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The Art of Holding Smiles: A Contemporary Review on Orthodontic Retainers

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Abstract: ***Retention represents a critical phase in orthodontic treatment, ensuring the stability of tooth alignment achieved after active therapy. This review explores the evolution, classification, and modern innovations in orthodontic retention. It highlights the design principles, materials, and clinical applications of both removable and fixed retainers, including traditional appliances such as the Hawley and newer options like Essix, Memotain, and CAD/CAM-fabricated retainers. Advances in biomaterials, particularly PEEK, shape memory alloys, and nanocomposites have enhanced the mechanical strength, biocompatibility, and aesthetic appeal of retainers, contributing to better patient comfort and compliance. The article also discusses the effects of different retainers on periodontal health, the importance of oral hygiene maintenance, and the survival and failure rates associated with various designs. Furthermore, emerging smart materials and digital fabrication technologies are paving the way for adaptive, precision-engineered retention systems. Overall, this review underscores that successful long-term orthodontic outcomes depend on individualized retainer selection, proper maintenance, and ongoing professional supervision. Through the integration of advanced materials and digital design, modern orthodontics continues to refine the art of maintaining smiles with durability, comfort, and long-term stability.***

Keywords: Orthodontic retainers, retention phase, fixed and removable retainers, biomaterials, PEEK, shape memory alloys, nanomaterials, CAD/CAM technology, Memotain, post-orthodontic stability, periodontal health, oral hygiene maintenance.

I. INTRODUCTION

Retention represents the final yet most critical stage of orthodontic treatment, ensuring that the beautifully aligned teeth achieved through months of active therapy remain stable over time[1]. Following appliance removal, teeth tend to drift toward their original positions due to periodontal fiber elasticity, growth-related changes, and muscular imbalances[2]. To counteract these tendencies, orthodontic retainers are used to preserve the corrected alignment while the surrounding tissues adapt and remodel. Over the years, various types of retainers—removable, fixed, and combination designs—have been developed to balance effectiveness, comfort, and aesthetics. Traditional retainers such as the Hawley appliance continue to hold clinical significance, whereas newer options like thermoplastic, fiber-reinforced, and CAD/CAM-fabricated retainers offer improved precision and patient acceptance[3,4].Advances in biomaterials, including PEEK, shape memory alloys, and nanocomposites, have further enhanced mechanical strength, biocompatibility, and design flexibility[5,6]. The selection of a suitable retainer depends on multiple factors such as treatment type, patient compliance, and oral hygiene maintenance. This review explores the evolution of orthodontic retainers, highlighting their materials, designs, and clinical applications, while emphasizing how modern innovations continue to refine retention strategies for long-term stability and patient satisfaction.

A. Removable Retainers

These retainers are commonly prescribed and typically worn by patients for a period of six to twelve months following the completion of orthodontic treatment. This duration allows sufficient time for the soft and hard tissues surrounding the teeth to

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remodel and stabilize. Removable retainers help maintain intra-arch stability and serve as effective retention devices, particularly beneficial for patients experiencing growth-related changes[7].

B. Hawley's Retainer

The Hawley appliance is a common removable retainer made of acrylic resin and stainless-steel wire. It includes a labial archwire, clasps, and a palatal or lingual acrylic base plate.

The wire, usually 0.028"–0.032" in diameter, fits closely along the labial surfaces of the anterior teeth. The Adams clasp, commonly placed on first molars, provides retention, while other clasps or ball clasps may be used on premolars.

The acrylic base plate holds the wires and ensures proper positioning. Springs can be added to correct minor relapse. Adding colors or designs can improve the appliance's appearance and patient acceptance[8,9].



Fig 1. Hawley's Retainer



Fig 2. Wrap around Retainer

C. Removable Wrap Around Retainer

The wraparound or attachable retainer is made of a plastic bar that extends along both the labial and lingual surfaces of the teeth. A full-arch wraparound retainer allows each tooth to move independently, promoting reorganization of the periodontal ligament. Moreover, this type of retainer is considered more esthetic. It can also serve as a temporary bridge for a missing anterior tooth and function as a night guard. Additionally, it acts as a bite plane to help relieve bracket impingement[8,10].

D. Invisible Thermoplastic retainers (Essix retainers) / Vaccum formed retainers

Essix thermoplastic copolyester retainers are thin yet durable appliances. They can be delivered on the same day the fixed orthodontic appliances are removed. Due to their flexibility and active properties, they can help in correcting minor tooth movements. These retainers can also serve as a temporary bridge for a missing anterior tooth and act as a night guard or bite plane to prevent bracket impingement.

They are transparent, cost-effective, and do not affect speech. Essix retainers maintain close adaptation to the teeth while ensuring correction of minor individual tooth positions[8,11].

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Fig 3. Essix retainer



Fig 4. Crozat Appliance

E. Crozat Retainer

The Crozat appliance consists of clasps on the first bicuspids, lingual finger springs, and a labial bow made of recurved double stainless-steel wires. Its advantages include firm retention, flexibility, and ease of maintaining oral hygiene due to its open design. However, a major drawback of this appliance is that it is fragile and can break easily[8].

F. Osamu Active Retainer

The Osamu active retainer is a clear, elastic, and stable appliance designed to correct minor post-treatment tooth relapse. It allows precise adjustment of individual tooth positions while maintaining close adaptation to the adjacent teeth[8].

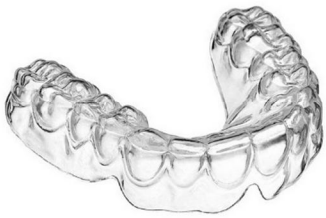


Fig 5. Osamu active retainer



Fig 6. Vander Linden Retainer

G. Vander Linden Retainer

The Vander Linden retainer is a specially designed appliance that provides effective control over the lower anterior teeth. It offers firm stabilization through secure fixation and is supported by clasps on the canines. This design minimizes interference with the occlusion, ensuring better comfort and functionality for the patient[8].

H. Astics Translucent Labial Bow

The Astics Translucent Labial Bow (ATLB) is an aesthetic alternative to the Hawley retainer, eliminating the visible metallic labial wire. Made from fiber-reinforced composite resin, it attaches to Adams clasps via metallic connectors and is light-cured on the working model. The transparent labial resin enhances appearance while maintaining strength, fracture resistance, and color stability, making it both durable and visually appealing. [12]

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Fig 7. Astics translucent labial bow



Fig 8. Reinforced removable retainer

I. Reinforced Removable Retainer (RRR)

The RRR is a modified Hawley appliance reinforced with a metallic mesh to improve strength and resistance to fracture. The mesh is embedded within the acrylic to keep It thin, comfortable, and easy to handle. Though it offers better durability, bulkiness and discomfort may occur, and further research is needed to confirm its effectiveness[13].

J. Positioner

The positioner is a transmaxillary removable appliance made of resilient, translucent silicone. It is primarily used after active orthodontic treatment to perfect tooth alignment, close small spaces, and refine occlusal relationships. Additionally, it helps correct minor rotations, manage overjet, and stabilize tooth positions by enhancing muscular balance and function. Despite its effectiveness in achieving precise finishing and improving intercuspation, it is often considered bulky and less aesthetic, which can affect patient compliance. Furthermore, its tooth movement capacity is limited to about 1–2 mm[14,15].



Fig 9. Positioner

K. Fixed Retainers

A fixed retainer typically consists of a passively bonded wire attached to the lingual surface of the teeth, most often in the mandibular incisor region. It is designed after a thorough evaluation of the patient's bite. Orthodontists commonly use fixed or mounted retainers in situations where stability is uncertain and long-term or permanent retention is necessary[7].

L. Resin fiberglass bonded retainer

Developed by Michael, the resin fiberglass bonded retainer is a quick, direct technique that uses glass fibers from woven fiberglass fabric. It effectively addresses issues seen with cuspid-to-cuspid retainers and requires minimal preparation. The retainer is rigid, impermeable, and tooth-colored, offering both comfort and aesthetics with its smooth margins. It is ideal for patients requiring canine retention and can also be adapted to bond incisors in cases of severe tooth rotation[8].

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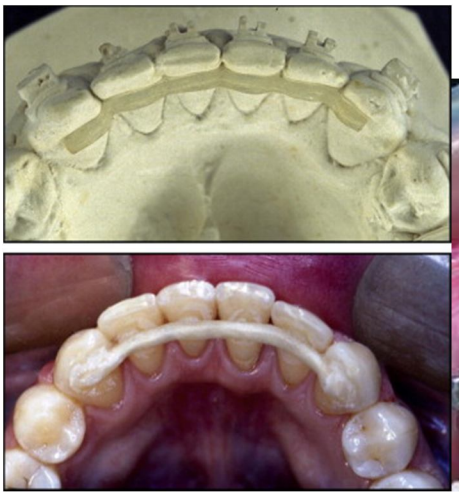


Fig 10. Resin fiberglass bonded retainer



Fig 11. Molar to molar mandibular retainer

M. Molar to Molar Mandibular Retainer

The molar-to-molar mandibular retainer is fabricated using a sturdy gauge wire that connects the mandibular molars, often with the use of molar bands. This design provides excellent stability and retention. Compared to Hawley's or cuspid-to-cuspid retainers, the molar-to-molar type offers the advantage of allowing both mandibular canines and molars to settle naturally into their final positions and mandibular arch can be expanded or contracted and rotations can be corrected by ligating the teeth to the lingual arch[8].

N. Bonded lingual retainer

Used when intra-arch stability is uncertain or long-term retention is needed, especially in the mandibular incisor region.

Indications:

1) Midline diastema
2) Spaced anterior teeth
3) Adults with post-orthodontic tooth movement
4) Loss of maxillary incisors with space closure needs
5) Severely rotated teeth

Typically made of stainless steel or multistranded wire, these retainers are bonded to the lingual surfaces (canines or all anterior teeth) using acid-etch composite for better stability[8].



Fig 12. Bonded lingual retainer



Fig 13. Memotain

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O. Memotain

Memotain is a CAD/CAM-fabricated lingual retainer made of custom nickel-titanium, serving as a modern alternative to traditional multistranded wires. Developed in 2012 by Pascal Schumacher, it features a 0.014×0.014-inch rectangular wire digitally customized to the patient's lingual anatomy. Its flexibility and shape-memory properties ensure precise adaptation without manual adjustment. Especially effective in the maxillary arch, Memotain provides excellent fit in complex morphologies, enhancing stability in common break-point areas. Its digital design prevents mandibular interference, reduces tongue irritation, and offers superior durability with resistance to microbial accumulation[8].

P. Current Concept of Removable Retainer

Thermoplastic removable retainers offer slightly less stability in the lower arch than multi-strand fixed retainers, though failure and relapse rates are similar across polyethylene ribbon, multi-strand, and thermoplastic types. Compared to Hawley retainers, thermoplastic ones provide better stability, comfort, and aesthetics, especially in the mandibular arch. They are also more stable than Begg retainers and equally durable as Hawley retainers. Relapse rates between maxillary thermoplastic, mandibular bonded, and interproximal stripping cases are comparable, though positioners remain the most effective for retention and stability[16].

Q. Current Concept of Fixed Retainer

In 1965, Newman introduced direct bonding for orthodontic attachments, and in 1973, Keirliem proposed fixed retainers for orthodontic retention. Since then, materials and designs have evolved through several generations:
First Generation: 0.025–0.036-inch round stainless steel or blue elgiloy wires joined with loops and twisted ends.
Second Generation: 0.032-inch triple-stranded wires bonded to all anterior teeth, improving flexibility.
Third Generation: 0.032-inch stainless steel or gold-coated elgiloy wires with sandblasted ends for better adhesion.
Fourth Generation: Five-stranded 0.0215-inch wires bonded to all anterior teeth.
Fifth Generation: 0.032-inch plain elgiloy wires with sandblasted ends, bonded only to canines.
Currently, two main types are used: (1) 0.032-inch stainless steel or nickel-titanium wires bonded to canines, and (2) 0.0175–0.0215-inch multistranded wires bonded from canine to canine for better adaptability. Fixed retainers are generally more comfortable for patients, though failure rates of 9–14% have been reported when bonded to all six lower incisors[16].

R. Combination Retainers

Combination retainers integrate both removable and fixed components to enhance stability and retention. In this design, vacuum-formed retainers (VFRs) are used alongside fixed bonded retainers attached to the lingual surfaces of teeth. This dual approach provides backup retention—if the fixed retainer fails, the removable one maintains tooth position, and vice versa. Combination retainers are especially beneficial for uncooperative patients or those with poor oral hygiene, as they reduce the risk of complete relapse. Circumferential supracrestal fiberotomy (CSF) performed along with combination retainers has shown to further minimize post-treatment relapse by up to 2 mm compared with removable retainers alone[17,18].

S. Survival and Failure of Retainers

The lingual fixed retainers and Hawley's retainers have the longest survival followed by combination retainers and vaccum-formed retainers. Failure rate is two times in the maxilla compared to the mandible. This can be attributed to the greater risk of occlusal forces being delivered to the maxilla along with the distortion in the wire to conform to the morphology of the canine. This can be prevented by taking the impression of the lower arch and fabricating the retainers by avoiding occlusal trauma. Due to the greater occlusal forces and kink in the wire during bonding, the risk of failure Increases when the upper canine or lower premolars are part of the retainers. The failure occurs most commonly on the wire composite interface. Hence it is recommended to use composite with greater abrasion resistance to decrease the rate of failure. The survival time of the mandibular Hawley retainer or VFRs was shorter than that of maxillary retainers due to the increased buccal root torque on the posterior segment, greater deformity of the retainer to overcome the mandibular undercut and high lingual attachment[19,20].

T. Fixed Retention Compared to Removable Retention

Fixed retainers ensure constant stabilization of teeth by remaining permanently bonded, eliminating the need for patient cooperation. They are highly effective in maintaining post-treatment alignment and preventing relapse, especially in cases with a high tendency for tooth movement. Removable retainers, though convenient and easy to clean, rely heavily on patient compliance, and inconsistent

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use often results in minor shifts or irregularities. While fixed retainers may require regular professional check-ups to monitor bonding integrity and hygiene, they generally provide superior long-term stability compared to removable retainers, making them the preferred choice for lasting orthodontic results[8].

U. Effects of fixed retainers on periodontal health

The main concern with long-term use of bonded fixed retainers is their potential to hinder oral hygiene and affect periodontal health. Some studies report increased plaque, calculus buildup, and gingival inflammation, while others show no adverse effects. Research indicates that these issues are more related to long-term wear than to retainer material, as cleaning the interproximal areas beneath the wire can be difficult. However, several studies also found that even prolonged use of fixed retainers does not cause significant gingival damage in most patients[21,22].

V. Maintenance of oral hygiene status

Removable retainers are simple to clean and maintain, making them more hygienic. In contrast, bonded retainers tend to trap more plaque and calculus, which can increase the risk of periodontal issues if proper oral hygiene is not maintained. It is important to note that the duration of the retainer in the mouth and oral hygiene status of the patient do have an effect[23,24,25].

W. Emerging Orthodontic Materials

1) *Biocompatible materials (PEEK):* PEEK (Polyetheretherketone) is a high-performance, biocompatible polymer with strength and elasticity comparable to human bone. It resists wear, corrosion, and intraoral irritation, making it ideal for retainers. Its low friction and high fatigue resistance ensure durability, while CAD/CAM and additive manufacturing enable precise, customizable fabrication for optimal fit and longevity[26,27,28].
2) *Shape memory alloys:* Shape memory alloys (SMAs), particularly nickel-titanium (NiTi) and copper-nickel-titanium (CuNiTi), have revolutionized orthodontic wire technology with their superelasticity and shape memory properties. These materials return to their original shape at specific temperatures, applying light, continuous forces that enhance tooth movement, reduce root resorption, minimize discomfort, and shorten treatment duration[29].
3) *Smart materials:* Smart materials like shape memory alloys (SMAs) and piezoelectric substances have revolutionized orthodontics by responding to thermal or mechanical stimuli to generate motion or force. This adaptability enhances tooth movement efficiency, shortens treatment time, and improves patient comfort[29,30].
4) *Nanomaterials:* Nanotechnology enhances orthodontic materials by improving their mechanical strength, biocompatibility, and antimicrobial properties. Nano-hydroxyapatite aids enamel remineralization, while silver nanoparticles prevent plaque buildup and periodontal issues, increasing material durability and clinical performance[29,31].

X. Retention phase

The retention phase is a crucial stage in orthodontic treatment, ensuring that the teeth remain in their corrected positions after active therapy. Several key factors must be carefully considered while planning this phase:

Obtaining informed consent: The patient should be clearly informed about the purpose, type, and duration of the retention process.

Evaluating the patient's growth pattern and malocclusion: The retention plan must be customized based on individual growth tendencies and the type of malocclusion treated.

Considering the treatment method used: Different orthodontic approaches may require specific retention strategies for stability.

Assessing the need for additional stabilization measures: Some cases may require supplementary retention aids to maintain results.

Selecting the type of retainer: The choice between fixed or removable retainers depends on clinical needs and patient compliance.

Determining the duration of retention: The time period should be decided collaboratively with the patient, considering long-term stability and relapse risks. By addressing these factors, orthodontists can effectively maintain treatment outcomes, minimize relapse, and ensure lasting alignment[16].

II. CONCLUSION

Retention is a vital phase in orthodontic treatment, maintaining alignment and occlusal harmony achieved during active therapy. Its success depends on appropriate selection of retainer type, material, and duration based on individual needs. Fixed retainers offer continuous stabilization, while removable ones allow better hygiene and flexibility. Advances in biomaterials and digital technology such as PEEK, shape memory alloys, nanocomposites, CAD/CAM, and 3D printing have improved strength, precision, and comfort.

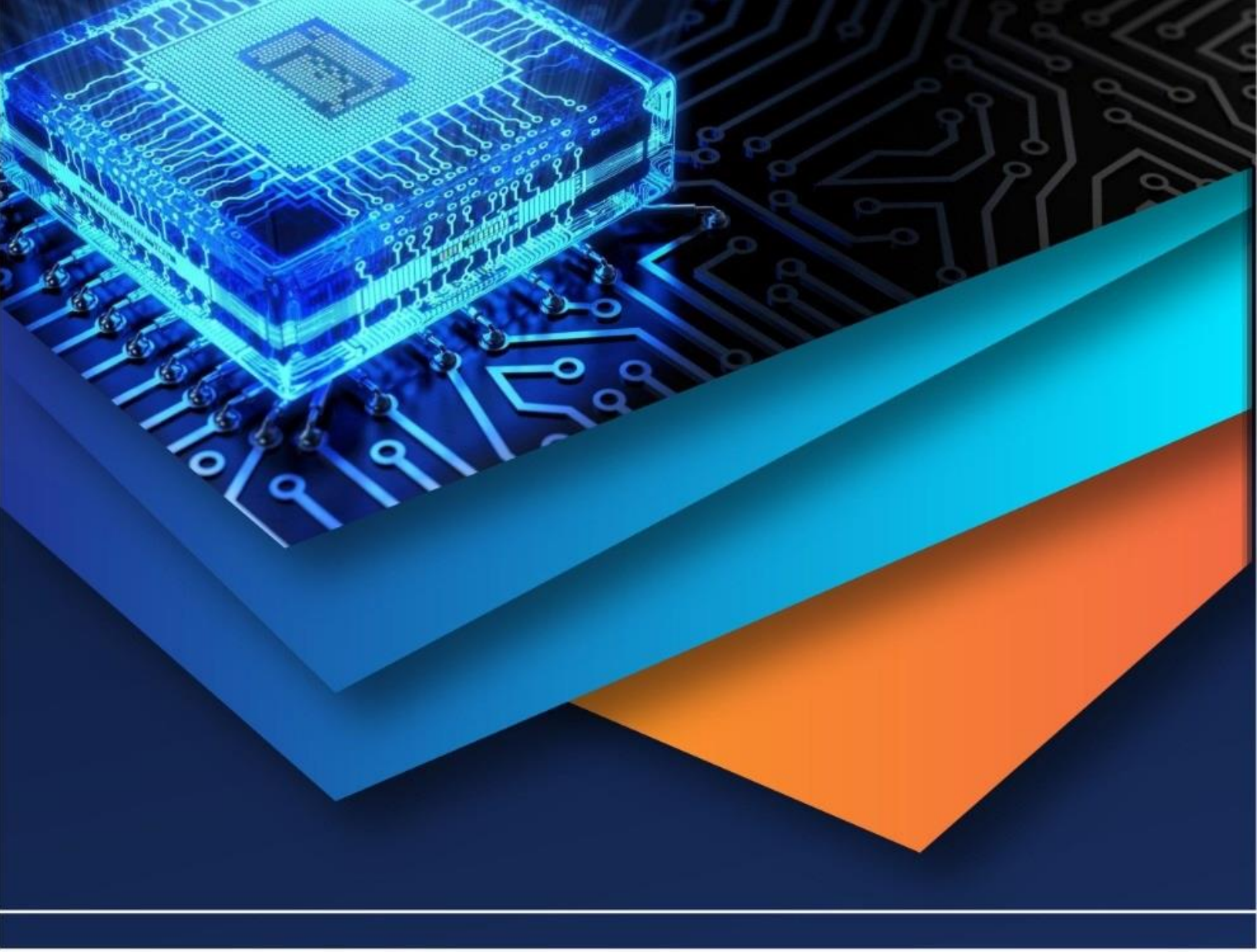
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Despite these innovations, long-term success relies on good oral hygiene, follow-up, and patient compliance. Emerging smart and bioresponsive materials may enable adaptive retainers that respond to oral changes, guiding future research toward enhanced durability and patient-centered outcomes[8,16].

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