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Finishing Quality in Orthodontics: Aligners vs. Fixed Appliances: A Systematic Review

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Abstract

Introduction: Fixed appliances are widely regarded as the gold standard in orthodontic treatment due to their ability to deliver precise control over tooth movements. However, the rising demand for more aesthetic options has driven the development and widespread adoption of clear aligners. This systematic review aims to evaluate and compare the finishing quality of orthodontic treatments completed with clear aligners versus fixed appliances. **Materials and Methods:** A systematic review was conducted in accordance with PRISMA guidelines. Searches were performed across three databases: PubMed, Scopus, and ScienceDirect and included analytical and interventional studies published between 2015 and 2025. Eligible studies assessed orthodontic treatment outcomes using standardized evaluation tools such as *The American Board of Orthodontics Objective Grading System* (ABO-OGS), *Peer Assessment Rating* (PAR) *Index*, *Little's Irregularity Index* (LII), or cephalometric analysis. The methodological quality of the included studies was evaluated using The National Institutes of Health (NIH), Quality Assessment Tools for randomized controlled trials and observational studies. Risk of bias was assessed using the ROB2 and ROBINS-I tools. **Results:** Twelve studies met the inclusion criteria (four randomized controlled trials, five cohort studies, and three case-control studies). Although the findings were somewhat heterogeneous, the majority of studies reported that clear aligners achieved a finishing quality comparable to that of fixed appliances in treating mild to moderate malocclusions. However, in cases involving extractions, fixed appliances demonstrated superior control over tooth movement and finishing outcomes. **Conclusion:** Clear aligners are a valid alternative to multi-bracket systems for orthodontic treatments of mild to moderate complexity. Nonetheless, their effectiveness remains limited in more complex cases requiring extractions or extensive tooth movements. Further research with more standardized methodologies is warranted to strengthen these findings.

Subject Areas

Orthodontics

Keywords

Clear Aligners, Fixed Appliances, Orthodontic Finishing Quality

1. Introduction

Orthodontics, a specialized branch of dental medicine, aims to diagnose, prevent, and treat dental malocclusions and dentofacial anomalies. Over the past few decades, this specialty has undergone significant advancements, particularly due to the evolution of materials and treatment techniques. Among the most commonly used approaches, fixed appliance systems are considered the gold standard in orthodontics due to their effectiveness in controlling tooth movements and ensuring optimal treatment finishing. These appliances enable the application of precise, continuous forces, promoting optimal alignment, functional occlusion, and long-term stability [1] [2].

However, the growing demand for more aesthetic and comfortable alternatives has led to the emergence and rapid development of clear aligners. Since their introduction in the 1990s with the Invisalign system, aligners have evolved substantially, thanks to innovations in 3D technology and polymer materials. Today, they are highly valued for their discreet appearance, ease of use, and minimal impact on patients' quality of life. Once limited to minor corrections, aligners are now increasingly used in more complex cases, including anterior open bites, bimaxillary protrusion, and severe crowding [3]-[6].

Regardless of the technique, the ultimate goal of orthodontic treatment is to achieve a functional and aesthetically pleasing occlusion. Treatment finishing quality is assessed based on several criteria, including precise tooth alignment, correction of mesiodistal and buccolingual inclinations, root parallelism, and balanced occlusal contacts. Fixed appliance treatments offer a well-structured finishing phase, allowing for enhanced control over these parameters. In contrast, clear aligners may present challenges in managing certain tooth movements, often requiring mid-course adjustments or refinements at the end of treatment to achieve optimal results.

Although clear aligners have become a widely accepted alternative to fixed appliances, their ability to deliver the same level of finishing precision remains debated. While some studies suggest that aligners can achieve outcomes comparable to those of metal brackets in mild to moderate malocclusions, others emphasize their limitations, particularly in cases involving extractions or significant tooth movement. This raises a key question: can clear aligners ensure the same finishing quality as fixed appliances across varying clinical scenarios?

The purpose of this study is to analyze and compare the finishing quality of

orthodontic treatments performed with clear aligners and fixed appliances.

2. Materials and Methods

2.1. Study Design

To address the objective of this study, a systematic review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, ensuring both transparency and reproducibility of the review process. The research question was formulated using the PICO framework, which provided a structured definition of the inclusion criteria. The intervention of interest was orthodontic treatment using clear aligners, compared to orthodontic treatment with fixed appliances. The primary outcome was the evaluation of finishing quality in orthodontic treatments, assessed with standardized tools such as the ABO-OGS, PAR Index, LII, and cephalometric analyses.

This study focuses on adolescent and adult patients, both male and female, who present with malocclusions requiring orthodontic treatment or who have previously undergone treatment with either aligners or fixed appliances. The intervention of interest is orthodontic treatment with aligners, which is compared to conventional fixed appliances using multi-bracket systems. Treatment outcomes are assessed through objective and standardized evaluation tools, including the American Board of Orthodontics Objective Grading System (ABO-OGS), the Peer Assessment Rating (PAR) index, the Little Irregularity Index (LII), as well as other assessment methods such as cephalometric analysis.

The PAR Index (Figure 1)**:**

In 1987, the Peer Assessment Rating (PAR) index was created and validated. Ten experienced orthodontists studied more than 200 pre- and post-treatment models to determine the occlusal criteria to be considered when evaluating occlusion. The occlusal criteria evaluated include: alignment, inter-arch relationships (antero-posterior, vertical, and transverse), overjet, overbite, and incisor tip-to-tip coincidence.

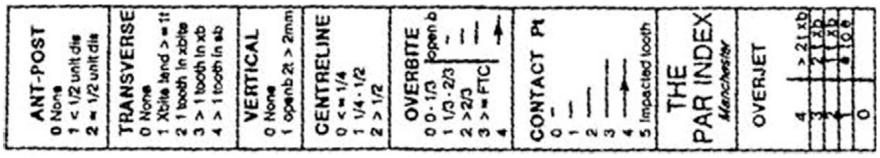

Figure 1. The PAR rule used to measure overjet: the recorded overjet is scored 2 (Richmond).

The principle is to assign a score to each criterion. The individual scores are then summed to give a total score, representing the degree of deviation of a case from ideal alignment and occlusion. A score of 0 indicates ideal alignment, while higher scores indicate irregularities. Both pre- and post-treatment models are scored, and the difference between these two scores represents the degree of improvement following orthodontic treatment. A percentage reduction of the PAR score is calculated from this difference. A reduction of 70% or more represents a

good improvement, while a reduction of 50% to 69% indicates an improvement. Despite its reliability and validity, the PAR index is not precise enough to detect minor dental positional anomalies found in ABO case reports. For this reason, the American Board of Orthodontics decided to create, after a series of four tests conducted over five years, the Objective Grading System (OGS) to evaluate treatment outcome quality on final dental models and panoramic radiographs.

The PAR rule provides a standardized method to score individual occlusal traits, such as overjet, allowing objective assessment of malocclusion severity. Each score reflects the degree of deviation from ideal alignment, and the summed scores generate a total PAR score. This total score enables comparison of pre- and post-treatment models to evaluate the effectiveness of orthodontic treatment.

The American Board of ABO-OGS (Figure 2):

Eight criteria are assessed: alignment, marginal ridge leveling, bucco-lingual inclination, occlusal relationships, occlusal contacts, overjet, interproximal contacts, and root angulation. A score is assigned to each criterion, and the individual scores are summed to give a total OGS score: the lower the score, the better the post-treatment occlusion. Terms such as crowding, overlapping, and dental irregularity are subjective and non-quantitative, and can represent different clinical meanings. Adjectives such as mild, moderate, or severe are useful for description but may be interpreted differently. For this reason, Robert M. Little decided to create a new index to objectively quantify anterior mandibular tooth crowding.

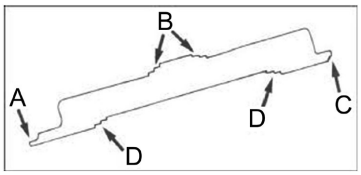

Figure 2. ABO Gauge.

Generally, a case with a score of more than 30 points is considered unsuccessful. This gauge was created to facilitate the measurement of each criterion. Each end of this gauge corresponds to a specific criterion.

Little's Irregularity Index (Figure 3):

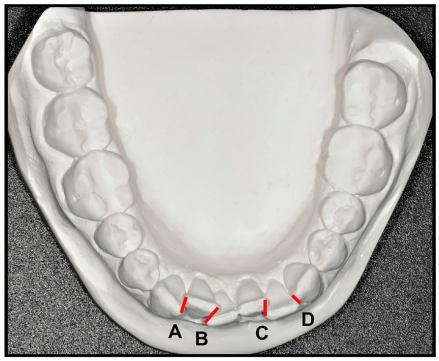

Figure 3. Little's irregularity index.

The principle is to measure the linear displacement of the anatomical contact points of each mandibular incisor relative to the adjacent tooth. The sum of these five displacements gives the relative degree of anterior irregularity. A perfectly aligned anterior segment, from the mesial edge of the right canine to the mesial edge of the left canine, would theoretically have a score of 0. A higher score reflects greater displacement of contact points and therefore more severe crowding. Measurements are performed on dental models using a caliper calibrated to one-tenth of a millimeter.

Little's Irregularity Index is a quantitative measure of anterior mandibular tooth crowding. It sums the linear displacements of the contact points of the six anterior teeth, with a score of 0 indicating perfect alignment and higher scores indicating greater irregularity.

2.2. Literature Search Strategy

***PICO criteria*:**

The study population consisted of adolescent and adult patients, both male and female, presenting with a malocclusion requiring orthodontic treatment or having previously undergone orthodontic therapy using either aligners or fixed appliances. The intervention involved orthodontic treatment with clear aligners, while the comparison group included patients treated with conventional fixed appliances using multibracket systems. The primary outcomes focused on the evaluation of treatment results obtained with aligners and fixed appliances, assessed through objective and standardized tools such as the American Board of Orthodontics Objective Grading System (ABO-OGS), the Peer Assessment Rating (PAR) index, the Little Irregularity Index (LII), or other evaluation methods, including cephalometric analysis.

The search strategy involved three major biomedical databases: PubMed, Scopus, and ScienceDirect, chosen for their wide coverage of clinical and biomedical research. Articles were included if they were published between 2015 and 2025, written in English, and designed as randomized controlled trials, cohort studies, or comparative studies that directly evaluated treatment outcomes with aligners and fixed appliances. Excluded from the review were literature and systematic reviews, meta-analyses, surveys, commentaries, case reports, and studies not focused on treatment finishing quality. Specific search equations were adapted for each database, using both MeSH terms and free-text keywords in PubMed, and free-text combinations in Scopus and ScienceDirect (Table 1).

Table 1. List of Keywords (MeSH terms) used in database searches.

Pubmed	(("Orthodontic Appliances, Fixed" [Mesh] OR "Orthodontic Brackets" [Mesh]) AND "Orthodontic Appliances, Removable" [Mesh]) AND ("Outcome Assessment, Health Care" [Mesh] OR "Treatment Outcome" [Mesh])
Scopus and ScienceDirect	(("Aligners" OR "Invisalign") AND ("Fixed appliance" OR "Braces" OR "Brackets")) AND ("Outcome" OR "ABO-OGS" OR "PAR" OR "LII")

All retrieved references were imported into Zotero, where duplicates were removed before screening. The selection process was conducted independently by two reviewers in three stages: title screening, abstract screening, and full-text screening, with a third reviewer consulted in cases of disagreement.

2.3. Article Selection Process

The selection of articles took place in three stages, carried out independently by two researchers. In the event of disagreement, a third researcher was consulted for arbitration.

- Selection on title: Exclusion of articles whose title did not correspond to the subject.

- Abstract selection: Analysis of abstracts to identify relevant articles; studies not meeting inclusion criteria were excluded.

- Full-text selection: Full-text reading of selected articles to ensure their relevance to the research question.

2.4. Assessment of Study Quality and Bias

The quality assessment of the included studies was carried out using the NIH Quality Assessment Tools, which allowed classification into low, moderate, or high quality. Risk of bias was evaluated using two validated instruments: the ROB2 tool for randomized controlled trials and the ROBINS-I tool for cohort and case-control studies. The results of these assessments were considered when interpreting the findings, to reduce the impact of methodological limitations.

2.5. Protocol Registration

To ensure the transparency and reproducibility of this systematic review, the study protocol was registered on the Open Science Framework (OSF) platform under DOI 10.17605/OSF.IO/R5N6B.

3. Results

3.1. Study Selection and Characteristics

The research identified a total of 248 articles: 37 from PubMed, 113 from Scopus, 49 from ScienceDirect, and 49 from Embase. Additionally, trial registries (ClinicalTrials.gov and WHO ICTRP) and the reference lists of included studies were handsearched to minimize publication bias. After removal of duplicates, 134 records were excluded during title and abstract screening. Of the 27 articles selected for full-text review, four were excluded due to unavailability in PDF format and one because it was written in Chinese. Following detailed evaluation, ten further articles were excluded for reasons such as lack of relevance to the objectives, focus on orthodontic forces rather than treatment outcomes, combination with orthognathic surgery, or evaluation of periodontal health rather than finishing quality. Ultimately, 12 studies were included in the review: four randomized clinical trials, five retrospective cohort studies, and three case-control studies (**Figure 1**). The general characteristics are

summarized in Table 2, and the PICO criteria are described in Table 3.

Table 2. General characteristics of included studies.

Author	Study type	Title	Review	Year of publication	Country
Jaber ST *et al.* [2]	Randomized Controlled clinical Trial	Treatment effectiveness of young adults using clear aligners versus buccal fixed appliances in class I malocclusion with first premolar extraction using the ABO-Objective Grading System: A randomized controlled clinical trial	International Orthodontics	2023	Syria
Alissa F. Borda *et al.* [5]	Retrospective Cohort Study	Outcome assessment of orthodontic clear aligner vs fixed appliance treatment in a teenage population with mild malocclusions	Angle orthodontist, Vol 90 No 4	2020	USA
Eric Lin *et al.* [6]	Randomized Controlled clinical Trial	Differences in finished case quality between Invisalign and traditional fixed appliances: A randomized controlled trial	Angle Orthodontist, Vol 92 No 2	2022	USA
Byron Chou *et al.* [7]	Retrospective Cohort Study	Outcome assessment of orthodontic clear aligner vs fixed appliance treatment in adolescents with moderate to severe malocclusions	Angle Orthodontist, Vol 93 No 6	2023	USA
Valentina Lanteri *et al.* [8]	Retrospective Cohort Study	The efficacy of orthodontic treatments for anterior crowding with Invisalign compared with fixed appliances using the Peer Assessment Rating Index	Quintessence international	2018	Italy
Jaber ST *et al.* [1]	Randomized Controlled clinical Trial	The Effectiveness of In-House Clear Aligners and Traditional Fixed Appliances in Achieving Good Occlusion in Complex Orthodontic Cases: A randomized control clinical trial	Cureus	2022	Syrie
Jiafeng Gu *et al.* [9]	Retrospective case-control study	Evaluation of Invisalign Treatment effectiveness and efficiency compared with conventional fixed appliances using the Peer Assessment Rating index	American Journal of Orthodontics and Dentofacial Orthopedics	2017	USA
Ruwa Irsheid *et al.* [10]	Retrospective case-control study	Comparative assessment of the clinical outcomes of clear aligners compared to fixed appliance in Class II malocclusion	Clinical Oral Investigations	2024	USA
Koji Fujiyama *et al.* [11]	Retrospective Cohort Study	Comparison of clinical outcomes between Invisalign and conventional fixed appliance therapies in adult patients with severe deep overbite treated with nonextraction	American Journal of Orthodontics and Dentofacial Orthopedics	2022	Japan
Joe Hennessy *et al.* [12]	Randomized Clinical Trial	A randomized clinical trial comparing mandibular incisor proclination produced by fixed labial appliances and clear aligners	Angle Orthodontist, Vol 86 No 5	2016	Irlande
Prudhvi Das Reddy S *et al.* [13]	Retrospective Cohort Study	Long-term Outcomes of Traditional Braces versus Invisalign in Orthodontic Treatment	Journal of Pharmacy and Bioallied Sciences	2024	India
Christou *et al.* [14]	Retrospective case-control study	Smile Outcome comparison of Invisalign and traditional fixed-appliance treatment: a case-control study	American Journal of Orthodontics and Dentofacial Orthopedics	2020	USA

Table 3. PICO criteria description.

Authors	Sample size (sex)	Mean age	Inclusion criteria	Treated group	Type of treatment	Duration of treatment	Comparison group	Outcome criteria
Jaber ST *et al.*	36 patients (12 men and 24 women)	21.24 ± 2.33 years	- Age between 18 and 25 years - Skeletal class I and dental class I - Severe crowding > 6 mm requiring orthodontic treatment with extraction of the 4 first premolars - No agenesis or extracted teeth (except 3rd molars) - No trauma history to the maxillofacial region or previous surgical interventions - No previous orthodontic treatment - No psychological or systemic diseases - No allergy to latex or plastic	16 patients treated with aligners	Orthodontic treatment with aligners (InHouse) or multi-bracket system (MBT)	Aligner group: 23.27 (±5.28) months Multi-bracket group: 26.20 (±5.27) months	16 patients treated with multi-bracket system	- Effectiveness evaluated using the Little Irregularity Index (LII) and PAR Index - Efficiency evaluated through treatment duration
Alissa F. Borda *et al.*	52 patients (24 men and 28 women)	11 - 17 years	- No syndromes - Orthodontic treatment without extractions - No previous orthodontic treatment - No missing teeth - No teeth requiring surgical exposure	26 patients treated with aligners	Orthodontic treatment with aligners or multi-bracket system	Aligners group: 16.9 (±5.7) months Multi-bracket group: 23.4 (±4.4) months	26 patients treated with multi-bracket system	ABO-DI, ABO-CRE, treatment duration, number of appointments
Eric Lin *et al.*	66 patients (24 men and 42 women)	26.7 years with IQR: 9.8 (aligners group) 25.9 years with IQR: 6.6 (multi-bracket group)	- Class I molar and canine -Orthodontic treatment without extractions - Mandibular crowding ≥ 4 mm - No missing teeth (except wisdom teeth)	32 patients treated with aligners	Orthodontic treatment with aligners or multi-bracket system	Aligners group: 1.7 years, IQR: 0.7 Multi-bracket group: 1.3 years, IQR: 0.7	34 patients treated with multi-bracket system	- Orthodontic treatment results evaluated according to ABO-OGS at the end of treatment (T1) and six months after (T2) - Duration of treatment
Byron Chou *et al.*	72 patients (38 men and 34 women)	CAT group: 13 ± 2 years FAT group: 13 ± 1 years	- Complete pre- and post-treatment records - Treatment start age: 12 - 18 years - Moderate or severe malocclusion determined by DI score ≥ 16 - No previous orthodontic treatment - Class III malocclusion - No syndrome or facial anomaly - No agenesis of teeth or teeth extracted for non-orthodontic reasons - No treatment stopped before the end	47 patients treated with aligners	Orthodontic treatment with aligners or fixed appliances	CAT group: 24 (±6) months FAT group: 27 (±5) months	25 patients treated with multi-bracket system	- ABO-DI - Results evaluated according to CRE (ABO-OGS) - Duration of treatment, number of appointments - Patient compliance - Craniofacial evolution and dental changes
Valentin A Lanteri *et al.*	200 patients (60 men and 140 women)	14 - 56 years Aligner group: 28 ± 10 years Multi-bracket group: 25 ± 10 years	- Treatments completed before June 2015 among Caucasian patients - Digital models before, during, and after treatment available - Age > 14 years - Treatment on 2 arches - No auxiliary devices (elastics, attachments, precision cuts) - No extractions - No orthognathic surgery or syndromes - Complete permanent dentition - Follow-up > 2 years	100 patients treated with aligners	Orthodontic treatment with aligners (Invisalign) or fixed appliances (MBT)	Aligner group: 14 months (+7 months for refinements) Multi-bracket group: 19 months (±4)	100 patients treated with multi-bracket system	- Little Index and PAR Index scores before treatment, after treatment, and after 2 years of follow-up - Treatment duration - Need for refinement - Interproximal reduction (in mm) - Gingival recession at mandibular incisors
Jaber ST *et al.*	36 patients (12 men and 24 women)	21.24 ± 2.33 years	- Age between 18 and 25 years - Skeletal class I and dental class I - Severe crowding > 6 mm requiring orthodontic treatment with extraction of the 4 first premolars - No agenesis or extracted teeth (except 3rd molars) - No trauma history to the maxillofacial region or previous surgical interventions - No previous orthodontic treatment - No psychological or systemic diseases - No allergy to latex or plastic	16 patients treated with aligners	Orthodontic treatment with aligners (InHouse) or fixed appliances (MBT)	Aligner group: 23.27 (±5.28) months Multi-bracket group: 26.20 (±5.27) months	16 patients treated with multi-bracket system	- Effectiveness evaluated using the Little Irregularity Index (LII) and PAR Index - Efficiency evaluated through treatment duration

Continued

Jiafeng Gu *et al.*	**96 patients (62 women and 34 men)**	**24.0 (SD 9.0) years**	**- Records before and after treatment with available digital models - Treatment start age ≥ 16 years - No auxiliary devices except elastics during treatment - No extractions - No orthognathic surgery or syndromes - Complete permanent dentition (except 3rd molars)**	**48 patients treated with aligners**	**Orthodontic treatment with aligners (Invisalign) or fixed appliances (straight wire edgewise appliances)**	**Aligner group: 13.35 months Multi-bracket group: 19.08 months**	**48 patients treated with multi-bracket system**	**- Treatment results evaluated using PAR index - Treatment duration - Improvement rate**
Ruwa Irshied *et al.*	66 patients (32 women and 34 men)	13.5 ± 1.6 years	- Age 12–18 years, Class II malocclusion treated with Invisalign or multi-bracket system - Complete permanent dentition without missing or supernumerary teeth - Records available before and after treatment: panoramic, cephalometric, and digital models - Compliance and regularity charts available - Patients with at least Class II elastics used for correction	31 patients treated with aligners	Orthodontic treatment with aligners (Invisalign) or fixed appliances (straight wire appliance)	Aligner group: 20.0 ± 11.6 months fixed appliances group: 27.4 ± 9.1 months	35 patients treated with multi-bracket system	- Treatment results evaluated using PAR index - Treatment duration - Number of visits - Posture changes
Koji Fujiyama *et al.*	50 patients (37 women and 13 men)	Aligner group: 23.3 ± 8.5 years	- Treatment started between January 2014 and August 2016 - Age > 18 years - No extractions - No previous orthodontic treatment in other clinics - No treatment interruption for more than 1 year	25 patients treated with aligners	Orthodontic treatment with aligners (Invisalign) or multi-bracket system	Aligner group: 31.9 ± 9.1 months Multi-bracket group: similar duration	25 patients treated with multi-bracket system	- Treatment results evaluated and compared using PAR index and cephalometric analysis
Da Silva *et al.*	27 patients (15 girls and 12 boys)	7 - 11 years	- Mixed dentition with erupted incisors and first permanent molars - Little Irregularity Index ≥ 3 mm in the maxillary arch - No incisor agenesis, white spots, clefts, or syndromes	14 patients treated with aligners	Orthodontic treatment with aligners and 2×4 fixed appliances	Aligner group: 8.00 (±2.90) months Multi-bracket group: 8.69 (±2.65) months	13 patients treated with multi-bracket system	- Little Irregularity Index (LII) - Treatment duration - Arch width, length, and perimeter - Incisor alignment and midline deviation - Plaque index and ICDAS index
Joe Hennessy *et al.*	44 patients	26.4 ± 7.7 years	- No caries or periodontal disease - Mild mandibular crowding (< 4 mm) requiring non-extraction orthodontic treatment - ANB between 1˚ and 4˚ - Age ≥ 18 years - No previous orthodontic treatment	22 patients treated with aligners	Orthodontic treatment with 3rd-generation Invisalign or fixed appliances	Aligner group: 10.5 months Multi-bracket group: 11.3 months	22 patients treated with multi-bracket system	- Cephalometric change in incisor inclination and mandibular plane angle
Ji Hye Song *et al.*	57 patients (15 men and 42 women)	Invisalign group: 25.5 (±5.2) years	- Age ≥ 18 years - 0˚ < ANB < 6˚ - Class I molar relationship - Mandibular crowding ≤ 4 mm - Extraction of 4 first premolars	27 patients treated with aligners	Orthodontic treatment with Invisalign G5 or fixed appliances	Aligner group: 38.7 (±12.0) months	30 patients treated with multi-bracket system	- Skeletal and dental changes: angular and linear measurements and changes in inclination
—	—	Multi-bracket group: 24.4 ± 5.8 years	- Patients requiring maximum anterior teeth retraction - No significant periodontal disease - No major medical history - No trauma history or major facial asymmetry - No previous orthodontic treatment or orthognathic surgery	—	Orthodontic treatment with fixed appliances	Multi-bracket group: 32.1 ± 9.1 months	—	- Changes in profile cephalometric parameters (SNA, SNB, ANB, Wits, Mpsn) - Angular changes between canines and second premolars on panoramic radiographs - Skeletal and dental changes (SN-U1, IMPA, overjet, OB, IIA) - Treatment duration

Continued

Cohen Levy *et al.*	**39 patients (16 women and 23 men)**	**Multi-bracket group: 18.7 ± 5.2 years Aligner group: 20.6 years**	**- Patients who completed orthodontic treatment without extractions or surgery, achieving Class I occlusion - Treatment performed in a university or private orthodontic clinic - No restorations, retention trays, or missing teeth (except third molars) - No severe periodontal disease or large restorations at data collection - Invisalign treatment only, with full compliance to instructions**	**14 patients treated with aligners**	**Orthodontic treatment with aligners (Invisalign) or self-ligating fixed appliances**	**Aligner group: 19.4 ± 7.88 months**	**25 patients treated with multi-bracket system**	**- Occlusal contact quality measured with digital T-Scan III system, evaluated immediately post-treatment and at 3 & 6 months of retention - Maxillary midline - Maxillary incisor position and inclination - Lip shape and arc of smile - Lip line**
Prudhvi Das Reddy S *et al.*	200 patients (104 men and 96 women)	Aligner group: 17.2 ± 2.1 years Multi-bracket group: 16.5 ± 2.3 years	-	100 patients treated with aligners	Orthodontic treatment with aligners (Invisalign) or fixed appliances	-	100 patients treated with multi-bracket system	- Dental alignment and occlusal parameters - Patient satisfaction - Treatment duration
Christou *et al.*	58 patients (39 women and 19 men)	ABO group: 13.00 years Invisalign group: 24.00 years	- Men and women aged 12 - 30 years - Class I molar - Treatment without extractions on both arches - Mild crowding on both arches (1 - 4 mm) - Pre- and post-treatment records available - ABO group: patients who presented to the ABO in St. Louis and passed the clinical exam in the last 3 years (2015-2018) - Invisalign group: treated with aligners	29 patients treated with aligners	Orthodontic treatment with aligners or fixed appliances	ABO group: 24.00 months Invisalign group: 19.03 months	29 patients treated with multi-bracket system	Smile outcomes evaluated on 15 variables: - Smile width - Lip symmetry - Smile index - Smile inclination - Buccal corridors (%) - Upper lip thickness - Lower lip thickness - Visible gingiva

The PRISMA diagram (Figure 4) illustrates the various selection stages, while Table 2 summarizes the main characteristics of the 12 included studies. Of these, 4 were randomized clinical trials, 5 were retrospective cohort studies and 3 were case-control studies.

The analysis of results revealed mixed but generally comparable findings between aligners and fixed appliances. Several trials reported no significant differences between systems in overall occlusal outcomes, though differences were observed in specific measures such as occlusal contacts, root angulation, or overbite correction. In some cases, aligners demonstrated advantages in overjet reduction, smile esthetics, or management of deep bite, while fixed appliances were associated with more favorable occlusal contacts and long-term stability in certain parameters.

To address this, outcomes were narratively summarized according to study type. RCTs tended to report more standardized evaluation criteria and lower risk of bias, while cohort and case-control studies contributed valuable longitudinal and practical insights. Although a formal sensitivity analysis could not be performed due to heterogeneity in study design and outcome metrics, the overall trends observed across both RCTs and observational studies were consistent, supporting the general conclusions of the review.

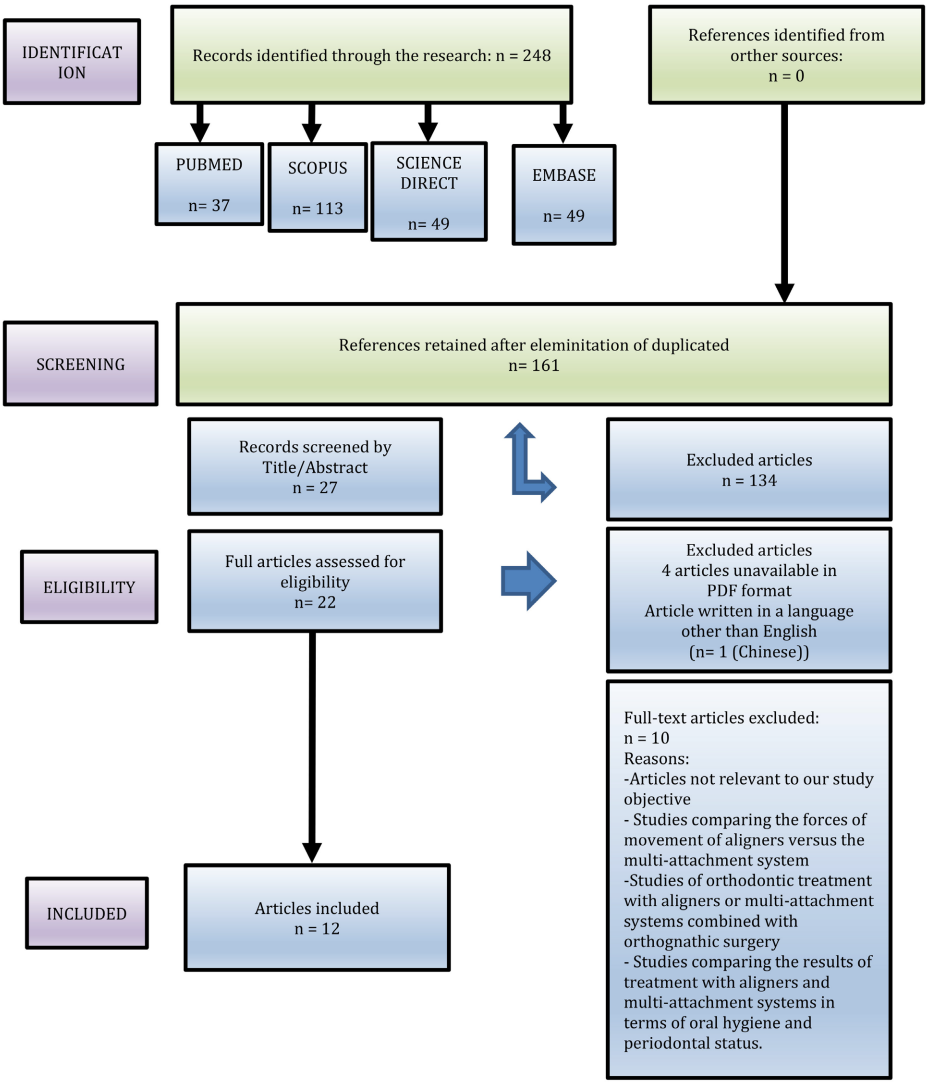

Figure 4. Flow chart according to PRISMA criteria.

3.2. Assessment of the Methodological Quality of the Included Studies

Assessment of methodological quality showed that three of the randomized clinical trials were of good quality, while one was of moderate quality. Among the non-randomized studies, five cohort studies were of moderate quality, one case-control study was rated as good, and two as moderate. Common limitations included small sample sizes, absence of long-term follow-up, and risks of selection bias.

3.3. Risk of Bias Assessment

The risk of bias analysis revealed that among the randomized clinical trials, three were rated as having some concerns and two as high risk (**Figure 5**, **Figure 6**). For cohort and case-control studies, three studies presented a serious risk of bias, four were judged to have a critical risk, and one could not be assessed due to insufficient information (**Figure 7**, **Figure 8**).

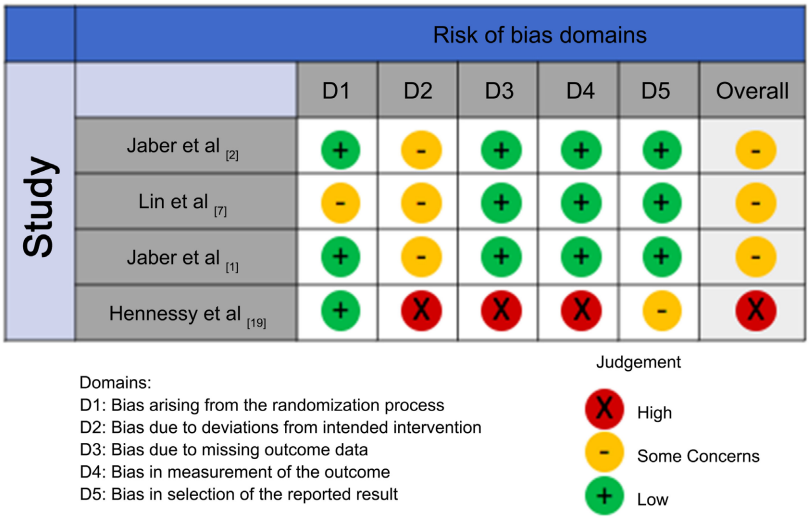

Figure 5. Traffic Light Plot: risk of bias assessment of included RCTs.

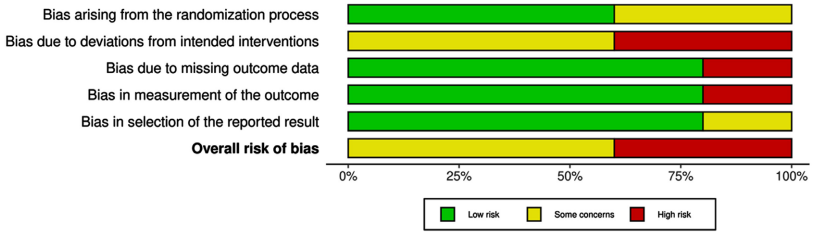

Figure 6. Summary Plot: risk of bias assessment of included RCTs.

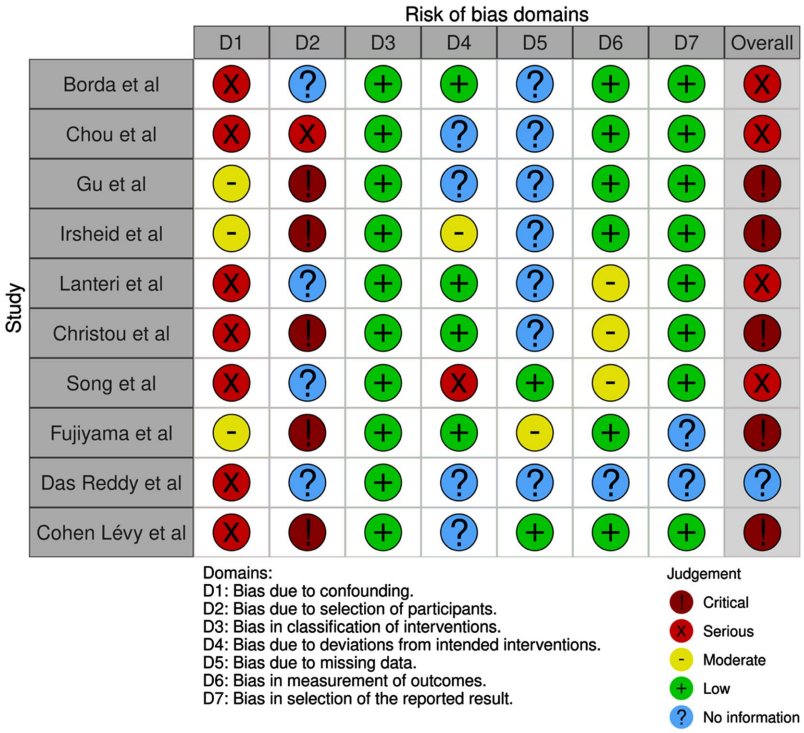

Figure 7. Traffic light plot: risk of bias assessment of included cohort and case-control studies.

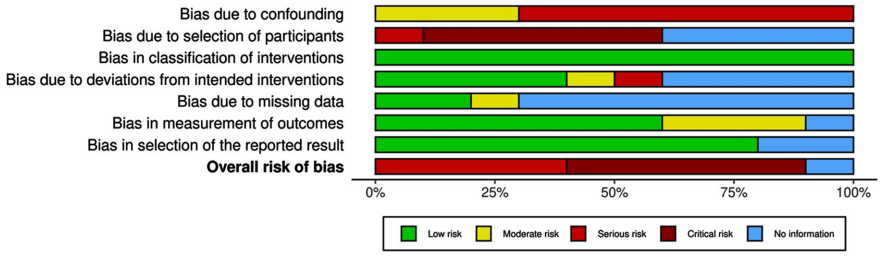

Figure 8. Summary plot: risk of bias assessment of included cohort and case-control studies.

4. Discussion

The aim of this systematic review was to assess the finishing quality of orthodontic treatments performed with clear aligners compared to multi-bracket fixed appliances, using standardized criteria including the ABO-OGS, PAR index, LII, and cephalometric analysis. Overall, the results suggest that both systems can achieve satisfactory outcomes, although performance varies depending on the type of malocclusion, treatment protocol, and evaluation criteria.

For cases not requiring extractions, aligners generally offered finishing quality comparable to that of fixed appliances, and in some studies, even slightly superior results in mild malocclusions. Borda *et al.* and Lin *et al.* reported better OGS scores with aligners, although only one study found statistically significant differences. These results are consistent with Kuncio et al [5]-[7]. but contrast with the findings of Djeu *et al.* [8], who reported better outcomes with fixed appliances. This discrepancy may be explained by differences in initial case severity, often evaluated with the Discrepancy Index (DI), as studies favoring aligners tended to focus on lower-DI cases, whereas Djeu *et al.* analyzed more complex malocclusions. The evolution of Invisalign technology may also account for improved results in more recent studies.

Regarding alignment and marginal ridge leveling, dental alignment appears better controlled by aligners, whereas marginal ridge leveling theoretically favors multi-bracket appliances due to superior vertical tooth control. However, most studies found no significant differences, except Lin *et al.* [6], who reported an advantage for fixed appliances.

Occlusal contacts and relationships yielded mixed results. Some studies suggest aligners achieve better final occlusion, while others report superior outcomes with fixed appliances [5] [6]. These differences may result from occlusal coverage of aligners, potentially inducing molar intrusion and modifying the posterior vertical dimension [9].

The PAR index generally showed comparable results between the two systems, with minor differences. For instance, Gu *et al.* [9] found slightly better PAR scores for fixed appliances, though not significant, while other studies reported opposite trends or equivalent outcomes [8] [10] [11].

Extraction cases demand more precise control of tooth movement, particularly

for space closure and anchorage management. In these cases, fixed appliances often produced better outcomes, particularly for controlling vestibulo-lingual inclination and occlusal contacts. Extrusion was the most difficult movement, with only 30% accuracy, followed by rotation. Bodily distalization of the maxillary molars up to 1.5 mm was the most predictable movement, with 88% accuracy. Consequently, aligners have been recommended for the treatment of simple malocclusions.

Treatments involving extractions require better control of tooth movements for space closure, incisor retraction, and anchorage management. Ideally, the space closure process requires the application of a three-point force system, combining tipping movements and couple movements (opposing forces generating torque). This movement pattern, known as "walking," is generally achieved by initially applying force at a single point, which first tips the crown forward and the root backward. A couple of forces subsequently develops at the bracket base, upright-ing the tooth by moving the apex until a new tipping movement is generated. This movement pattern has not been reproduced by aligners [12].

A meta-analysis in 2020 [13] found poorer ABO-OGS scores with aligners, although PAR index outcomes did not differ significantly. Moreover, recent evidence indicates that one in six patients initially treated with aligners required transition to fixed appliances to complete treatment [14].

Smile aesthetics, not captured by standardized indices, represents a crucial factor in orthodontic success. Christou *et al.* [15] found that fixed appliances improved certain smile parameters (buccal corridors, midline, gingival exposure), while aligners offered better positioning of the maxillary incisors.

Long-term stability is essential for treatment success. Overall, stability was comparable between aligners and fixed appliances, although recurrence trends may be influenced by the retention protocols applied [10] [11] [16]-[19].

Review limitations and outlook:

This systematic review has several limitations that should be considered when interpreting its findings. The included studies exhibited substantial heterogeneity, particularly regarding the generations of aligners assessed and the variability of retention protocols, which complicates the comparability of outcomes. Moreover, the predominance of retrospective designs increases the risk of selection bias, while small sample sizes limit the statistical power and reliability of the conclusions. The absence of studies focusing on Class III malocclusions further restricts the generalizability of the results across diverse clinical situations.

The inclusion of both randomized controlled trials (RCTs) and observational studies broadened the scope of available evidence but introduced methodological variability. RCTs generally provide stronger evidence through randomization and better control of confounding factors, whereas observational studies offer valuable insights into real-world clinical practice but are more susceptible to selection and measurement biases. Combining these designs may therefore influence the overall consistency and internal validity of the results.

5. Conclusion

This systematic review has shown that aligners offer a quality of finish comparable to multi-attachments in treatments without extractions, but remain less effective for cases requiring extractions, where multi-attachments provide better control of tooth displacements and occlusal contacts. However, the methodological limitations of the included studies call for further research. Randomized clinical trials with extended follow-up are crucial to reduce bias and better assess long-term treatment stability. Given the heterogeneity of evaluation criteria, which complicates the comparability of results, a standardized evaluation protocol is needed. It would also be appropriate to extend the analysis to Class III cases and complex malocclusions. Finally, technological advances in aligners justify further longitudinal studies to measure their effectiveness against multi-attachment over the long term. Refining this knowledge will enable us to optimize the indication of aligners and guide the choice of treatment towards solutions adapted to each patient.

Conflicts of Interest

The authors declare no conflicts of interest.

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