------------------------------------------------------------------------|------------------------------------|----------------------------|----------------------------------------------------------------------------------------|------------------|
| Long-Term Effects of Periodontal Regeneration with Orthodontic Movement [31]              | Retrospective Cohort Review        | ROBINS-I Tool              | Confounding factors, selection issues, incomplete data, outcome evaluation             | Moderate to High |
| Integrated Orthodontic and Periodontal Treatment [32]                                     | Randomized Clinical Experiment     | Cochrane RoB 2 Tool        | Randomization quality, group equivalence, clinical metrics, reporting selectivity      | Low to Moderate  |
| Orthodontic Effects on Periodontally Affected Patients [33]                               | Prospective Randomized Trial       | Cochrane RoB 2 Tool        | Randomization process, outcome measurement, selective reporting                        | Low              |
| Orthodontic Care in Aggressive Periodontitis Cases [34]                                   | Pre-Post Clinical Analysis         | Newcastle-Ottawa Framework | Selection bias, group similarity, exposure and outcome assessment                      | Moderate         |
| Collaborative Orthodontic-Periodontal Management in Stage IV Periodontitis [35]           | Retrospective Evaluation           | ROBINS-I Tool              | Confounding, selection bias, treatment categorization, outcome trustworthiness         | Moderate         |
| Quality of Life Impact from Combined Periodontal and Orthodontic Therapy [36]             | Multicenter Randomized Study       | Cochrane RoB 2 Tool        | Randomization, evaluator blinding, outcome dependability, reporting bias               | Low to Moderate  |
| Influence of Orthodontic Timing on Periodontal Surgery Outcomes [37]                      | Multicenter Randomized Experiment  | Cochrane RoB 2 Tool        | Randomization, blinding procedures, outcome assessment, selective reporting            | Low to Moderate  |
| Periodontal Changes Post-Orthodontic Treatment in Aggressive Periodontitis [38]           | Pre-Post Clinical Study            | Newcastle-Ottawa Framework | Subject recruitment, procedure standardization, data completeness, monitoring rigor    | Moderate         |
| Orthodontic Management Following Periodontal Regeneration [39]                            | Retrospective Analysis             | ROBINS-I Tool              | Confounding, intervention scheduling, outcome classification                           | Moderate         |
| Orthodontic Therapy After Periodontal Defect Regeneration [40]                            | Long-Term Retrospective Review     | Newcastle-Ottawa Framework | Subject enrollment, follow-up thoroughness, intervention timing                        | Moderate         |
| Combined Periodontal Regeneration and Orthodontic Movement in Stage IV Periodontitis [41] | Retrospective Cohort Analysis      | ROBINS-I Tool              | Confounding, selection issues, data gaps, intervention categorization, outcome metrics | Moderate to High |
| Periodontal Regeneration and Orthodontic Treatment Synergy [42]                           | Prospective Observational Analysis | Newcastle-Ottawa Framework | Confounding factors, monitoring reliability, treatment timing                          | Low to Moderate  |
| Orthodontic Needs in Malocclusion and Pathologic Tooth Migration [43]                     | Cross-Sectional Analysis           | JB1 Evaluation Tool        | Subject selection, data precision, reporting bias, external applicability              | Moderate         |

Findings from the bias analysis were:

- Retrospective Cohort Studies: Bias ranged from moderate to serious, mostly due to confounding variables, selective recruitment, and incomplete reporting.
- Cross-Sectional Studies: Moderate bias was common, largely because of weak participant representativeness and external validity issues. Outcome measurement and reporting were usually acceptable.
- Controlled Clinical/Pilot Trials: Showed moderate bias, influenced by small cohorts, protocol variability, and incomplete follow-up.
- Randomized Controlled Trials (RCTs): Generally low to moderate bias. Most had strong randomization/blinding, but selective reporting and gaps in outcome data were occasional limitations.

In summary, RCTs carried the lowest overall bias (though still moderate in some cases), while retrospective designs were most vulnerable due to uncontrolled confounding and missing data. Cross-sectional studies also showed notable bias, especially around sampling and outcome evaluation (**Figure 2**).



**Figure 2.** Bias risk distribution across the 17 studies [28–44]

#### *General features of the selected studies*

Seventeen studies were analyzed, and their essential details are outlined in the table, covering demographics, participant counts, and study populations. A large proportion investigated subjects with advanced periodontal breakdown, especially Stage IV, Grade C, where both bone and attachment levels were markedly affected [27, 28, 30, 31, 35]. Enrollment numbers varied from 8 to 121 participants, aged 18–78 years. Sex distribution was documented in 15 studies, while one mentioned only female percentages and another gave no sex data. Most studies were consistent with the 2017 classification, whereas earlier research was retrospectively categorized using clinical and radiographic evidence (**Table 5**).

**Table 5.** Demographics, participant size, and classification of the 17 included studies according to the 2017 periodontal framework

| Researcher/Year                           | Sample Size Determined | Study Cohort                                  | Participants | Gender (F/M) | Average Age (±SD) | Age Span (Years) | 2017 Periodontal Classification         |
|-------------------------------------------|------------------------|-----------------------------------------------|--------------|--------------|-------------------|------------------|-----------------------------------------|
| Ghouraba <i>et al.</i> , 2024 [27]        | Yes                    | Teeth with overeruption and angular bone loss | 10           | Not reported | No data           | 30–55            | Stage IV, Grade C                       |
| Jiao <i>et al.</i> , 2019 [28]            | Yes                    | Severe periodontitis (Stage IV, Grade C)      | 24           | 16/8         | No data           | 18–35            | Stage IV, Grade C                       |
| Corrente <i>et al.</i> , 2003 [29]        | No                     | Advanced periodontal conditions               | 10           | 8/2          | No data           | 33–53            | Stage IV, Grade C                       |
| Zasčiurinskienė <i>et al.</i> , 2023 [30] | Yes                    | Stage III–IV periodontitis patients           | 96           | 67/29        | 45.7 (±10.2)      | 30–78            | Stage III–IV, Grade C                   |
| Tietmann <i>et al.</i> , 2023 [31]        | Yes                    | Severe periodontitis (Stage IV)               | 22           | 13/9         | 43.9 (±N/A)       | 29–62            | Stage IV, Grade C (three cases Grade B) |

|                                           |     |                                                   |     |               |                     |         |                                                     |
|-------------------------------------------|-----|---------------------------------------------------|-----|---------------|---------------------|---------|-----------------------------------------------------|
| Zasčiurinskienė <i>et al.</i> , 2018 [32] | Yes | Periodontitis patients requiring orthodontic care | 50  | 35/15         | 47 ( $\pm 3.4$ )    | 25–55   | Stage III, Grade B                                  |
| Gehlot <i>et al.</i> , 2023 [33]          | Yes | Mild to severe periodontitis cases                | 36  | 23/13         | 47 ( $\pm 3.0$ )    | No data | Stage II, Grade B; Stage III–IV, Grade C (per CBCT) |
| Carvalho <i>et al.</i> , 2017 [34]        | Yes | Aggressive periodontitis and healthy controls     | 20  | 17/3          | 25.0 ( $\pm 5.22$ ) | No data | Stage IV, Grade C and healthy subjects              |
| Garbo <i>et al.</i> , 2022 [35]           | No  | Generalized severe periodontitis                  | 29  | 23/6          | 55.1 $\pm$ 6.5      | 44–68   | Stage IV, Grade C                                   |
| Jepsen <i>et al.</i> , 2023 [36]          | No  | Severe periodontitis cases                        | 43  | 26/17         | 45.4 $\pm$ 11.9     | No data | Stage IV, Grade C                                   |
| Jepsen <i>et al.</i> , 2021 [37]          | Yes | Severe periodontitis patients                     | 43  | 26/17         | 45.4 $\pm$ 11.9     | 30–55   | Stage IV, Grade C (6 cases Grade B)                 |
| Khorsand <i>et al.</i> , 2013 [38]        | No  | Aggressive periodontitis patients                 | 8   | 7/1           | 30 ( $\pm$ NA)      | No data | Stage III/IV, Grade C                               |
| Tu <i>et al.</i> , 2022 [39]              | No  | Stage III or IV periodontitis, Grade B or C       | 21  | 11/10         | 40 ( $\pm$ NA)      | 23–66   | Stage III or IV, Grade B or C                       |
| Dung <i>et al.</i> , 2024 [40]            | No  | Severe periodontitis with malocclusion            | 9   | 7/2           | 44.2 $\pm$ 9.0      | 30–59   | Stage IV, Grade C                                   |
| Tietmann <i>et al.</i> , 2021 [41]        | No  | Stage IV periodontitis patients                   | 48  | 60.4% females | 45.3 ( $\pm$ NA)    | 29–66   | Stage IV, Grade C                                   |
| Roccuzzo <i>et al.</i> , 2018 [42]        | No  | Severe periodontitis cases                        | 48  | 28/20         | 44.3 $\pm$ 8.5      | No data | Stage IV, Grade C (CAL $\geq$ 10 mm)                |
| Zasčiurinskienė <i>et al.</i> , 2023 [43] | Yes | Stage III–IV periodontitis, Grades A–C            | 121 | 85/36         | 44 ( $\pm 0.48$ )   | 30–78   | Stage III–IV periodontitis                          |

#### Specific characteristics of the studies

The reviewed literature focused on how orthodontics, when integrated into periodontal care, influenced clinical outcomes. Patients presented with varying severity of disease, from mild to advanced forms, staged under the 2017 system. Orthodontic management involved a range of approaches, including fixed appliances, aligners, and intrusion methods, sometimes paired with regenerative procedures such as bone grafts or guided tissue regeneration (GTR) (Table 6).

**Table 6.** Summary of aims, methodologies, populations, results, and follow-up durations of clinical studies addressing orthodontic care in periodontally compromised patients

| Researcher/Year                    | Study Objective                                                                                      | Participant Group                                                      | Assessment Methods                                                         | Key Findings                                                                                                                     | Monitoring Duration |
|------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Ghouraba <i>et al.</i> , 2024 [27] | Assess outcomes of GTR followed by OI versus OI followed by GTR for overerupted teeth with bone loss | 10 patients (20 teeth) with overerupted teeth and angular bone defects | Clinical (PD, BOP, TM) and radiographic (CBCT for defect depth, bone area) | GTR + OI showed better short-term outcomes; OI + GTR had superior long-term results with reduced PD and TM at one-year follow-up | 1 year              |
| Jiao <i>et al.</i> , 2019 [28]     | Examine orthodontic treatment's impact on periodontal                                                | 24 patients with Stage IV/Grade C periodontitis                        | PD, BOP, RBH% pre- and post-treatment                                      | No notable changes in PD, BOP, or RBH%;                                                                                          | Not specified       |

|                                           |                                                                                                                                               |                                                                                                           |                                                                                              |                                                                                                                                                                                            |                           |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
|                                           | health in Stage IV/Grade C periodontitis                                                                                                      |                                                                                                           |                                                                                              | periodontal status remained stable                                                                                                                                                         |                           |
| Corrente <i>et al.</i> , 2003 [29]        | Investigate combined periodontal-orthodontic therapy effects on tissue changes post-surgery and intrusion in advanced periodontal disease     | 10 patients with advanced periodontal disease and extruded maxillary incisors with infrabony defects      | PD, CAL, radiographs (vertical/horizontal bone fill)                                         | Significant PD reduction (4.35 mm), CAL gain (5.50 mm), bone fill (vertical: 1.35 mm, horizontal: 1.40 mm); no root resorption or adverse effects                                          | 10 ± 2.6 months           |
| Zasčiurinskienė <i>et al.</i> , 2023 [30] | Explore interest in orthodontic treatment and its relation to oral health and disease knowledge in Stage III–IV periodontitis patients        | 96 adults (≥30 years) with Stage III–IV periodontitis                                                     | Periodontal-orthodontic exam, 44-question survey, statistical analysis                       | 56.3% showed interest in OT; Stage IV, Grade C predicted higher OT interest                                                                                                                | Not specified             |
| Tietmann <i>et al.</i> , 2023 [31]        | Assess long-term efficacy of regenerative periodontal treatment with orthodontics                                                             | 22 patients with Stage IV periodontitis, 256 intra-bony defects                                           | Radiographic bone level (rBL), PPD                                                           | rBL gain: 4.48 mm after 10 years, 90% pocket closure, 4.5% tooth loss                                                                                                                      | 10 years                  |
| Zasčiurinskienė <i>et al.</i> , 2018 [32] | Compare timing of orthodontic treatment on periodontal outcomes in susceptible patients                                                       | 50 periodontal patients, split into test/control groups                                                   | CAL, PD, gingival recession (REC)                                                            | Both groups showed CAL gain, PD reduction; control group (periodontal therapy first) had more healed 4–6 mm PD sites                                                                       | 6 years (2010–2016)       |
| Gehlot <i>et al.</i> , 2022 [33]          | Evaluate fixed orthodontic treatment's effect on periodontal health in compromised patients                                                   | 36 adults with periodontitis, randomized into test/control groups                                         | Clinical (CAL, PD, PI, GI, BOP) and radiographic (ABL) at baseline, start, 1 year post-ortho | Both groups showed significant periodontal improvement; no significant inter-group differences                                                                                             | 1 year                    |
| Carvalho <i>et al.</i> , 2018 [34]        | Assess orthodontic movement's impact on periodontal tissues in aggressive periodontitis                                                       | 10 aggressive periodontitis patients (25.0 ± 5.22 years), 10 healthy controls (22.9 ± 5.23 years)         | PPD, CAL, BoP, PI at baseline, post-orthodontic, and 4 months later                          | Improved PPD (−0.29 mm), CAL (+0.38 mm), BoP (−4%), PI (−11%)                                                                                                                              | 4 months post-orthodontic |
| Garbo <i>et al.</i> , 2022 [35]           | Examine periodontal-orthodontic synergy in Stage IV periodontitis with tooth migration                                                        | 29 patients with Stage IV periodontitis and PTM                                                           | Clinical (CAL, PD, GI), radiographic assessments                                             | Notable CAL gain, PD reduction, enhanced esthetics, and functional outcomes                                                                                                                | 1 year                    |
| Jepsen <i>et al.</i> , 2023 [36]          | Evaluate combined regenerative periodontal surgery and orthodontic treatment on periodontal health and QoL in Stage IV periodontitis with PTM | 43 Stage IV periodontitis patients, randomized to early (4 weeks post-RPS) or late (6 months post-RPS) OT | CAL, PPD, GOHAI index at baseline, 6, 12, 24 months                                          | Early OT: higher CAL gain (5.96 ± 2.1 mm) vs. late OT (4.65 ± 1.76 mm, p = 0.034); pocket closure 91% (early) vs. 90% (late); QoL improved, with greater GOHAI score reduction in early OT | 24 months                 |

|                                           |                                                                                                                       |                                                                                                           |                                                          |                                                                                                                   |               |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------|
| Jepsen <i>et al.</i> , 2021 [37]          | Compare early (4 weeks) vs. late (6 months) orthodontic therapy outcomes                                              | 43 patients with Stage IV periodontitis                                                                   | CAL, PPD, BOP, pocket closure                            | CAL gain: 5.4 mm (early) vs. 4.5 mm (late); pocket closure: 91% (early) vs. 85% (late); no significant difference | 12 months     |
| Khorsand <i>et al.</i> , 2013 [38]        | Assess periodontal changes post-orthodontic treatment in aggressive periodontitis                                     | 8 patients with aggressive periodontitis, extruded maxillary incisors, infrabony defects, PPD $\geq$ 5 mm | PI, PPD, defect width/depth at baseline, 3, 6 months     | Significant reductions in PPD, PI, defect dimensions at 3 and 6 months; stable root length and papilla height     | 6 months      |
| Tu <i>et al.</i> , 2022 [39]              | Evaluate orthodontic outcomes after periodontal regeneration                                                          | 21 patients with compromised teeth (Stage III/IV, Grade B/C)                                              | PD, CAL, radiographic analysis                           | Enhanced periodontal stability, reduced PD and CAL                                                                | 1 year        |
| Dung <i>et al.</i> , 2024 [40]            | Assess long-term effects of immediate orthodontic treatment post-regenerative procedures                              | 9 patients with 17 intrabony defects                                                                      | PD, attachment level, bone fill                          | PD reduction: 3.94 mm, CAL gain: 3.47 mm, bone fill: 4.89 mm                                                      | 12.8 years    |
| Tietmann <i>et al.</i> , 2021 [41]        | Evaluate orthodontic tooth movement outcomes post-regenerative periodontal surgery in Stage IV periodontitis with PTM | 48 Stage IV periodontitis patients with PTM                                                               | CAL, PD, radiographic bone levels, periodontal stability | Significant CAL and PD improvement, radiographic bone gain                                                        | 12 months     |
| Roccuzzo <i>et al.</i> , 2018 [42]        | Investigate long-term orthodontic outcomes after periodontal regeneration                                             | 48 patients with severe periodontitis and PTM                                                             | PD, BOP, pus measurements                                | PD reduced from $6.3 \pm 1.5$ mm to $3.1 \pm 0.6$ mm; notable BOP and pus reduction                               | 10 years      |
| Zasčiurinskienė <i>et al.</i> , 2023 [43] | Assess malocclusion prevalence and orthodontic needs in Stage III–IV periodontitis                                    | 121 subjects with Stage III–IV periodontitis                                                              | Comprehensive periodontal-orthodontic exam               | Class II malocclusion most common (49.6%), PTM in 74.4% of maxillary AT; OTN needed in >50%                       | Not specified |

### Outcomes based on the 2017 periodontal classification

#### Orthodontic and periodontal therapies

- **GTR and Intrusion Combined:** Ghouraba *et al.* tested sequencing of GTR and orthodontic intrusion (OI) in 10 individuals with overerupted teeth and angular bone loss. Performing GTR first produced better early results, whereas the reverse order yielded greater one-year stability with lower probing depth (PD) and less tooth migration [27].
- **Orthodontics in Severe Periodontitis:** Jiao *et al.* examined 24 Stage IV, Grade C patients. Periodontal probing depth (PD) and bleeding on probing (BOP) remained unchanged, indicating orthodontics did not destabilize the periodontal condition [28].
- **Surgical-orthodontic Combination:** Corrente *et al.* assessed patients with advanced disease and extruded incisors. After 10 months, reductions in PD (mean 4.35 mm) and CAL gains (mean 5.50 mm) were reported, with no evidence of root resorption [29].
- **Patients' Interest in Orthodontics:** Zasčiurinskienė *et al.* surveyed 96 adults diagnosed with Stage III–IV disease. More than half (56.3%) were interested in orthodontic care, with Stage IV, Grade C most strongly linked to treatment demand [30].

*Long-Term stability and follow-up*

- **Regenerative-Orthodontic Treatment over 10 Years:** Tietmann *et al.* (2023) tracked 22 Stage IV patients for a decade. Findings included 4.48 mm mean radiographic bone gain, closure of 90% of pockets, and only 4.5% tooth loss, confirming the long-term benefit of combining regenerative and orthodontic therapy [31].
- **Timing of Orthodontics and Healing:** Zasčiurinskienė *et al.* evaluated 50 patients in a six-year trial. Periodontal therapy carried out before orthodontics led to better healing in PD sites (4–6 mm) compared with the test group, emphasizing the influence of treatment sequence [32].

*Patient-Centered outcomes*

- **Quality of Life Gains with Orthodontics:** Jepsen *et al.* followed 43 patients for 24 months. Starting orthodontics four weeks after regenerative surgery resulted in higher CAL improvement (5.96 mm) and more pocket closure than waiting six months. Both groups, however, reported significant oral health-related quality of life benefits (GOHAI) [36].
- **Fixed Appliances in Periodontitis Cases:** Gehlot *et al.* studied 36 subjects treated with fixed appliances. Results showed consistent improvement across CAL, PD, and plaque index, with no significant difference between groups, confirming safety in compromised patients [33].
- **Orthodontics in Aggressive Periodontitis:** Carvalho *et al.* observed 20 individuals with aggressive disease. They reported a mean reduction in probing depth (−0.29 mm) and CAL increase (+0.38 mm), highlighting measurable periodontal gains [34].

*Radiographic bone changes and tooth intrusion strategies*

- **Clinical and Radiographic Outcomes:** Dung *et al.* investigated the effects of initiating orthodontic treatment immediately after regenerative procedures in a cohort of 9 patients presenting with 17 intrabony defects. Over a follow-up period of 12.8 years, mean pocket depth decreased by 3.94 mm, while clinical attachment levels improved by an average of 3.47 mm [40].
- **Intrusion Methods for Extruded Teeth:** Khorsand *et al.* assessed orthodontic intrusion in 8 patients diagnosed with aggressive periodontitis. Within six months, notable reductions in probing depth and defect dimensions were observed, indicating meaningful periodontal improvements [38].

**Discussion**

The aim of this systematic review was to synthesize evidence regarding the effects of combining orthodontic therapy with periodontal management on clinical, radiographic, and patient-centered outcomes in individuals classified under the 2017 Periodontal Classification. The analysis demonstrates that interdisciplinary treatment has considerable potential, but limitations exist due to heterogeneity in intervention protocols, small sample sizes, and inconsistencies across studies.

The 2017 classification system introduced a structured method to evaluate periodontitis severity and progression through defined staging and grading [44]. This allows a more precise correlation between patient disease profile and treatment outcomes, facilitating targeted clinical decision-making [45]. For example, cases categorized as Stage III or IV, Grade C—such as those included in Jepsen *et al.*—require adjusted periodontal and orthodontic strategies to address severe attachment loss and accelerated disease progression [36]. Prior to this system, the absence of such stratification often resulted in inconsistent comparisons across studies and uncertainty regarding optimal treatment pathways. Adoption of this framework supports individualized treatment planning and enables more accurate assessment of intervention effectiveness [46].

The clinical significance of this updated classification is substantial. It encourages clinicians to incorporate disease stage and grade into both diagnostic evaluations and therapeutic planning [46]. Patients with Stage IV periodontitis, in particular, demand comprehensive management that addresses functional impairments and esthetic concerns from pathologic tooth migration while integrating regenerative and orthodontic interventions [26].

Evidence from studies using the 2017 classification underscores the value of synchronizing orthodontic tooth movement with procedures such as guided tissue regeneration (GTR) or bone grafting to maximize CAL improvement and PD reduction

[40,41,42]. These findings highlight the importance of coordinated, interdisciplinary care, with attention to patient-specific characteristics including disease severity and systemic health status to achieve optimal outcomes. Furthermore, the updated classification provides practical guidance for treatment planning. Clinicians should conduct thorough risk assessments encompassing systemic factors like diabetes and tobacco use to tailor therapy appropriately [46]. Cases with rapid progression (Grade C) may require intensified follow-up and adjunctive strategies, such as host-modulating agents, in addition to standard periodontal and orthodontic treatment. Orthodontic forces should be carefully controlled to prevent further periodontal deterioration [47]. Accounting for these considerations can improve predictability and enhance long-term treatment success.

#### *Critical review and limitations of evidence*

This systematic review reveals that most available data derive from observational and retrospective research, highlighting a shortage of high-quality evidence, particularly randomized controlled trials (RCTs). Observational studies provide insight into clinical practice, yet their inherent limitations—such as potential bias, inconsistent methodology, and lack of standardization—reduce the reliability of conclusions [48]. To address this, a rigorous assessment of bias was conducted, allowing cautious interpretation of findings from studies with higher risk.

Examination of clinical management strategies reveals notable differences, especially in how orthodontic and regenerative treatments are ordered. For instance, Ghouraba *et al.* reported that applying guided tissue regeneration (GTR) prior to orthodontic intrusion achieves superior short-term defect correction, while initiating with orthodontic intrusion and following with GTR results in enhanced long-term stability [27]. This emphasizes the importance of customizing treatment protocols according to each patient's specific clinical situation. The ideal timing of orthodontic therapy after regenerative procedures remains a topic of discussion: certain studies (e.g., Jepsen *et al.* [37]) suggest that early orthodontic intervention promotes faster bone formation and greater CAL improvements, whereas other evidence supports postponing treatment to ensure full tissue recovery [37]. Such divergent findings underscore the necessity for controlled comparative studies to determine the most effective timing strategy.

The type of orthodontic appliance further influences treatment outcomes. Fixed appliances have proven effective in addressing severe malocclusion and pathologic tooth migration but may increase plaque accumulation and risk further periodontal damage [30,43]. Clear aligners offer aesthetic, minimally invasive alternatives; however, limited evidence exists to confirm their efficacy in patients with compromised periodontium [33]. The lack of head-to-head studies prevents definitive guidance, pointing to the need for future comparative research.

The robustness of evidence differs depending on the clinical outcomes measured. High-quality research demonstrates clear improvements in clinical attachment level (CAL), particularly in severe cases (Stages III and IV, Grade C), as reported by Jepsen *et al.* [36] and Tietmann *et al.* [31]. In contrast, the data supporting reductions in probing depth (PD) and gains in radiographic bone levels are of moderate strength, with results influenced by factors such as the shape of defects, the regenerative methods employed, and the duration of follow-up. Long-term evaluations, including the 10-year follow-up presented by Rocuzzo *et al.*, are essential to determine the persistence of treatment effects and the likelihood of relapse [36, 41, 42].

Variability in regenerative outcomes also warrants attention. Vertical and horizontal bone fill is reported, yet differences in defect type and technique affect results. Intrabony defects typically respond more consistently to GTR than horizontal bone loss, emphasizing the need for individualized strategies. While short-term regenerative outcomes appear favorable, long-term sustainability is uncertain [27, 38, 41]. Future studies should investigate factors promoting stable bone regeneration and minimizing relapse.

Patient-reported outcomes (PROs) are underrepresented. Despite clear clinical improvements, quality of life, satisfaction, and psychosocial impact assessments are sparse. Jepsen *et al.* observed oral health-related quality of life improvement (GOHAI), but such assessments are inconsistently included [36]. Integrating validated PROs into future studies would broaden understanding of treatment benefits.

Publication bias further complicates conclusions, as positive results are more likely to be published, potentially underrepresenting inconclusive or negative findings. While our review applied a comprehensive search and critical bias evaluation, greater transparency in reporting is needed.

In summary, while the combination of orthodontic and periodontal treatments demonstrates significant potential, considerable knowledge gaps persist. Differences in treatment protocols, a lack of extended follow-up data, and minimal attention to patient-reported outcomes highlight the necessity for more robust investigations. Upcoming research should emphasize randomized controlled trials, uniform methodologies, and long-term monitoring to enhance therapeutic effectiveness and patient-focused care. Filling these gaps will reinforce the evidence base for incorporating orthodontic interventions into periodontitis management.

## Conclusions

The review highlights significant benefits of integrating orthodontic treatment with periodontal therapy, particularly for advanced periodontitis as defined by the 2017 classification. CAL improvement and PD reduction were most pronounced when treatment was tailored and multidisciplinary collaboration applied. However, the lack of RCTs and standardized methodology limits definitive recommendations. Future investigations should focus on long-term outcomes and patient-reported measures to establish comprehensive guidelines for managing periodontally compromised patients.

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