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Review Article **Orthodontics**

Contemporary Approaches to Orthodontic Retention and Stability: A Review

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Abstract

Retention and stability in orthodontic treatment are of critical importance for maintaining the achieved esthetic, functional, and occlusal outcomes. However, relapse remains one of the most significant clinical challenges due to the tendency of teeth and surrounding tissues to return to their initial positions. This review discusses the biological basis, risk factors, preventive strategies, and the effectiveness of retention appliances in maintaining post-treatment stability. Factors such as periodontal adaptation, quality of occlusal finishing, mandibular incisor dimensions, neuromuscular balance, and continued growth are key determinants of long-term stability. Approaches including overcorrection, interproximal reduction, supracrestal fiberotomy and frenectomy are highlighted as methods to enhance retention success. Supportive biophysical modalities, such as low-level laser therapy, mechanical vibration, and low-intensity ultrasound, may accelerate periodontal and skeletal adaptation; however, further clinical evidence is needed. Both removable and fixed appliances remain essential in retention therapy, with appliance selection determined by malocclusion type, patient compliance, and clinical requirements. Modern CAD/CAM-fabricated customized retainers also provide alternatives to conventional methods. Nevertheless, appliance breakage, hygiene challenges and relapse risk remain persistent concerns. Recent evidence emphasizes that retention should be planned from the outset of treatment, with individualized protocols and regular follow-up appointments. In conclusion, a lifelong retention approach is increasingly recognized as fundamental for the sustainability of orthodontic treatment success.

Keywords: retention, stability, relapse, fixed retainer, removable retainer, orthodontic treatment.

INTRODUCTION

Retention is defined as the process of preserving teeth in their most favorable aesthetic and functional alignment after orthodontic treatment. In contemporary orthodontics now recognizes the retention period as a part of active orthodontic treatment [1]. Retention therapy is passive treatment applied to maintain the ideal function, aesthetics, and occlusion achieved in the teeth and jaw structures after active orthodontic treatment [2]. Retention therapy allows adaptation to the skeletal and dental changes resulting from orthodontic treatment, reshaping the periodontium and thus achieving stability [3].

For many years, authors have been unable to reach a consensus on retention therapy. While there are differing opinions on the duration of retention therapy and the appliances to be used, four schools of thought have emerged regarding the primary focus of retention [1]:

In the first school, according to Kingsley [4], maintaining the teeth in optimal occlusion is the most important factor in maintaining their new position.

In the second school of thought, Lundström [5] emphasized the apical base as the principal determinant for both the correction of malocclusion and the preservation of the achieved occlusal relationships. He further maintained that the intercanine and intermolar widths should remain unaltered to ensure stability.

In the third school, Tweed [6] and Grieve [7] argued that the incisors should be positioned upright on the basal bone.

In the fourth school, Rogers [8] argued that a harmonious functional muscle balance should be established at the end of active treatment.

Relapse is defined as the return of the teeth and jaw structures to their pre-treatment positions and the reappearance of the malocclusion. The initial position of the teeth is their most stable position. After treatment, the teeth attempt to return to their initial position. This behavior is called "elastic recoil" [9]. Relapse can occur when the retention treatment is inadequate or incorrectly applied, the patient is uncooperative, and the surrounding tissues do not allow adaptation to the new position achieved [10]. Relapse occurs due to structures connected to the marginal third of the root. There is less tendency for relapse in the apical and middle thirds of the root [11].

Factors Affecting Stability

Factors potentially associated with post-orthodontic relapse are examined under eight main categories [12].

1. **Periodontal and Gingival Tissues**: Following orthodontic tooth movement, the periodontium needs to remodel and adapt to the new tooth position. Until this adaptation is complete, forces that may lead to relapse can develop in the teeth [1].
2. **Post-Treatment Tooth Positions and Functional Occlusion:** Severe occlusal conflicts and abnormal occlusal forces on the teeth are thought to increase tooth mobility and lead to relapse [13]. Ideal posterior interdigitation (14), adequate interincisal angle, overjet and overbite are important factors for retention [12].
3. **The Effect of Third Molars:** Whether third molars cause crowding of the anterior teeth during their eruption is still a matter of research. The presence or eruption of third molars is thought to have little or no effect on crowding or relapse [11,15-18].
4. **Continued Growth:** Continued growth in all three planes after orthodontic treatment may lead to changes in the skeletal structure, potentially affecting treatment outcomes and causing relapse [1]. It has been reported that continued growth in patterns associated with Class II, Class III, deep bite, or open bite malocclusions is an important factor contributing to relapse [19,20].
5. **The Effect of Pre-Treatment Malocclusion:** Severe Class II, Class III and openbite cases are considered difficult to stabilize post-orthodontic treatment and present a high tendency for relapse [1,21,22].
6. **Changes in Arch Form:** It is considered that arch form should be maintained during orthodontic treatment [23, 24].
7. **Mandibular Incisor Tooth Dimensions:** In a study of untreated individuals, a relationship was suggested between mandibular incisor size and incisor crowding [25]. Conversely, studies tracking treated individuals have reported only a weak correlation between mandibular incisor dimensions and crowding [20,26,27].
8. **Neuromuscular Structure and Environmental Factors:** During orthodontic treatment, it is necessary to establish a neutral zone, which is a soft tissue balance between the tongue (lingually) and the lips and cheeks (labially) to avoid exposing the teeth to abnormal muscle and soft tissue pressure [11].

Adjunctive Retention Procedures

a. **Overcorrection:** In the treatment of orthodontic disorders, overcorrection is defined as correcting the desired movement slightly more than the desired final result (an average of 25-30%). Proffit [1] recommends overcorrection in four situations: in Class II and III treatment, in the treatment of transversal malocclusions, in rotated teeth, in crowded teeth, or in teeth that are significantly out of arch.

b. **Interproximal Reduction:** Interproximal reduction (IPR) can be defined as reducing the mesiodistal dimensions of teeth by removing enamel from the contact points. When IPR is applied during orthodontic treatment, the goal is to level the teeth using the resulting spaces, minimizing the increase in crown inclination. It is believed that treatment stability will increase due to the widening of the contact surfaces after IPR [1, 28].

c. **Circumferential Supracrestal Fiberotomy (Pericision):** This procedure is performed to prevent relapse of the elastic supracrestal fibers, which are delayed in reorganizing after orthodontic treatment. This procedure, described by Edwards [29] in 1970, is based on the principle of incising the gingival sulcus with a scalpel and separating the gingival fibers from the tooth. It has been shown to be particularly effective in preventing rotational relapses [30].

d. **Frenectomy:** Frenectomy is a surgical procedure in which the labial frenulum is repositioned more apically in the labial region, the transseptal fibers are destroyed, the gingival papilla is reshaped, and the interdental fibrous tissue is removed. Maintaining the position achieved after maxillary median diastema closure and preventing the space from reopening are of paramount importance in treatment. Frenectomy is recommended after diastema closure; otherwise, the scar tissue that forms after the procedure will prevent diastema closure [31].

e. **Papilla Split:** The papilla split method is performed by vertically dividing the papillae 1-2 mm below the gingival margin on the buccal and lingual surfaces in the area of rotated teeth. This vertical incision is not made down to the tip of the papilla; in other words, the papilla is not divided into right and left halves. [1].

f. **Mechanical Vibration:** Recent studies have shown that high-frequency mechanical vibration, used in accelerated tooth movement, stimulates the

differentiation of multipotent stem cells in the periodontal ligament into osteoblasts and stimulates cellular metabolism, with the ability to promote osteoblast proliferation, osteoblastic gene expression, and bone formation (32). Several studies have reported anabolic effects of mechanical vibration; however, its positive contribution to orthodontic retention has not yet been clearly demonstrated. Therefore, more comprehensive clinical investigations are required before it can be considered a supportive method in retention [33-35].

g. **Low-Level Laser Therapy (LLLT):** Low-level laser therapy is a method that enhances cellular metabolism through photostimulation [36]. This effect is thought to be associated with increased calcium permeability and ATP production [37]. By inducing vasodilation in the application area, it improves blood flow and accelerates repair and remodeling processes [34]. In patients with fixed retainers after orthodontic treatment, LLLT may facilitate the healing of periodontal fibers and shorten the retention period. However, it should be considered that in teeth without retainers, it may increase the risk of relapse [38].

h. **Low-Intensity Ultrasound (LIUS):** The effects of ultrasound on wound healing and bone metabolism are similar to those of mechanical vibration [39]. LIUS has been employed in areas such as fracture healing and mandibular growth support in hemifacial microsomia cases; additionally, it has been used to accelerate orthodontic tooth movement and reduce treatment-associated root resorption. By stimulating periodontal ligament and bone cells, it is regarded as a potential approach for preventing relapse following orthodontic therapy [40].

i. **Medication:** Agents such as relaxin hormone, bisphosphonates, lithium, and strontium are suggested to have positive effects on stability [33,41–45]. Nevertheless, further clinical studies are necessary to substantiate these findings.

RETAINER APPLIANCES

1. Removable Retainer Appliances

1.a. Hawley Appliance: The Hawley retainer was described by Charles Hawley in 1919. It consists of a vestibular arch, Adams clasps and acrylic. The Hawley appliance can be modified in various ways to enhance its function, including thickening the palatal acrylic to control deep bite, incorporating stops to prevent eruption of the second molars, adding acrylic teeth, or placing the vestibular arch mesially to the canines [46].

1.b. Wraparound Appliance: In the wraparound appliance, the vestibular arch passes over the labial and lingual surfaces of all teeth. It is especially effective in retention of open-bite and transverse expansions cases [47].

1.c. Clip-on / Spring Retainer: The clip-on retainer, a modification of the wraparound appliance, is generally applied between the canines or premolars in the anterior region of the mandibular jaw. In addition to its aesthetic appeal, it offers a clinical advantage because it tightly wraps the teeth, especially when closing diastemas or correcting rotations [1,47]. A modified version in which extends a wire from the lingual surface to the central groove of the premolar distally, is called a Moore retainer [1].

1.d. Coregg Retainer: The Coregg retainer is a hybrid appliance that integrates the design principles of the Wrap-around**,** Sarhan and Spring retainers. A stainless steel wire is meticulously adapted to the buccal and lingual surfaces of all teeth, over which acrylic resin is applied to fully envelop the dentition from buccal, lingual, and occlusal aspects. The incorporation of precise wire bends enables controlled post-treatment adjustments, allowing minor corrections in anterior and posterior segments to counteract potential relapse [48].

1.e. Vacuum-formed Retainers: Vacuum-formed retainers (Essix, Biostar) are among the most commonly used retainer appliances. These appliances offer the advantages of being modified to allow for minimal tooth movement. They provide effective retention after overjet reduction by tightly wrapping the incisors labially. They allow for the addition of prosthetic teeth if necessary. They can be manufactured on the same day as treatment. They are inexpensive, easy to manufacture, and aesthetically pleasing. Replacement of the appliance may be required due to discoloration, cracking, or fracture [49-51]. The simultaneous use of Essix splints in both arches may result in disruption of the occlusal relationship. Furthermore, the material thickness on the occlusal surfaces can create a posterior bite blocking effect [1].

1.f. Osamu Retainer: The Osamu retainer is a thermoplastic appliance designed to cover the entire dental arch and alveolar mucosa. It consists of two thermoplastic layers: a 1.5 mm soft layer and a 0.5 mm rigid layer. The rigid layer, 2 mm in width, is positioned over the incisal edges of the teeth, while the remaining areas are covered by the soft layer. A daily wear time of approximately 12 hours is recommended. The soft layer enhances patient comfort, facilitating more tolerable appliance wear [48].

1.g. Positioner: The positioner was first described by Kesling in 1945 and is often preferred in cases with open bites. They are also preferred for sagittal retention in Class II and Class III malocclusions [1].

1.h. Van Der Linden / G. Jensen Appliance: The Van Der Linden / G. Jensen appliance is a modified version of the vestibular arch of the Hawley appliance. The anterior segment of the arch passes distal to the lateral incisors, while molar stabilization is provided via C clasps. Posterior occlusal relationships are maintained, whereas the absence of the arch over the canines eliminates occlusal contact in this region, ensuring that retention forces are directed primarily toward the anterior teeth [47].

1.i. Sarhan Appliance: The Sarhan appliance was originally described by Sarhan and Fones [52]. This appliance does not contain acrylic and is relatively smaller in size. It consists of Adams clasps on the molars,

a vestibular arch with U-bends in the premolar region, and a lingual arch contacting the lingual surfaces of the teeth. Continuous 24-hour wear is recommended. This appliance is particularly useful for retention in extraction cases [48].

2. Fixed Retainers

Fixed retainers are commonly preferred because they do not rely on patient compliance, have minimal impact on smile aesthetics, provide effective retention, and are generally more reliable than removable retainers. However, their disadvantages include the need for precise technique during bending and bonding, fragility, and an increased risk of periodontal problems, particularly by complicating oral hygiene practices [53].

Fixed retainers can be categorized into two main types: flexible wires bonded across all teeth in the relevant segment, or rigid steel wires bonded solely to the terminal canines [13]. Rigid wires attached to the canines are generally successful in preserving intercanine distance, yet they may not provide sufficient control over incisor positioning. A key advantage of this design is that any wire fracture is immediately perceptible to the patient, allowing timely intervention and preventing relapse [54]. In situations where incisor teeth relapse is anticipated, bonding flexible multi-stranded wires to all teeth is preferred. The combination of flexibility and increased surface roughness enhances the retentive capacity of these wires [55].

While stainless steel wires are most commonly used for fixed retainers, some clinicians prefer nickel-titanium or Blue Elgiloy wires. Multi-stranded retention wires are also employed in various forms, including round or rectangular cross-sections, 3–8 strands, coaxial, braided, or twisted configurations, with different thicknesses and flexibility ranging from flexible to dead soft [56,57].

The V-Loop retainer, a fixed retention appliance consisting of wires with wave-shaped bends bonded to the anterior six teeth, is designed to reduce the risk of adverse effects on the periodontium [58]. Nonetheless, current evidence is insufficient to confirm any advantage of this design regarding gingival health or patient comfort [59].

More recently, CAD/CAM-fabricated, patient-specific retention wires such as the Memotain (CA-Digital, Mettmann, Germany) [60] and Suresmile Retainer (OraMetrix, Richardson, Texas, USA) [61] have been introduced. Chain-shaped wires, which can be easily adapted intraorally, are also among the recently used fixed retainer appliances and are available in stainless steel or 14-karat gold variants [60].

In addition to traditional metal retainers, fiber-reinforced retainers made of polyethylene or resin have been introduced as a fixed retention option. These retainers are particularly indicated for individuals with metal allergies and can be easily customized directly in the patient's mouth. While they offer superior aesthetic integration and a smaller form factor, their widespread use is limited due to high failure rates over time and their rigidity, which restricts physiological tooth movement [62].

The Linglock porcelain retainer is an additional aesthetic fixed appliance, consisting of male and female porcelain components connected via a three-dimensional locking interface. A carrier device assists in intraoral placement. Each component bonds to the adjacent teeth while preserving small interproximal spaces for flossing, and its porcelain composition provides light transmission to minimize aesthetic concerns. Other advantages include no laboratory fabrication, reduced clinical working time compared with conventional retainers, low risk of fracture, and ease of repair. The main limitation is its higher cost [33].

RETENTION APPROACHES ACCORDING TO MALOCCLUSION TYPE

In early-phase treatments's retention, nighttime use of functional appliances or headgears has been shown to reduce relapse until the completion of growth. Additionally, during the mixed dentition period, the use of a lingual arch contributes to stability by preserving the Leeway space [63].

Overcorrection of the occlusal relationship is recommended to prevent recurrence of orthodontic treatment in Class II individuals. The tendency for differential jaw growth, which causes sagittal recurrence, can be overcome by using a headgear in the upper jaw or a functional appliance in the lower jaw [1].

After treatment of Class III malocclusions in the early permanent dentition, a functional appliance or positioner can be helpful in maintaining the occlusal relationship, but it must be used until completion of growth. Applying a restraining force to the lower jaw with a chin cup is another retention method [1].

To reduce recurrence in deep bites, adding a bite block to the upper retention appliance, overcorrection for vertical correction, and maintaining the intercanine distance are recommended [1, 64-67]. It is known that deep bite treatments involving extrusion of posterior teeth should be initiated before growth is complete to ensure a stable outcome [47].

In cases of anterior open bite, eruption control of the upper molars are pivotal in retention. Tongue position and growth pattern are also important [1]. For retention treatment, a removable appliance in the maxilla should be used in combination with a high-pull headgear, an open bite activator, or a bionator until the completion of growth. Retention can also be achieved by providing exercises to the patient using a Hawley appliance with an

opening in the palatal area [47]. Lingual frenectomy is also recommended [68].

It is recommended that expansion treatment be completed with 1-2 mm overcorrection to prevent relapse. Additionally, the expansion appliance should be kept in the mouth for passive retention for 3-4 months after expansion [1,69].

Retention planning can be examined under three headings depending on the type of treatment applied according to Graber [47]:

1. Situations requiring limited retention:

- Anterior crossbite: If the dentition has been corrected and there is an adequate overbite
- Posterior crossbite: When a ideal posterior occlusion is achieved (skeletal expansions involving opening the median palatal suture are not included in this group)
- After serial extractions
- After extraction of vestibular canines
- After treatment of subdivision-type cases in which one or more teeth have been extracted (a fixed retainer wire may be used to prevent the extraction spaces from widening)
- If growth is complete after treatments aimed at restricting maxillary growth
- After space has been created for the unerupted teeth to allow them to erupt

2. Situations requiring moderate retention:

- After treatment of Class I non-extraction cases where the maxillary incisors are proclined
- Until the balance of tongue and lip functions is achieved in Class I/II extraction cases
- If the deep bite is corrected in Class I/II cases
- If the rotation of teeth is corrected before root formation is complete
- Until muscular adaptation is achieved following the treatment of Class II Division 2 cases
- After treatment of supernumerary teeth or ectopic eruption teeth

3. Situations requiring permanent retention:

- If mandibular arch expansion has been performed
- After polydiastema treatments
- After correction of severely crowded and rotated teeth
- Especially in adult patients, after closure of maxillary midline diastema

DURATION OF RETENTION TREATMENT

Short-term retention generally lasts 3–6 months, while medium-term retention may extend from 1 to 5 years [1,70]. As the optimal duration necessary to maintain long-term stability in orthodontically treated individuals has not yet been definitively established, considerable variation exists among researchers. Nevertheless, a widely accepted view today recommends lifelong retention both to prevent potential relapse and to minimize problems arising from ongoing growth and development [1,71,72].

CONCLUSION

The retention phase should be planned at the very beginning of treatment. Factors such as the patient's malocclusion, growth pattern, age, treatment modality, changes in arch form, and neuromuscular characteristics must be carefully considered when managing this phase. Etiological factors contributing to malocclusion should be addressed as early as possible, and adjunctive retention procedures—such as overcorrection, interproximal stripping, or fiberotomy—should be employed when necessary. Ensuring proper fissure-tubercle relationships through adequate interdigitation and preserving the intercanine distance in the mandible are also crucial for effective retention. It is important to recognize that retention constitutes an integral part of orthodontic treatment, and regular follow-up examinations are essential.

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