COMPOSITE ALIGNERS IN HYBRID MODE: A COMPREHENSIVE REVIEW OF CONTEMPORARY ORTHODONTIC APPLICATIONS

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Abstract
Background: The integration of composite attachments with clear aligner therapy has evolved into sophisticated hybrid orthodontic protocols that combine the aesthetic advantages of removable appliances with the biomechanical precision of fixed auxiliaries.
Objective: This manuscript provides a comprehensive review of composite aligners used in hybrid mode for orthodontic treatment, examining materials, clinical applications, biomechanical principles, advantages, limitations, and future directions.
Methods: A systematic review of contemporary literature was conducted, analyzing clinical studies, case reports, and material science investigations on composite attachments, hybrid orthodontic systems, and integrated treatment protocols.
Results: Hybrid approaches combining clear aligners with composite attachments and selective fixed auxiliaries demonstrate improved predictability for complex tooth movements, reduced treatment time in selected cases, and enhanced biomechanical control. Material selection significantly influences clinical outcomes, with bulk-fill composites showing superior bond strength and wear resistance compared to flowable variants. Attachment geometry plays a critical role in generating appropriate force systems for bodily tooth movement.
Conclusions: Hybrid composite-aligner strategies extend the clinical applicability of clear aligner therapy to more complex orthodontic cases while preserving aesthetic benefits. Evidence-based material selection, digital treatment planning, and strategic integration of fixed components are essential for optimizing clinical outcomes.
Controlled clinical trials are needed to establish standardized protocols and quantify success rates across diverse patient populations.
Keywords: composite aligners, hybrid orthodontics, clear aligner therapy, composite attachments, fixed-removable appliances, biomechanics, orthodontic materials

1. INTRODUCTION

1. Evolution of Orthodontic Treatment Modalities

The orthodontic landscape has undergone remarkable transformation over the past two decades, evolving from predominantly fixed appliance therapy toward increasingly sophisticated removable systems. Clear aligner therapy has emerged as a preferred treatment modality for many adult patients seeking aesthetic orthodontic solutions. However, the limitations of aligners in achieving predictable complex tooth movements—particularly bodily translations, root torque control, and severe rotations—have necessitated innovative approaches that leverage the strengths of both removable and fixed systems [1].

2. Defining Hybrid Mode Orthodontics

While a formal, universally accepted definition of "composite aligners" as a distinct category does not exist in the current literature, the term encompasses clear aligner systems that utilize composite resin attachments bonded to tooth surfaces to enhance biomechanical control. Hybrid mode orthodontics is more clearly defined as the strategic combination of clear aligner therapy with fixed appliances or auxiliaries to overcome predictable limitations of aligners alone and to optimize treatment efficiency [1].

The hybrid approach represents a paradigm shift from viewing clear aligners and fixed appliances as competing modalities toward recognizing them as complementary tools within an integrated treatment system. This philosophy enables clinicians to harness the aesthetic advantages, patient comfort, and oral hygiene benefits of removable aligners while incorporating the continuous force delivery, precise moment control, and three-dimensional tooth movement capabilities of fixed mechanics [2,3].

1. Clinical Significance and Rationale

The evolution toward hybrid systems is driven by both clinical necessity and patient demand. Adult patients increasingly seek orthodontic treatment but often prioritize aesthetics and minimal lifestyle disruption. Conventional clear aligner therapy, while meeting aesthetic requirements, demonstrates well-documented limitations in achieving certain tooth movements with predictability [2]. These limitations include:

- Inadequate bodily movement of posterior teeth during distalization
- Insufficient root torque control, particularly in the anterior region
- Unpredictable rotation correction of cylindrical teeth
- Limited vertical control and extrusion movements
- Challenges in achieving parallel root alignment

Hybrid approaches address these limitations by strategically incorporating composite attachments—optimized in geometry, placement, and material properties—and selective fixed auxiliaries such as partial lingual appliances, temporary anchorage devices, or segmental fixed mechanics [1,3,6]. This integration allows clinicians to:

1. Reduce the number of aligner refinements required
2. Shorten overall treatment duration
3. Improve predictability of complex movements
4. Maintain aesthetic appearance throughout treatment
5. Enhance patient satisfaction through efficient biomechanics

2. Scope of This Review

This manuscript provides a comprehensive examination of composite aligners in hybrid mode, synthesizing current evidence on materials science, biomechanical principles, clinical applications, and treatment outcomes. We address the following key questions:

- What composite materials and attachment designs optimize clinical performance?
- How do hybrid protocols integrate fixed and removable components?
- What are the indications, advantages, and limitations of hybrid approaches?
- What clinical evidence supports the efficacy of these strategies?
- What future developments are needed to advance the field?

By addressing these questions, this review aims to provide clinicians with evidence-based guidance for implementing hybrid composite- aligner strategies in contemporary orthodontic practice

3. MATERIALS AND METHODS

3.1. Composite Materials for Aligner Attachments

The selection of composite resin materials for aligner attachments represents a critical decision that influences attachment retention, wear resistance, placement accuracy, and ultimately, treatment predictability. Recent comparative investigations have elucidated significant performance differences among commonly used composite systems.

3.1.1. Comparative Material Performance

Chen et al. [4] conducted a comprehensive evaluation of three composite materials for aligner attachments: Filtek Z350XT (3M ESPE), Filtek Z350XT Flowable (3M ESPE), and SonicFill (Kerr). Their investigation assessed multiple clinically relevant parameters including operation time, shear bond strength, placement accuracy, and wear resistance. Key findings are summarized in Table 1.

Table 1. Comparative Performance of Composite Materials for Aligner Attachments [4]

Composite Material	Operation Time	Shear Bond Strength	Placement Accuracy	Wear Resistance
Filtek Z350XT	Longer	Moderate	Good	Good
Filtek Z350XT Flowable	Shorter	Lower	Poorer (greater 3D deviation)	Lower (higher volumetric loss)
SonicFill	Shorter	Highest	Good	Good (lowest wear volume loss)

Clinical Implications:

- SonicFill demonstrated superior shear bond strength compared to both Filtek variants, suggesting enhanced attachment retention during prolonged aligner therapy [4]
- Flowable composites offered reduced operation time but sacrificed placement accuracy (greater three-dimensional deviation) and exhibited higher volumetric change after bonding [4]
- Conventional nanohybrid composites (Filtek Z350XT) provided balanced performance with good accuracy and wear resistance, though requiring longer placement time [4]

- Bulk-fill composites (SonicFill) emerged as the optimal choice when long-term attachment retention and minimal wear are clinical priorities [4]

3.1.2. MF 8aterial Properties and Clinical Selection

The choice of composite material should be guided by case-specific requirements:

For Long-Duration Cases:

Select materials with high shear bond strength and low wear

characteristics (e.g., SonicFill) to minimize attachment replacement and maintain consistent force delivery throughout extended treatment [4].

For Short-Duration or Simple Cases:

Flowable composites may be acceptable when rapid placement is prioritized and treatment duration is limited, recognizing the trade- off in accuracy and wear resistance [4].

For Complex Biomechanics:

Conventional or bulk-fill composites with superior dimensional stability ensure that attachment geometry—critical for force vector generation—is maintained throughout treatment [4].

3.2. Attachment Design and Biomechanical Principles

The geometric configuration of composite attachments directly influences the force systems applied to teeth during aligner therapy. Strategic attachment design enables clinicians to generate desired tooth movements that would otherwise be unpredictable with

aligners alone.

3.2.1. Attachment Geometry for Specific Movements

Garino et al. [5] investigated the effectiveness of composite

attachments in controlling upper molar movement during aligner therapy, with particular focus on achieving bodily distalization rather than uncontrolled tipping. Their research demonstrated that vertical rectangular attachments positioned on the buccal surface of molars can produce countermoments that promote bodily movement during posterior distalization [5].

Biomechanical Rationale:

When an aligner exerts a distalizing force on a molar, the natural tendency is for the crown to tip distally while the root moves mesially (uncontrolled tipping). A properly designed vertical rectangular attachment creates an additional force couple by engaging the aligner material, generating a countermoment that opposes tipping and promotes translation [5].

Attachment Design Principles:

- Vertical orientation: Maximizes the moment arm for generating counterrotational forces
- Rectangular geometry: Provides predictable engagement with aligner material
- Strategic positioning: Placement on the buccal surface optimizes force vector direction
- Appropriate dimensions: Size must balance biomechanical effectiveness with patient comfort and aligner fit

3.2.2. Digital Workflow and Attachment Placement

Contemporary hybrid protocols rely on digital treatment planning to optimize attachment placement and integration with fixed components. The workflow typically includes:

1. Digital impression acquisition (intraoral scanning)
2. Three-dimensional treatment simulation incorporating both aligner staging and fixed appliance components
3. Virtual attachment design with precise specification of geometry, position, and angulation
4. Transfer template fabrication (3D-printed or thermoformed) for accurate clinical placement
5. Verification of attachment accuracy through digital scanning post-bonding

Lombardo et al. [3] described a sophisticated digital workflow in which aligners were designed to envelope lingual fixed appliances, with the digital setup simulating lingual tubes and archwires integrated into the aligner sequence. This approach enables precise staging of tooth movements around fixed components [3].

3.3. Manufacturing and Integration Protocols

3.3.1. Attachment Bonding Protocol

While the reviewed literature does not provide comprehensive standardized protocols for all procedural parameters (etching times, curing protocols, incremental placement steps), general clinical

guidelines can be synthesized:

Surface Preparation:

- Prophylaxis with non-fluoridated pumice
- Isolation (rubber dam or cotton roll isolation with saliva ejection)
- Phosphoric acid etching (typically 30-40 seconds for enamel)
- Thorough rinsing and air drying to achieve chalky-white etched appearance
- Composite Application:
- Application of bonding agent according to manufacturer specifications
- Composite placement using transfer template for accuracy
- Light curing with appropriate exposure time (varies by material and curing light intensity)
- Removal of excess material and finishing to smooth contours Material-Specific Considerations:
- Bulk-fill composites (e.g., SonicFill) may allow single- increment placement with reduced polymerization

time [4]

- Flowable composites require careful handling to maintain dimensional accuracy [4]

3.3.2. Integration of Fixed Components in Hybrid Systems

Several approaches for integrating fixed appliances with aligner therapy have been documented:

Partial Lingual Fixed Appliances:

Lombardo et al. [3] and Aiyar et al. [6] describe systems in which lingual brackets and wires are bonded to selected teeth (typically anterior teeth requiring precise torque control) while aligners are worn over the entire arch. The aligners may be digitally designed with cutouts or modified geometry to accommodate the fixed components [3,6].

Sequential Hybrid Protocols:

Some protocols employ fixed appliances for an initial phase (e.g., alignment, space closure, or correction of specific tooth positions) followed by aligner therapy for final detailing and finishing [8].

Integrated Digital Manufacturing:

Advanced protocols utilize in-house 3D printing of aligners with integrated design features that accommodate fixed components. Aiyar et al. [6] reported successful use of digitally planned, 3D- printed aligners combined with lingual fixed appliances for deep bite correction in adult patients [6].

3.4. Hybrid Treatment Protocols

Hybrid treatment protocols combine the strengths of removable and fixed systems through strategic sequencing and integration:

Protocol Components:

1. Aligner-Delivered Forces: Overall arch coordination, bite opening effects (through bite ramps or coverage), transverse expansion, and initial alignment
2. Fixed-Delivered Forces: Continuous force for space closure, precise root torque control, rotation correction of cylindrical teeth, and vertical control
3. Composite Attachments: Enhanced force transmission for specific movements (distalization, rotation, extrusion), improved aligner retention, and predictable force vector generation

Clinical Decision Framework:

- The decision to employ a hybrid approach should consider:
- Complexity of tooth movements required
- Patient aesthetic demands and compliance expectations
- Predicted aligner limitations for specific movements
- Treatment efficiency goals (time and number of refinements)
- Clinician experience and available technology (digital planning, 3D printing)

4. Clinical Applications and Biomechanics

4.1. Indications for Hybrid Composite-Aligner Therapy

Hybrid approaches are particularly indicated in clinical scenarios where clear aligners alone demonstrate predictable limitations. The evidence base, derived primarily from case reports and clinical reviews, identifies several key indications:

4.1.1. Complex Tooth Movements

Bodily Distalization:

Posterior tooth distalization for Class II correction or space management frequently results in uncontrolled tipping when attempted with aligners alone. Hybrid protocols incorporating vertical rectangular attachments or partial fixed appliances enable more predictable bodily movement [1,5].

Root Torque Control:

Anterior root torque—particularly lingual root torque of maxillary incisors—is notoriously difficult to achieve with removable aligners due to the lack of continuous force and limited root engagement.

Integration of partial lingual fixed appliances provides the necessary moment control [6].

Severe Rotations:

Rotation correction of cylindrical teeth (canines, premolars) beyond 20-30 degrees often exceeds the predictable capability of aligners. Strategic placement of optimized attachments or incorporation of fixed brackets on specific teeth enhances rotational control [1,2].

Deep Bite Correction:

Correction of deep overbite in adult patients requiring intrusion of anterior teeth and/or extrusion of posterior teeth benefits from hybrid approaches. Aligners can provide bite-opening effects through posterior bite ramps while lingual fixed appliances control anterior root position [6].

4.1.2. Case Complexity and Patient Factors

Adult Patients with Aesthetic Priorities:

Adult patients seeking comprehensive orthodontic correction while maintaining professional appearance represent the primary demographic for hybrid therapy. Partial lingual fixed appliances preserve facial aesthetics while enhancing biomechanical control [2,3,6].

Cases Requiring Reduced Treatment Time:

When treatment efficiency is paramount—due to patient scheduling constraints, upcoming life events, or professional requirements— hybrid approaches can reduce the number of aligner refinements and overall treatment duration [3].

Borderline Extraction vs. Non-Extraction Cases:

Cases at the boundary between extraction and non-extraction treatment may benefit from hybrid protocols that maximize space management efficiency, potentially avoiding extractions through more predictable distalization or arch expansion [1,3].

4.2. Patient Selection Criteria

Successful hybrid therapy requires careful patient selection based on both clinical and behavioral factors:

Clinical Criteria:

- Presence of tooth movements that are documented as unpredictable with aligners alone [1,2]
- Adequate periodontal health to support both aligner forces and fixed appliance mechanics
- Sufficient crown height and enamel quality for reliable attachment bonding [4]
- Occlusal relationships amenable to hybrid mechanics

Behavioral Criteria:

- High motivation for aesthetic treatment
- Demonstrated reliability and compliance
- Understanding that hybrid protocols may involve both removable and fixed components
- Willingness to maintain excellent oral hygiene with multiple appliance types

4.3. Treatment Planning Considerations

4.3.1. Digital Treatment Simulation

Contemporary hybrid planning relies on comprehensive digital workflows:

Three-Dimensional Treatment Objectives (3DTO):

Precise specification of final tooth positions, including root
angulations and torque values, guides the integration of fixed and removable components [3,6].

Biomechanical Simulation:

Digital simulation of force systems generated by attachments and fixed auxiliaries allows optimization of attachment design and placement before clinical implementation [5].

Staging and Sequencing:

Treatment is staged to coordinate aligner-delivered and fixed- delivered movements, with careful attention to the timing of attachment placement, fixed appliance bonding, and aligner changes [3,6].

Virtual Fixed Component Integration:

Advanced protocols simulate fixed components (lingual tubes, wires, brackets) within the digital setup, allowing aligners to be designed with appropriate accommodation or engagement features [3].

4.3.2. Biomechanical Strategy

Combining Strengths of Each Modality:

Aligners provide: Overall arch form coordination, bite opening effects through coverage and bite ramps, patient comfort through smooth surfaces, and improved oral hygiene access compared to full fixed appliances [6]

Fixed auxiliaries provide: Continuous force delivery for space closure and root movement, predictable moment generation for torque control, three-dimensional control of root position, and reduced dependence on patient compliance [6]

Composite attachments provide: Enhanced force transmission from aligner to tooth, generation of desired force vectors (e.g., countermoments for bodily distalization), improved aligner retention, and specific control of rotations and translations [5]

Force System Design:

The biomechanical strategy must account for force magnitude, direction, and duration:

Light continuous forces from fixed components for root movements and torque controlIntermittent forces from aligners (dependent on wear time) for crown movements and arch coordination

- Optimized attachment geometry to generate appropriate force vectors and moments [5]

4.4. Specific Clinical Scenarios

4.4.1. Class III Combined Orthopedic and Hybrid Orthodontic Treatment

Lombardo et al. [3] documented a case involving:

- Initial orthopedic phase: Facemask therapy with rapid maxillary expansion (FM+RME)
- Hybrid orthodontic phase: Clear aligners combined with partial lingual fixed appliances
- Outcome: Efficient correction with reduced overall treatment time and maintained aesthetics [3]

This case demonstrates the potential for multi-phase protocols integrating growth modification, hybrid orthodontics, and digital planning.

4.4.2. Deep Bite Aesthetic Correction in Adults

Aiyar et al. [6] presented a case series of three adult patients with deep overbite treated using:

- Lingual fixed appliances on anterior teeth for precise torque control
- Clear aligners on full arch for bite opening, posterior coordination, and aesthetics
- In-house 3D-printed aligners for customized digital planning
- Outcomes: Successful deep bite correction with maintained aesthetics, no prolonged treatment time, and high

patient satisfaction [6]
This series illustrates the effectiveness of hybrid approaches for complex adult cases requiring both vertical and sagittal corrections.

4.4.3. Class I Crowding with Hybrid Techniques

Fonseca Junior et al. [8] described a hybrid technique combining:

- 3D-BOT (Three-Dimensional Bracket Optimization Technique) for initial alignment
- Clear aligners for final detailing and finishing
- Outcome: Efficient resolution of crowding with strategic sequencing of fixed and removable phases [8]

4.5. Occlusal Considerations and Monitoring

Ortiz et al. [7] investigated occlusal contact changes during
orthodontic treatment with clear aligners and fixed appliances, finding that:

- Early occlusal contact reductions occur during initial months of treatment with both modalities
- Timing differences exist between aligners and fixed appliances in how occlusal contacts evolve
- Clinical implication: Close monitoring of occlusal relationships is essential throughout hybrid treatment, with adjustments made as needed to prevent adverse changes [7]

Monitoring Protocol:

- Regular assessment of occlusal contacts using articulating paper or digital occlusal analysis
- Evaluation of posterior support and anterior guidance
- Adjustment of aligner design or fixed mechanics if unfavorable occlusal changes are detected
- Coordination of vertical dimension changes with patient comfort and function

5. Advantages and Limitations

5.1. Clinical Advantages

5.1.1.Enhanced Predictability

The primary advantage of hybrid composite-aligner therapy is improved predictability for tooth movements that are challenging with aligners alone. Lombardo et al. [1] argue that hybrid workflows can overcome aligner unpredictability for difficult movements, providing clinicians with greater confidence in treatment outcomes [1].
Specific Predictability Improvements:

- Bodily tooth movement during distalization through optimized attachment design [5]
- Root torque control via continuous forces from fixed auxiliaries [6]
- Three-dimensional root positioning through integration of fixed mechanics [6]
- Rotation correction of cylindrical teeth beyond the typical aligner capability [1]

5.1.2. Treatment Efficiency

Reduced Treatment Duration:
Case reports document reduced overall treatment time when fixed segments are combined with aligners, attributed to:

- Fewer aligner refinements required [3]
- More efficient space closure with continuous forces
- • Simultaneous achievement of multiple treatment objectives [3]

Fewer Refinements:
By addressing predictable aligner limitations proactively through hybrid design, the number of mid-course corrections and additional aligner series is reduced [1,3].

5.1.3. Superior Biomechanical Control

Continuous Force Delivery:
Fixed auxiliaries provide continuous forces that are independent of patient compliance, ensuring consistent progress for critical
movements such as space closure and root torque [6].
Moment Control:
Fixed appliances generate precise moments for torque control that are difficult to achieve with removable aligners, particularly for lingual root torque of maxillary incisors [6].
Three-Dimensional Control:
Integration of fixed components enables true three-dimensional control of tooth position, including root angulation in all planes [6].

5.1.4. Patient-Centered Benefits

Aesthetic Maintenance:
Hybrid protocols can minimize or eliminate visible appliances by using:

- Lingual fixed components that are not visible during smiling or speaking [6]
- Clear aligners that maintain facial aesthetics during social and professional interactions [2]
- Strategic timing of fixed component placement to minimize aesthetic impact [3]

Comfort and Oral Hygiene:
Compared to full fixed appliances, hybrid approaches offer:

- Removable aligners that allow normal oral hygiene procedures
- Reduced soft tissue irritation compared to full buccal fixed appliances

- Ability to remove aligners for important events while fixed components continue working [2]

Patient Satisfaction:
Case reports consistently note high patient satisfaction with hybrid approaches, attributed to the combination of aesthetic appearance, treatment efficiency, and successful outcomes [3,6].

5.1.5. Material-Driven Reliability

The selection of appropriate composite materials enhances clinical reliability:
Superior Attachment Retention:
Use of bulk-fill composites with high shear bond strength (e.g., SonicFill) reduces attachment failure rates and the need for rebonding [4].
Reduced Wear:
Materials with lower wear characteristics maintain attachment geometry throughout treatment, ensuring consistent force delivery [4].
Predictable Performance:
Composites with good dimensional stability preserve the designed attachment shape, critical for generating intended force vectors [4].

5.2. Limitations and Clinical Challenges

5.2.1. Inherent Movement Limitations

Despite the advantages of hybrid approaches, certain limitations remain:
Unpredictability Persists:
Some movements remain unpredictable even with optimized attachments, necessitating the hybrid approach as a partial solution rather than a complete resolution of aligner limitations [1,2].
Biomechanical Constraints:
The intermittent force delivery from removable aligners (dependent on wear time) still limits certain types of tooth movement compared to continuous fixed appliance forces [2].
Root Movement Challenges:
Even with hybrid approaches, achieving precise root parallelism and optimal root angulations may require longer treatment times or more extensive fixed components than initially planned [1].

5.2.2. Material and Technical Limitations

Composite Material Trade-offs: Chen et al. [4] documented that:

- Flowable composites sacrifice placement accuracy and wear resistance for faster operation time [4]
- Conventional composites require longer placement time despite good performance [4]
- No single material optimizes all parameters simultaneously [4]

Attachment Failure:
Despite improved materials, attachment debonding remains a clinical challenge, particularly:

- In areas of high occlusal stress
- With suboptimal bonding technique
- In patients with parafunctional habits

Wear and Degradation:
All composite materials experience some degree of wear during prolonged aligner therapy, potentially altering attachment geometry and force systems over time [4].

5.2.3. Patient Compliance Dependency

Removable Component Reliance:
Hybrid protocols still depend on patient compliance for aligner wear time. While fixed components reduce this dependency for specific movements, overall treatment success remains partially compliance- dependent [2].
Oral Hygiene Complexity:
Patients must maintain excellent oral hygiene around both fixed
components and aligner-covered teeth, which can be challenging and requires thorough patient education.
Appliance Management:
Patients must manage multiple appliance types (aligners, fixed components, elastics if used), increasing complexity compared to single-modality treatment.

5.2.4. Technical and Logistical Challenges

Digital Planning Complexity:
Successful hybrid protocols require sophisticated digital planning to integrate fixed segments with aligner staging, demanding:

- Advanced software capabilities for simulating fixed components [3]
- Clinician expertise in digital treatment planning
- Laboratory or in-house capability to manufacture integrated systems [6]

Coordination of Treatment Phases:
Timing the placement of attachments, bonding of fixed components, and progression through aligner stages requires careful coordination and clinical judgment [3,6].
Increased Clinical Time:

Hybrid approaches may require more chair time for:

- Bonding multiple attachment types
- Placement and adjustment of fixed components
- Monitoring and coordination of multiple force systems

5.2.5. Evidence Limitations

Lack of Controlled Trials:

The current evidence base consists primarily of case reports and small case series. Randomized controlled trials comparing hybrid protocols to aligners alone or full fixed therapy are lacking [1,3,6].

Absence of Standardized Protocols:

No universally accepted protocols exist for:

- Attachment shape and size selection for specific movements
- Composite material selection guidelines
- Integration strategies for fixed auxiliaries [4,5]

Insufficient Outcome Data:

Quantitative pooled outcomes, standardized complication rates, and population-level success rates for hybrid protocols are not available in the current literature, limiting evidence-based decision-making.

5.2.6. Cost Considerations

Increased Material Costs: Hybrid approaches may involve:

Costs of both aligner systems and fixed appliance components

Additional attachments and composite materials

- Potential for increased refinements if coordination is suboptimal

Laboratory and Technology Costs:

Advanced digital planning and in-house 3D printing capabilities require significant investment in technology and training [6].

5.3. Clinical Decision-Making Framework

Given the documented advantages and limitations, clinicians should employ a systematic decision-making framework:

- When Hybrid Approaches Are Strongly Indicated:
- Complex movements requiring root control or bodily translation [1,5,6]
- Adult patients with high aesthetic demands and specific biomechanical needs [2,6]
- Cases where aligner-only treatment has demonstrated inadequate progress [1]
- When Aligner-Only Treatment May Suffice:
- Simple alignment and leveling cases
- Mild to moderate crowding without complex root movements
- Patients with excellent compliance and realistic aesthetic expectations

When Full Fixed Appliances May Be Preferred:

- Severe malocclusions requiring comprehensive three- dimensional control
- Patients with poor compliance history for removable appliances
- Cases where treatment efficiency outweighs aesthetic concerns

6. Clinical Evidence and Outcomes

6.1. Case Reports and Clinical Series

The current evidence base for hybrid composite-aligner therapy consists primarily of case reports and small clinical series. While
these studies provide valuable insights into feasibility and technique, they represent a lower level of evidence than randomized controlled trials.

6.1.1. Class III Orthopedic-Orthodontic Integration

Study: Lombardo et al. [3] - "Clear aligner hybrid approach: A case report"

Case Description:

Treatment phases:

1. Orthopedic phase: Facemask therapy with rapid maxillary expansion
2. Hybrid orthodontic phase: Clear aligners combined with partial lingual fixed appliances

- Digital workflow: Aligners designed to envelope lingual tubes and archwires, with integrated staging

Outcomes:

- Successful Class III correction
- Efficient treatment progression with reduced refinements
- Maintained aesthetics throughout orthodontic phase
- Demonstration of feasibility for complex multi-phase protocols [3]

Clinical Significance:

This case illustrates that hybrid approaches can be successfully integrated into comprehensive treatment protocols involving growth modification, demonstrating the versatility of composite-aligner
strategies across treatment phases.

6.1.2. Deep Bite Correction in Adults

Study: Aiyar et al. [6] - "Hybrid Orthodontics for Aesthetic Deep Bite Correction—Case Series and General Clinical Considerations"

Case Series Description:

- Three adult patients with deep overbite requiring vertical and sagittal corrections
- Treatment protocol:
- Lingual fixed appliances on anterior teeth for precise torque control
- Clear aligners on full arch for bite opening, posterior coordination, and aesthetics
- In-house 3D-printed aligners for customized digital planning

Outcomes:

- Successful deep bite correction in all three cases
- Precise root torque achieved through lingual fixed mechanics
- No prolongation of treatment time compared to conventional approaches
- High patient satisfaction with aesthetics and outcomes
- Maintained oral hygiene and periodontal health [6]

Clinical Significance:

This series demonstrates that hybrid approaches are effective for complex adult cases requiring both vertical dimension changes and precise anterior tooth positioning, with the added benefit of maintained aesthetics critical for adult patients.

6.1.3. Class I Crowding with Sequential Hybrid Technique

Study: Fonseca Junior et al. [8] - "Técnica Híbrida Para Tratamento De Classe I Com Apinhamento – Relato De Caso"

Case Description:

- Class I malocclusion with moderate crowding

Sequential hybrid protocol:

1. Initial phase: 3D-BOT (Three-Dimensional Bracket Optimization Technique) for primary alignment
2. Final phase: Clear aligners for detailing and finishing

Outcomes:

- Efficient resolution of crowding
- Strategic sequencing reduced overall treatment time
- Smooth transition between fixed and removable phases [8]

Clinical Significance:

This case demonstrates an alternative hybrid strategy in which fixed and removable phases are sequential rather than simultaneous, offering flexibility in treatment design based on case requirements and patient preferences.

6.2. Biomechanical and Material Science Studies

6.2.1. Attachment Effectiveness for Molar Control

Study: Garino et al. [5] - "Effectiveness of Composite Attachments in Controlling Upper-Molar Movement with Aligners"

Study Design:

- Investigation of attachment geometry for controlling molar movement during distalization
- Focus on vertical rectangular attachments

Key Findings:

- Vertical rectangular attachments generate countermoments that promote bodily movement during molar distalization
- Attachment geometry directly influences force systems and movement patterns
- Properly designed attachments can reduce uncontrolled tipping [5]

Clinical Implications:

- Attachment design should be customized based on desired tooth movement
- Vertical rectangular geometry is preferred for bodily distalization of molars
- Biomechanical principles must guide attachment placement and design [5]

6.2.2. Comparative Composite Material Performance

Study: Chen et al. [4] - "Comparative study of three composite materials in bonding attachments for clear aligners"

Study Design:

- In vitro comparison of three composite systems: Filtek Z350XT, Filtek Z350XT Flowable, and SonicFill
- Parameters evaluated: operation time, shear bond strength, placement accuracy, wear resistance
- Key Findings:
- SonicFill: Highest shear bond strength, good placement accuracy, excellent wear resistance, shorter operation time
- Filtek Z350XT: Moderate bond strength, good accuracy and wear resistance, longer operation time
- Filtek Z350XT Flowable: Shortest operation time, lower bond strength, poorer placement accuracy, higher wear [4]

Clinical Implications:

- Material selection significantly impacts clinical performance
- Bulk-fill composites (SonicFill) offer optimal balance for long- duration cases
- Flowable composites should be used cautiously due to accuracy and wear limitations [4]

6.3. Synthesis of Clinical Evidence

6.3.1. Observed Outcome Themes

Across the available case reports and clinical series, several consistent themes emerge:

Improved Predictability:

- Hybrid approaches demonstrate enhanced predictability for
- movements that are challenging with aligners alone, particularly bodily distalization, root torque control, and severe rotations [1,3,6].

Treatment Efficiency:

- Multiple reports document reduced treatment time and fewer
- refinements when hybrid protocols are employed strategically [3,6].

Aesthetic Maintenance:

All reported cases successfully maintained aesthetic appearance throughout treatment, a critical outcome for adult patients [3,6].

Patient Satisfaction:

High patient satisfaction is consistently reported, attributed to the combination of aesthetic appearance, treatment efficiency, and successful outcomes [3,6].

Technical Feasibility:

Digital planning and integration of fixed components with aligners is technically feasible with current technology and clinical expertise [3,6].

6.3.2. Evidence Gaps and Limitations

Despite encouraging case reports, significant evidence gaps remain:

Lack of Controlled Trials:

No randomized controlled trials compare hybrid protocols to:

- Clear aligners alone
- Conventional fixed appliances
- Other hybrid strategies

Absence of Population-Level Data:

Success rates, complication rates, and treatment duration data across broader patient populations are not available.

Limited Long-Term Follow-Up:

Most case reports present immediate post-treatment outcomes without long-term stability data.

Heterogeneity of Protocols:

Significant variation exists in hybrid protocols (attachment designs, fixed component types, sequencing strategies), making synthesis and comparison difficult.

Selection Bias:

Published case reports likely represent successful outcomes, with unsuccessful cases underreported.

6.4. Clinical Recommendations Based on Current Evidence

Given the available evidence, the following clinical recommendations can be made:

Patient Selection:

- Favor hybrid protocols for adult patients with complex movements requiring root control or bodily translation [1,6]
- Consider hybrid approaches when aesthetic maintenance is critical and specific biomechanical needs exist [2,6]
- Reserve hybrid strategies for cases where aligner-only treatment is predicted to be inadequate [1]

Material Selection:

- Use bulk-fill composites with high shear bond strength (e.g., SonicFill) when long-term attachment retention is critical [4]
- Avoid flowable composites for attachments requiring dimensional accuracy and wear resistance [4]
- Consider operation time trade-offs when selecting materials for high-volume practices [4]
- Attachment Design:
- Employ vertical rectangular attachments for bodily distalization of posterior teeth [5]
- Customize attachment geometry based on desired force systems and tooth movements [5]
- Use digital planning to optimize attachment placement before clinical bonding [3,6]

Digital Planning:

- Utilize comprehensive digital workflows that simulate fixed components within aligner staging [3,6]
- Verify attachment accuracy through post-bonding digital scanning [4]
- Plan treatment phases to coordinate aligner-delivered and fixed- delivered movements [3,6]

Monitoring:

- Assess occlusal contacts regularly throughout treatment to detect unfavorable changes [7]
- Monitor attachment integrity and replace failed attachments promptly [4]

- Track treatment progress against digital predictions and adjust protocols as needed

7. Future Directions and Research Needs
7.1. Material Innovation
7.1.1. Next-Generation Composite Materials
The comparative material studies by Chen et al. [4] highlight the need for continued material innovation. Future composite materials for aligner attachments should aim to optimize multiple parameters simultaneously:
Desired Material Properties:
- High shear bond strength for long-term retention without failure
- Low wear characteristics to maintain attachment geometry throughout treatment
- Excellent dimensional stability for predictable force vector generation
- Rapid placement capability to minimize chair time
- Biocompatibility with minimal plaque accumulation
- Aesthetic properties (tooth-colored, stain-resistant) for patient acceptance

Emerging Material Technologies:
- Nanocomposites with enhanced mechanical properties and wear resistance
- Self-adhering composites that simplify bonding protocols
- Smart materials with controlled force release or degradation properties
- Antimicrobial composites to reduce plaque accumulation around attachments

7.1.2. Aligner Material Advances
Concurrent advances in aligner materials themselves will influence hybrid protocol design:
- Multi-layer aligners with varying stiffness zones for differential force delivery
- Shape-memory polymers with optimized force delivery characteristics
- Transparent materials with enhanced strength for better attachment engagement
- Customizable stiffness based on individual tooth movement requirements

7.2. Digital Integration and Artificial Intelligence
7.2.1. Enhanced Digital Planning
The successful hybrid protocols reported by Lombardo et al. [3] and Aiyar et al. [6] rely on sophisticated digital planning. Future
developments should include:
Biomechanical Simulation:
- Finite element analysis (FEA) integrated into treatment planning software
- Real-time prediction of force systems generated by specific attachment geometries
- Optimization algorithms that suggest ideal attachment designs for desired movements
- Simulation of stress distribution in periodontal ligament and alveolar bone

Artificial Intelligence Applications:
- Machine learning algorithms trained on treatment outcomes to predict success probability
- AI-assisted attachment design based on tooth morphology and desired movement
- Automated treatment planning that suggests optimal hybrid strategies
- Predictive analytics for identifying cases requiring hybrid approaches vs. aligner-only treatment

7.2.2. In-Office Manufacturing
The trend toward in-house 3D printing of aligners, demonstrated by Aiyar et al. [6], offers several advantages:
- Customization: Ability to modify aligner design mid-treatment based on progress
- Efficiency: Reduced turnaround time for refinements and adjustments
- Cost-effectiveness: Potential reduction in per-aligner costs for high-volume practices
- Integration: Seamless coordination between fixed component placement and aligner fabrication

Future Developments:
- Improved 3D printing materials with clinical-grade properties
- Automated post-processing systems for printed aligners
- Quality control systems ensuring consistent manufacturing
- Regulatory frameworks supporting in-office aligner production

7.3. Standardization and Protocol Development
7.3.1. Evidence-Based Guidelines
The current literature lacks standardized protocols for hybrid composite-aligner therapy. Future research should establish:
Attachment Design Guidelines:
- Standardized attachment geometries for specific tooth movements
- Evidence-based recommendations for attachment size, shape, and placement
- Protocols for attachment selection based on tooth morphology and movement requirements

Material Selection Criteria:
- Clinical decision trees for composite material selection
- Evidence-based recommendations based on case duration, attachment location, and force requirements

- Standardized bonding protocols for different composite systems [4]

Hybrid Integration Protocols:

- Guidelines for determining when to use simultaneous vs. sequential hybrid approaches
- Protocols for coordinating fixed and removable components
- Timing recommendations for attachment placement and fixed appliance bonding

7.3.2. Quality Assurance Systems

Standardized quality assurance protocols should be developed:

- Attachment Accuracy Verification: Digital scanning protocols to verify attachment placement accuracy
- Force System Validation: Methods to confirm that intended force systems are being delivered
- Progress Monitoring: Standardized assessment of treatment progress against digital predictions
- Outcome Tracking: Systematic collection of treatment outcomes, complications, and patient satisfaction data

7.4. Clinical Research Priorities

7.4.1. Randomized Controlled Trials

The most critical research need is for high-quality randomized controlled trials comparing:

Hybrid vs. Aligner-Only Treatment:

Primary outcome: Accuracy of tooth movement (measured digitally)

- Secondary outcomes: Treatment duration, number of refinements, patient satisfaction
- Subgroup analyses: Different malocclusion types, age groups, complexity levels

Different Hybrid Strategies:

- Simultaneous vs. sequential integration of fixed components
- Different attachment designs and materials
- Varying degrees of fixed appliance integration

Hybrid vs. Conventional Fixed Appliances:

- Treatment efficiency and predictability
- Patient-reported outcomes (aesthetics, comfort, quality of life)
- Cost-effectiveness analysis

7.4.2. Long-Term Stability Studies

Current evidence lacks long-term follow-up data. Future studies should assess:

- Post-treatment stability of cases treated with hybrid protocols
- Retention requirements and relapse patterns
- Periodontal health long-term after hybrid treatment
- Patient satisfaction over extended follow-up periods

7.4.3. Biomechanical Research

- Fundamental biomechanical research should investigate:
- Force systems generated by different attachment geometries (using pressure sensors or FEA)
- Optimal force magnitudes for specific tooth movements in hybrid protocols
- Interaction effects between aligner forces and fixed appliance forces
- Periodontal response to combined force systems from multiple appliance types

7.4.4. Material Science Studies

Building on the work of Chen et al. [4], future material research should:

- Expand comparative studies to include emerging composite materials
- Investigate long-term clinical performance (not just in vitro properties)
- Assess wear patterns under clinical conditions with actual aligner cycling
- Develop accelerated aging protocols to predict long-term attachment performance

7.5. Technology Integration

7.5.1. Monitoring and Compliance Technology

Integration of technology to monitor treatment progress and patient compliance:

- Smart aligners with embedded sensors to track wear time
- Intraoral scanning apps for patient self-monitoring of progress
- Artificial intelligence analysis of progress photos to detect deviations from plan
- Remote monitoring platforms for virtual check-ins and progress assessment

7.5.2. Robotic and Automated Systems

Emerging technologies that may enhance hybrid protocols:

- Robotic attachment placement for enhanced accuracy and consistency
- Automated bonding systems with controlled curing and finishing
- Chairside aligner fabrication with rapid prototyping technology
- Automated quality control using computer vision and AI

7.6. Personalized Orthodontics

The future of hybrid composite-aligner therapy lies in personalized treatment:

Genomic and Biological Factors:

- Integration of genetic markers for bone remodeling rate into treatment planning

- Personalized force systems based on individual biological response
- Consideration of age-related bone density and remodeling capacity

Patient-Specific Biomechanics:

- Treatment planning based on individual tooth root morphology
- Customized attachment designs for each patient's tooth anatomy
- Force systems tailored to individual periodontal biotype

Lifestyle Integration:

- Treatment protocols adapted to patient lifestyle and compliance patterns
- Flexible hybrid strategies that accommodate professional and social requirements
- Patient preference integration into treatment design decisions

8. CONCLUSIONS

8.1. Summary of Key Findings

This comprehensive review of composite aligners in hybrid mode orthodontic treatment synthesizes current evidence on materials, biomechanics, clinical applications, and outcomes. Several key
conclusions emerge:

8.1.1. Clinical Efficacy

Hybrid approaches combining clear aligners with composite
attachments and selective fixed auxiliaries represent an effective strategy for extending the applicability of aligner therapy to more complex orthodontic cases. The evidence, derived primarily from case reports and clinical series, demonstrates:

- Enhanced predictability for tooth movements that are challenging with aligners alone, particularly bodily distalization, root torque control, and severe rotations [1,3,6]
- Improved treatment efficiency with reduced refinements and potentially shorter treatment duration in selected cases [3]
- Maintained aesthetics throughout treatment, addressing the primary concern of adult patients [2,3,6]
- High patient satisfaction resulting from the combination of aesthetic appearance and successful outcomes [3,6]

8.1.2. Material Science Insights

Material selection for composite attachments significantly influences clinical outcomes:

- Bulk-fill composites (e.g., SonicFill) demonstrate superior shear bond strength and wear resistance, making them optimal for long-duration cases requiring reliable attachment retention [4]
- Flowable composites offer reduced operation time but sacrifice placement accuracy and exhibit higher wear, limiting their use to short-duration or less demanding applications [4]
- Conventional nanohybrid composites provide balanced performance with good accuracy and wear resistance [4]
- The clinical implication is clear: material selection should be case- specific, guided by treatment duration, attachment location, force requirements, and the importance of dimensional stability for the intended biomechanics.

8.1.3. Biomechanical Principles

Attachment geometry plays a critical role in generating appropriate force systems:

- Vertical rectangular attachments are effective for generating
- countermoments during molar distalization, promoting bodily movement rather than uncontrolled tipping [5]
- Strategic attachment placement and customized geometry enable force vector optimization for specific tooth movements [5]
- Integration of fixed components provides continuous force delivery and moment control that complement intermittent aligner forces [6]
- These findings underscore the importance of biomechanically informed treatment planning and the need for digital simulation tools that predict force systems before clinical implementation.

8.2. Clinical Recommendations

Based on the synthesized evidence, the following clinical recommendations are proposed:

8.2.1. Patient Selection

Hybrid protocols are strongly indicated for:

- Adult patients with complex movements requiring root torque control or bodily translation [1,6]
- Cases where aesthetics must be maintained while achieving biomechanically demanding movements [2,6]
- Situations where aligner-only treatment is predicted to be
- inadequate based on documented movement limitations [1,2]

Careful patient selection should consider:

- Clinical complexity and specific movement requirements
- Patient aesthetic demands and professional/social considerations
- Compliance expectations and ability to manage multiple appliance types
- Periodontal health and anatomical factors (crown height, enamel quality)

8.2.2. Material Selection
For composite attachments:
- First choice: Bulk-fill composites with high shear bond strength and low wear (e.g., SonicFill) for long-duration cases and attachments critical for complex movements [4]
- Alternative: Conventional nanohybrid composites for balanced performance in most clinical situations [4]
- Limited use: Flowable composites only for short-duration cases where operation time is prioritized over accuracy and wear
- resistance [4]

8.2.3. Attachment Design and Placement
Evidence-based attachment strategies:
- Use vertical rectangular attachments for bodily distalization of posterior teeth [5]
- Customize attachment geometry based on desired force systems and specific tooth movements [5]
- Employ digital planning to optimize attachment position, angulation, and size before clinical bonding [3,6]
- Verify attachment accuracy through post-bonding digital scanning to ensure intended biomechanics [4]

8.2.4. Hybrid Integration Protocols
Strategic integration of fixed and removable components:
- Use digital simulation to plan the coordination of aligner staging with fixed appliance placement [3,6]
- Consider partial lingual fixed appliances for anterior torque control while maintaining facial aesthetics [6]
- Employ sequential or simultaneous integration based on case requirements and patient preferences [8]
- Monitor occlusal contacts regularly to detect and address unfavorable changes early [7]

8.2.5. Digital Workflow
Comprehensive digital planning should include:
- Three-dimensional treatment objectives specifying final tooth positions including root angulations [3,6]
- Simulation of fixed components within the aligner staging sequence [3]
- Biomechanical analysis of force systems generated by attachments and fixed auxiliaries [5]
- Verification protocols to ensure clinical outcomes match digital predictions

8.3. Research Priorities
The evidence base for hybrid composite-aligner therapy, while promising, remains limited by the predominance of case reports and the absence of controlled clinical trials. Critical research priorities include:

8.3.1. High-Priority Clinical Research
Randomized controlled trials comparing:
- Hybrid protocols vs. aligner-only treatment for specific malocclusion types
- Different hybrid strategies (simultaneous vs. sequential, varying degrees of fixed integration)
- Hybrid approaches vs. conventional fixed appliances for complex cases
- Different attachment designs and composite materials in clinical settings

Long-term outcome studies assessing:
- Post-treatment stability of hybrid-treated cases
- Periodontal health following combined force systems
- Patient satisfaction and quality of life over extended follow-up
- Cost-effectiveness compared to alternative treatment modalities

8.3.2. Material Science and Biomechanics Research
Material development and testing:
- Next-generation composites optimizing multiple performance parameters
- Long-term clinical wear studies under actual treatment conditions
- Biocompatibility and plaque accumulation characteristics
- Smart materials with controlled force release properties

Biomechanical investigations:
- Finite element analysis of force systems from various attachment geometries
- Experimental measurement of forces generated by attachments using pressure sensors
- Optimal force magnitudes for specific tooth movements in hybrid protocols
- Periodontal and bone response to combined aligner and fixed appliance forces

8.3.3. Technology Development
Digital integration priorities:
- AI-assisted treatment planning with outcome prediction
- Automated attachment design optimization algorithms
- Real-time biomechanical simulation integrated into planning software
- In-office manufacturing systems with quality assurance protocols

Monitoring and compliance technology:
- Smart aligners with embedded wear-time sensors
- Remote monitoring platforms for virtual progress assessment
- Computer vision systems for automated progress analysis
- Patient-facing apps for self-monitoring and education

8.4. Limitations of Current Evidence

This review must be interpreted in light of several important limitations:

Evidence Level:

The current evidence base consists primarily of case reports, small case series, and in vitro studies. Level I evidence from randomized controlled trials is absent.

Heterogeneity:

Significant variation exists in hybrid protocols, attachment designs,
composite materials, and integration strategies, making synthesis and comparison challenging.

Publication Bias:

Published case reports likely represent successful outcomes, with unsuccessful cases underreported.

Limited Follow-Up:

Most studies present immediate post-treatment outcomes without long-term stability data.

Lack of Standardization:

No universally accepted protocols exist for attachment design, material selection, or hybrid integration strategies.

8.5. Final Perspective

Hybrid composite-aligner orthodontics represents a significant evolution in contemporary orthodontic treatment, addressing the limitations of clear aligners alone while preserving their aesthetic advantages. The strategic integration of composite attachments— optimized in material properties and geometric design—with selective fixed auxiliaries enables clinicians to expand the envelope of aligner therapy to include more complex cases that would traditionally require full fixed appliances.

The evidence, while currently limited to case reports and material studies, consistently demonstrates the feasibility and clinical
effectiveness of hybrid approaches for selected cases. Material
science investigations have identified specific composites (bulk-fill materials like SonicFill) that offer superior performance for attachment applications [4], and biomechanical studies have elucidated the role of attachment geometry in generating desired
force systems [5].

However, the field requires rigorous clinical research to establish evidence-based protocols, quantify success rates across diverse patient populations, and determine optimal strategies for integrating fixed and removable components. The development of standardized guidelines, supported by controlled clinical trials, will be essential for the widespread adoption and optimization of hybrid composite- aligner therapy.

For clinicians currently implementing hybrid approaches, the
evidence supports careful patient selection (favoring adult patients with specific biomechanical needs and aesthetic requirements), evidence-based material selection (bulk-fill composites for demanding applications), biomechanically informed attachment design (customized geometry for specific movements), and
comprehensive digital planning (simulating fixed components within aligner staging). Close monitoring of treatment progress, with
adjustments based on clinical response, remains essential given the evolving nature of these protocols.

As material science advances, digital technologies mature, and clinical evidence accumulates, hybrid composite-aligner orthodontics will likely become an increasingly refined and predictable treatment modality, offering patients the benefits of aesthetic treatment without compromising biomechanical objectives.

9. REFERENCES

1. Agarwal Y, Kumar M, Goyal MK, et al. Driftodontics: A neglected treatment approach. Journal of Contemporary Orthodontics. 2023;7(2):120-124. doi:10.18231/j.jco.2023.025
2. Aiyar A, Scuzzo G, Scuzzo G, Verna C. Hybrid Orthodontics for Aesthetic Deep Bite Correction—Case Series and General Clinical Considerations. Oral. 2024;4(2):125-147. doi:10.3390/oral4020011
3. appliance. Research, Society and Development. 2021;10(8):e56910817726. doi:10.33448/RSD-V10I8.17726
4. Chen W, Qian L, Qian Y, Zhechen Z, Wen X. Comparative study of three composite materials in bonding attachments for clear aligners. [Journal details to be completed based on full citation information]
5. Effectiveness of Composite Attachments in Controlling Upper-Molar Movement with Aligners. Journal of Clinical Orthodontics.
6. Fonseca Junior G, Lima Neto NT, de Andrade EP, et al. Técnica Híbrida Para Tratamento De Classe I Com Apinhamento – Relato De Caso. 2021. doi:10.24077/2021;1456-2329
7. Garino F, Castroflorio T, Daher S, Ravera S, Rossini G.
8. Lombardo L, Albertini P, Siciliani G. The hybrid approach: A solution to overcome unpredictable movements in clear aligner therapy. APOS Trends in Orthodontics. 2020;10(3):172-181. doi:10.25259/APOS_48_2020
9. Lombardo L, Palone M, Carlucci A, Siciliani G. Clear aligner hybrid approach: A case report. Journal of the World Federation of Orthodontists. 2020;9(1):32-43. doi:10.1016/J.EJWF.2020.01.001