

FACTORS ASSOCIATED WITH RELAPSE AND DURATION OF ORTHODONTIC RETENTION

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Abstract

Introduction: The main aim of orthodontic therapy is not only to correct malocclusions but also to maintain the results achieved over time. Retention after orthodontic therapy plays a critical role in this process, preventing relapses and ensuring long-term stability.

The aim of this systematic literature review was to analyze the factors influencing the relapses after orthodontic treatment and duration of the retention.

Material and methods: A literature search was conducted covering publications between the period from 1990 to 2024, using electronic databases such as PubMed, Scopus and Web of Science. Data were systematically organized regarding the principles of retention, factors affecting retention success, duration of retention and future research directions.

Results: Literature reviews indicate that the most common causes of relapses after orthodontic therapy are the following: (1) Aging process; (2) Periodontal ligament and gingival fibers; (3) Soft-tissue maturation; (4) Occlusal factors; (5) Limits of the dentition; (6) Presence of third molars and (7) Maxillary and mandibular expansion. Also, there are many factors influencing on the duration of the retention after orthodontic therapy.

Conclusion: Retention in orthodontics is a process influenced by various factors: patient compliance, retention modalities, and retention duration. Although many retention strategies have been proposed and implemented, challenges such as relapse and negative effects of long-term retention remain significant. To optimize stability post-therapy and enhance patient satisfaction in orthodontic practice, focus should be on personalized retention protocols, digital monitoring systems and the effects of long-term retention.

Keywords: orthodontic retention, retention protocols, relapses after orthodontic therapy, retention outcomes

Introduction

After orthodontic treatment, it can be quite difficult to keep teeth in their right position. The occlusal, gingival fibers, periodontal ligament and growth factors are related variables that can cause teeth to revert to their initial malocclusion. However, typical aging changes might also result in tooth movement following orthodontic therapy.

Clinicians must treat all patients with the awareness that there is a high chance of relapse since orthodontics cannot anticipate which patients will relapse, which will remain stable, or the level of relapse that will occur over the long term. It is recommended to use long-term retention to lower this risk. For patients, this requires a major commitment, and a crucial component of the informed consent procedure before beginning orthodontic treatment.

It is critical that patients understand their obligations to wear retainers as instructed in order to lower the risk of relapses. Patients must be ready to accept that their teeth position may shift after treatment if they are unable to follow instructions. Since there is currently a lack of high-quality information about the most effective retention strategy or regimen, each clinician's approach will depend on their own clinical experience and competence as well as the expectations of their patients.

Because there is a shortage of reliable clinical evidence and individual professional experience, opinions and methods regarding retention vary^[1]. Before implementing appropriate retention, the orthodontist considers the expected occlusal and craniofacial changes, the treatment plan^[2], the patient's oral hygiene effectiveness and oral habits^[3].

On the one hand, the orthodontist's responsibility is to provide well-fitting, comfortable retainers along with proper instructions and motivation for the patient to wear them on a regular basis. On the other hand, the patient must wear the retainer as prescribed by the orthodontist. However, while easier said than done, the retention stage is still the most difficult part of orthodontic treatment^[4].

Evidence-based practice is based on the use of the best available evidence, clinical expertise, and consideration of patient preferences and values in making appropriate clinical decisions.

Teeth tend to return to their original positions due to tension of the periodontal fibers, particularly those around the teeth's necks (interdental and dento-gingival fibers). The final occlusion's quality also influences the stability of the orthodontic outcome, as unwanted displacing occlusal contacts may result in unfavorable changes in tooth position^[5].

Riedel *et al.*^[6] published ten rules (theorems) explaining retention and recurrence, as follows:

- Teeth that have been displaced tend to return to their original positions.
- Removing the cause of malocclusion prevents recurrence.
- To ensure safety, malocclusion should be re-corrected.
- Proper occlusion is crucial for keeping teeth in their correct positions.
- Allow time for bone and soft tissues to reorganize in the new position.
- Position the lower incisors perpendicular to the base of the jaw for better stability.
- Growth corrections are less likely to be affected by recurrence.
- Displaced teeth are less likely to relapse.
- Arch shape cannot be changed permanently.
- Some therapeutically treated anomalies require permanent retention appliances.

The most appropriate classification regarding etiology, i.e. the causes of relapses after orthodontic therapy are the following:

- Aging process
- Periodontal ligament and gingival fibers
- Soft-tissue maturation
- Occlusal factors
- Limits of the dentition
- Presence of third molars
- Maxillary and mandibular expansion

The aim of this systematic review was to analyze the most common causes that lead to relapses after orthodontic treatment and the factors that affect the duration of retention.

Material and methods

A comprehensive literature search was performed using electronic databases such as PubMed, Scopus, and Web of Science. Keywords included “orthodontic retention”, “retention protocols”, “orthodontic retention devices”, and “retention outcomes” to identify relevant

studies published between 1990 and 2024 years. Articles were screened for relevance to retention strategies, including randomized controlled trials, prospective cohort studies, systematic reviews, and meta-analyses.

Data extractions were performed to synthesize information on retention principles, factors influencing retention success and challenges in retention, and future research directions. For the purposes of this study, papers published exclusively in English were used, in peer-reviewed professional and scientific journals from the last two decades. Data related only to the goal of this study were used, as well as certain papers that aimed to further explain the topic.

Factors associated with relapse after orthodontic treatment

There are several factors that influence on the relapse after orthodontic treatment: (1) Aging process; (2) Periodontal ligament and gingival fibers; (3) Soft-tissue maturation; (4) Occlusal factors; (5) Limits of the dentition; (6) Presence of third molars and (7) Maxillary and mandibular expansion.

1. Age

Due to normal aging processes, recurrence is frequently possible after orthodontic treatment. Throughout life, age-related changes or moderate facial growth may take place. These changes may include minor adjustments to the maxilla-mandible relation and changes caused by the pressure on the teeth by soft tissues^[7]. Muscular activity and residual growth, whether skeletal or dental, must be closely evaluated in relation to the patient's chronological age.

Age-related changes in the surrounding soft tissues and continuous dentofacial growth can also impact the stability of the orthodontic results.^[8] Therefore, it is crucial that patients, orthodontists, and general dentists comprehend the significance of using retainers following orthodontic treatment^[9]. Even in patients who have not received orthodontic treatment, unwanted tooth movements following treatment may arise due to typical aging processes.

Changes in the skeletal structures surrounding the dentition and soft tissue stresses are the cause of this degradation in the positioning of their teeth. Unpredictable, these soft tissue alterations and slight continuous development can be considered a normal aspect of aging. Therefore, retainers are recommended to prevent undesirable long-term age changes as well as the tendency of teeth to revert to their pre-treatment positions after orthodontic tooth movement^[9]. The stability of the therapeutic outcomes and recurrence may be impacted by the patient's age at the time of treatment. The idea that the age alignment of teeth and occlusal connections change over the lifetime is also not surprising. These alterations in occlusal alignment and connectivity can be regarded as normal aging changes.

The age of patients when they have orthodontic treatment can affect the stability of the achieved therapeutic results and the occurrence of relapses. Irrespective of the good or negative history of orthodontic treatment, all participants experience tooth movement due to aging. In the study by Schubert *et al.* the majority of young patients displayed higher noticeable cytokine levels and quicker orthodontic movement during the initial phase of treatment^[10]. Specifically, the tendency is more noticeable in adolescents after therapeutic recurrence when there is crowding in the mandibular incisor area, but the incisors' horizontal and vertical folding is more stable than in adult patients. Increases in intercanine space have been linked to post-therapy recurrence in adult patients^[11].

2. Periodontal and gingival factors

Aging, post-pubertal cranial growth, orofacial muscles and occlusal contacts exert stresses on the teeth and periodontal fibers must be reorganized. Additionally, it is vital to schedule follow-up appointments following treatment due to the patient's compliance with wearing detachable retainers and the negative effects of fixed retainers^[12].

Tension in periodontal fibers, especially those surrounding the teeth's necks (inter-dental and dento-gingival fibers), causes teeth to revert to their original positions. The stability of the orthodontic result is also influenced by the quality of the final occlusion-unintended occlusal contact displacement may result in unfavorable tooth position changes. Orthodontic relapse can be reduced with careful treatment planning and the accomplishment of suitable soft tissue and occlusal treatment objectives^[13].

It is common for orthodontic therapy to cause PDL space expansion and collagen fiber bundle disruption. In reality, the tooth cannot move without these modifications. As long as the tooth is securely affixed to its neighbors, as it is when it is attached for a rigid orthodontic wire arch, periodontal disease will not develop until the normal structure returns, even if tooth movement stops before the orthodontic device is removed (which means that holding teeth with passive wire arches cannot be considered initial retention).

Once the teeth can individually respond to chewing forces (when each tooth during chewing can move individually in relation to the neighboring ones), there is a reorganization of the PDL in a period of 3 to 4 months, and the slight mobility present after removing the device disappears.

Impacted wisdom teeth has long been associated with the appearance of post-retention crowding of the mandibular incisors. However, the similar frequency of occurrence of post-retention compaction in patients with impacted, extracted, or even absent wisdom teeth indicates that there is no direct relationship between the presence/absence of wisdom teeth and retention complications. The form and size of the mandibular incisors do not significantly affect the likelihood of recurrence, and the morphology of the mandibular incisors affects the long-term stability of the results after the removal of the retention appliance^[14].

Less calculus accumulation was found with fixed retainers bonded with an unfilled bonding resin and composite adhesive, compared with retainers bonded with adhesive alone after two years^[15].

In the study by Arn et al, a statistically significant difference for plaque indexes in both examined groups was found, with higher scores among subjects with retainers for 12 months. These results were similar to the results for the gingival index. Based on the findings obtained in this study, it can be noted that orthodontic retainers have minimal effects on periodontal health for a duration of 3, 6 or 12 months^[16].

Following orthodontic treatment, a retention phase is necessary, primarily because it is important:

1. To facilitate the reorganization of periodontal and gingival fibers.
2. To minimize any modifications in the orthodontic outcome resulting from any remaining growth.
3. To facilitate neuromuscular adaptations towards the corrected occlusion.
4. To ensure the stability of tooth positions^[17].

Patients should be regularly monitored for retention status and its impact on periodontal health throughout the first six months following retainer bonding^[18].

It should be emphasized that fixed retainers are typically used only in individuals who maintain adequate dental hygiene. Long-term follow-ups of patients with fixed retention indicate that up to 1% of patients^[19] with flexible spiral fixed retainers may exhibit unexpected changes in terms of the development of inadvertent torque expression. This could put patients at risk for periodontal breakdown, including gingival recession and loss of attachment^[20].

3. Occlusal factors

Avoiding occlusal interference is a crucial component of a good retainer^[21]. However, problems related to retention should not be held responsible for all occlusal post-treatment variations. The procedure of active orthodontic treatment may be the cause of late tooth

crowding. For instance, mandibular incisor protrusion and intercanine growth may raise the chance of secondary crowding^[22].

Gross occlusal interferences, shifting tooth contacts, and aberrant tooth loading must be acknowledged as potential risk factors for recurrence by making the affected teeth more mobile. Positioning teeth in a soft tissue equilibrium between the tongue on the lingual side and the lips and cheeks on the labial side is ideal, whenever feasible^[11].

Some complications can be ascribed to the wire's deformation to fit the canine's shape and the increased danger of occlusal stress reaching the maxilla. By obtaining a lower arch impression and preventing occlusal stress during the retainer fabrication process, these complications can be avoided. When upper canines or lower premolars are included in the retainers, the risk of failure rises because of the increased occlusal stresses and kink in the wire during bonding^[23].

Relapse can occur as a result of deflecting occlusal contacts if the final occlusion is less than ideal^[24].

There are different conclusions regarding the importance of occlusal stability at the end of orthodontic treatment for the stability of the achieved results. Some authors consider that large occlusal contacts at the end of orthodontic treatment are associated with long-term stability. However, some authors suggest that a perfect occlusion at the end of orthodontic treatment is not fundamentally a guarantee of long-term stability. Changes in occlusion and incisor position after treatment do not seem to be significantly different, regardless of whether perfect occlusion is achieved or not^[10].

4. Influence of third molar

The extraction of mandibular third molars to avoid late lower incisor crowding remains a common disputable subject in dentistry. From an orthodontic point of view, third molars have basically a small effect on lower incisor crowding^[25].

Numerous authors have examined the impact of third molars on crowding and evaluated their impact on the lower dental midline, front crowding and cases of two-sided and one-sided third molar agenesis^[26,27].

In literature can be found that there is a little (irrelevant clinical noteworthiness) or no impact of third molars with huge standard deviations. The large standard deviations demonstrated that, in some cases, crowding was more prominent in patients without third molars. Late incisor crowding is multifactorial in nature, and factors other than third molars play a critical part. The removal of third molars on the sole premise of anticipating lower incisor crowding is unconfirmed and not evidence-based^[28].

There is a common concern that third molars may cause incisor swarming after their eruption. Research on the effects of third molars show negligible or no impact on crowding and vice versa. Consequently, it is not necessary to extract third molars solely for the reason to prevent crowding.

5. Soft-tissue factors

When it is possible, teeth should be positioned in a soft tissue equilibrium between the lips and cheeks from the labial side and the tongue from the lingual side. Relapse is more common if incisors are significantly retroinclined or proinclined. Significant changes in the arch form, specifically when there is decreased intercanine width, will increase relapse brought on by soft tissue pressures^[29].

Even in patients who have not undergone orthodontic treatment, unwanted tooth movements that are following orthodontic treatment, may arise due to typical aging processes. Changes in the skeletal structures surrounding the dentition and soft tissue stresses are the cause of this degradation in the alignment of the teeth. Unpredictably, these soft tissue alterations and

slight continuous development can be considered a natural aspect of aging. Therefore, retainers are recommended to prevent undesirable long-term age changes as well as the tendency of teeth to revert to their pre-treatment positions after orthodontic tooth movement^[10].

6. Maxillary and mandibular expansion

Longitudinal research on dental arch dimensions in untreated individuals has indicated that both intercanine and intermolar widths increase until the full eruption of the permanent teeth, after which a decline in dental widths begins, with more significant reduction observed in intercanine widths compared to intermolar. This width reduction persists for several decades, continuing into the eighth decade of life^[9].

Inadequate maxillary width and the ensuing transverse discrepancy between the maxillary and mandibular arches, skeletal maxillary expansion is part of the orthodontic treatment plan. Nowadays, there is a tendency to treat malocclusions with "non-extraction," or at the very least, without extracting premolars by extending the maxillary arch (even in cases where there is no transverse discrepancy)^[30]. Consequently, any orthodontic dental expansion beyond the initial pretreatment condition will heighten the risk of relapse following treatment, thus underscoring the necessity for lifelong retention.

The mandibular arch is thought to be the best indicator for determining the success of expansion because any expansion of the arch is fundamentally unstable, particularly in the intercanine region. Expanding the maxillary arch necessitates expanding the mandibular arch as well, which is inherently unstable, particularly in the absence of buccal crossbite^[31].

When treating malocclusions with arch expansion, one must be aware of the dentition's limitations, despite the lack of compelling evidence supporting long-term stability. To give the patient the best chance of long-term stability, expansion in the maxillary arch should result in only minimal expansion of the lower arch^[32].

Duration of retention after orthodontic treatment

There are numerous factors that influence the length of retention after orthodontic therapy.

In current orthodontic practice, considerable variation exists in the duration of the retention period. This includes a number of factors, such as the preference of the orthodontist, and the variability of occlusal, skeletal and soft tissue relationships.

When the patient is in the growth period, significant bone remodeling happens and continues even after orthodontic treatment is finished. Then retention must be maintained until growth ceases^[17]. Also, retention after orthodontic therapy must be continued until third molars erupt^[33].

There is no single definitive duration of retention that can be applicable for all patients. Many factors, such as the orthodontist's preference, occlusal condition, skeletal and soft tissue features and lack of evident data contribute to this^[34].

Unfortunately, there is no universal consensus on the type of retention protocol or retention appliance to be used. Authors have noted that a retention period range from 2–3 weeks to life-long retention^[35].

The choice of retention protocol and appliance preference is largely determined by the orthodontist's experience, patient's expectations and clinical circumstances. In most clinical scenarios, patients are monitored for a period of one year after the end of active orthodontic treatment. It is known that variations in the duration and intensity of removable retainer wear are clinically acceptable.

In view of practical and ethical barriers of conducting randomized studies on all possible retention regimens, it is unlikely that an accepted definitive recommended retention duration will be established. Furthermore, the wide variation in the severity and complexity of

patients' malocclusions and their orthodontic treatment also militate against establishing a 'one size fits all' approach to retention. Current good orthodontic practice is that a patient's individual retention regime should be based on an assessment of the specific factors which are known to be more likely to relapse.^[9] In particular, the decision to recommend prolonged or indefinite retention (usually with fixed retainers) is based on consideration of the factors detailed below in the text.

Ideally, after achieving proper alignment and occlusion, it takes around a year for the surrounding periodontium to reorganize and adapt itself. Most studies have reported that the majority of relapses occur in the first 2 years posttreatment^[35].

Conclusion

Retention in orthodontics is a process influenced by various factors: patient compliance, retention modalities, and retention duration. Although many retention strategies have been proposed and implemented, challenges such as relapse and negative effects of long-term retention still remain. Advancements in retention materials and techniques offer promising opportunities to improve retention outcomes. To optimize stability post-therapy and enhance patient satisfaction in orthodontic practice, focus should be on personalized retention protocols, digital monitoring systems, and the effects of long-term retention.

Conflict of interest statement. None declared.

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