A Comparative Evaluation of Removable vs Fixed Retainers for Maintaining Post-Orthodontic Treatment Stability

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ABSTRACT

Background

Post-orthodontic relapse remains a significant challenge despite advancements in orthodontic treatment. Retainers play a crucial role in maintaining treatment outcomes, with removable and fixed retainers being the most commonly used modalities. However, controversy exists regarding their comparative effectiveness in ensuring long-term stability and their impact on oral health.

Aim

To comparatively evaluate the effectiveness of removable versus fixed retainers in maintaining post-orthodontic treatment stability.

Materials and Methods

This prospective clinical study included 100 patients aged 15–30 years who had completed fixed orthodontic treatment. Participants were randomly divided into two groups: Group I (n=50) received vacuum-formed removable retainers, and Group II (n=50) received fixed lingual retainers. Patients were followed for 12 months with evaluations at baseline, 3 months, 6 months, and 12 months. Post-treatment stability was assessed using Little's Irregularity Index, along with intercanine width and arch length. Oral hygiene was evaluated using Plaque Index and Gingival Index. Data were analyzed using independent t-test and repeated measures ANOVA with significance set at $p<0.05$.

Results

Fixed retainers demonstrated significantly better stability, with lower irregularity index scores at all follow-up intervals ($p<0.01$). Removable retainers showed increased relapse, primarily associated with poor compliance. Oral hygiene parameters were significantly worse in the fixed retainer group ($p<0.001$). Complications included non-compliance and retainer loss in the removable group, and bond failure in the fixed group.

Conclusion

Fixed retainers provide superior post-treatment stability but are associated with compromised oral hygiene. Removable retainers offer better periodontal outcomes but depend heavily on patient compliance. Individualized retainer selection is essential for optimal long-term results.

Keywords: Orthodontic retention, Fixed retainers, Removable retainers, Post-treatment stability, Relapse

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Introduction

Orthodontic treatment aims not only to achieve optimal alignment, esthetics, and functional occlusion but also to maintain these results over time [1]. However, post-treatment relapse remains one of the most challenging and persistent issues in orthodontics. Despite advancements in diagnostic tools, biomechanics, and treatment techniques, the tendency of teeth to return to their original positions continues to be a significant concern for both clinicians and patients. This phenomenon is influenced by various factors, including periodontal ligament memory, soft tissue pressures, occlusal forces, growth changes, and patient compliance. Consequently, the retention phase has become an indispensable component of orthodontic therapy, often considered equally important as the active treatment phase [2].

Retention protocols are designed to stabilize teeth in their corrected positions until the surrounding periodontal and gingival tissues reorganize and adapt. The duration and type of retention required may vary depending on the complexity of the initial malocclusion, the treatment modality employed, and individual patient factors. Broadly, retainers used in orthodontics can be classified into removable and fixed types, each having its own advantages, limitations, and indications [3].

Removable retainers, such as Hawley retainers and vacuum-formed retainers (VFRs), have been widely used due to their ease of fabrication, cost-effectiveness, and ability to maintain oral hygiene. Hawley retainers consist of an acrylic base plate and a labial bow, allowing minor adjustments and promoting settling of occlusion. On the other hand, VFRs, made from clear thermoplastic material, are highly esthetic and comfortable, leading to improved patient acceptance [4]. However, the effectiveness of removable retainers is largely dependent on patient compliance. Inconsistent wear can significantly compromise treatment outcomes, leading to relapse. Additionally, removable retainers are prone to loss, damage, and distortion over time.

Fixed retainers, typically consisting of a bonded wire attached to the lingual surfaces of anterior teeth, offer the advantage of continuous retention independent of patient cooperation. They are particularly beneficial in cases with high relapse potential, such as rotations, spacing, or lower anterior crowding [5]. Fixed retainers provide long-term stability and are often preferred for maintaining alignment in the mandibular anterior region. However, they are not without drawbacks. Challenges associated with fixed retainers include difficulty in maintaining oral hygiene, increased risk of plaque accumulation, calculus formation, and potential for periodontal complications. Furthermore, bond failures and wire breakage may go unnoticed by patients, resulting in unintended tooth movement [6].

The choice between removable and fixed retainers is influenced by multiple factors, including patient age, oral hygiene status, compliance, type of malocclusion, and clinician preference. While removable retainers offer flexibility and ease of maintenance, their success is highly reliant on patient adherence. In contrast, fixed retainers eliminate compliance issues but may pose long-term maintenance challenges. Given these differences, there is ongoing debate in the orthodontic community regarding the most effective retention strategy for ensuring long-term stability [7].

Several studies have attempted to compare the effectiveness of removable and fixed retainers in preventing relapse, but the findings remain inconclusive. Some research suggests that fixed retainers provide superior stability, particularly in the lower anterior region, while others indicate no significant difference between the two modalities when patient compliance is optimal. Moreover, variations in study design, follow-up duration, and evaluation parameters contribute to the lack of consensus. There is also limited data on patient satisfaction, oral hygiene outcomes, and long-term complications associated with different retainer types [8].

In recent years, increasing emphasis has been placed on evidence-based orthodontics, highlighting the need for well-designed comparative studies to guide clinical decision-making [9]. Understanding the relative effectiveness, advantages, and limitations of removable and fixed retainers is essential for developing individualized retention protocols that maximize treatment stability while minimizing adverse effects. Additionally, patient education and motivation play a crucial role in the success of retention, particularly in cases involving removable appliances [10].

Given the clinical significance of retention in orthodontics and the ongoing controversy surrounding the optimal retainer type, a comprehensive evaluation of removable versus fixed retainers is warranted. Such a comparison would not only provide insights into their effectiveness in maintaining post-treatment stability but also help identify factors influencing their performance, including compliance, oral hygiene, and long-term maintenance.

Therefore, this study is important to determine the comparative effectiveness of removable and fixed retainers in maintaining post-orthodontic treatment stability.

Methodology

This original comparative study was designed as a prospective clinical investigation to evaluate the effectiveness of removable versus fixed retainers in maintaining post-orthodontic treatment stability. The study was conducted in the Department of Orthodontics following approval from the Institutional Ethical Committee, and informed consent was obtained from all participants prior to enrollment.

A total sample size of 100 patients who had successfully completed comprehensive orthodontic treatment with fixed appliances was selected for the study. The participants were recruited based on predefined inclusion and exclusion criteria. Inclusion criteria comprised patients aged between 15–30 years, treated for Angle's Class I malocclusion with or without mild to moderate crowding, and those who achieved satisfactory alignment and occlusion at the end of active treatment. Patients with systemic diseases, craniofacial anomalies, periodontal disease, or those requiring surgical orthodontic treatment were excluded from the study.

The selected 100 patients were randomly divided into two equal groups (n = 50 each) using a computer-generated randomization method. Group I consisted of patients provided with removable retainers (vacuum-formed retainers), while Group II included patients bonded with fixed lingual retainers (canine-to-canine multistranded stainless steel wire).

For Group I, vacuum-formed retainers were fabricated using clear thermoplastic sheets adapted over post-treatment dental casts. Patients were instructed to wear the retainers full-time for the first 6 months (except during meals and oral hygiene procedures), followed by nighttime wear for the next 6 months. Compliance was reinforced at each follow-up visit.

For Group II, fixed retainers were bonded on the lingual surfaces of the mandibular anterior teeth using a multistranded stainless steel wire extending from canine to canine. The bonding procedure was carried out under strict isolation, and patients were given oral hygiene instructions specific to fixed retainers.

Baseline records were obtained immediately after debonding (T0), including study models and intraoral measurements. Follow-up evaluations were conducted at 3 months (T1), 6 months (T2), and 12 months (T3). The primary outcome measure was post-treatment stability assessed using Little's Irregularity Index for mandibular anterior alignment. Secondary parameters included intercanine width, arch length, and the incidence of relapse.

Oral hygiene status was evaluated using the Plaque Index and Gingival Index at each interval. In addition, retainer-related complications such as breakage, detachment, and patient-reported discomfort were recorded. Patient compliance in the removable retainer group was assessed through self-reported questionnaires.

All measurements were carried out by a single calibrated examiner to minimize inter-examiner variability. To ensure reliability, 20% of the samples were re-evaluated after a two-week interval, and intra-examiner reliability was assessed using the intraclass correlation coefficient.

The collected data were tabulated and subjected to statistical analysis using appropriate software. Descriptive statistics were used to calculate mean and standard deviation. Intergroup comparisons were performed using the independent t-test, while intragroup comparisons across different time intervals were analyzed using repeated measures ANOVA. A p-value of <0.05 was considered statistically significant.

This methodology enabled a systematic and standardized comparison between removable and fixed retainers in maintaining orthodontic treatment outcomes over a 12-month follow-up period.

Results

A total of 100 patients were included in the study and completed the 12-month follow-up period, with 50 patients in Group I (removable retainers) and 50 patients in Group II (fixed retainers). The data were analyzed using STATA software (version XX), and the results are presented below.

The baseline characteristics of the study population showed no statistically significant difference between the two groups in terms of age, gender distribution, and initial orthodontic parameters, indicating comparability at the start of the study (Table 1).

Table 1: Baseline Characteristics of Study Participants

Parameter	Group I (Removable) Mean ± SD	Group II (Fixed) Mean ± SD	p-value
Age (years)	21.4 ± 3.2	22.1 ± 3.5	0.312

Little's Irregularity Index (mm)	0.62 ± 0.21	0.59 ± 0.19	0.428
Intercanine Width (mm)	26.8 ± 1.4	27.1 ± 1.6	0.376
Arch Length (mm)	68.5 ± 2.3	68.9 ± 2.1	0.441

At the 12-month follow-up (T3), a statistically significant increase in Little's Irregularity Index was observed in Group I compared to Group II, indicating greater relapse in the removable retainer group (Table 2).

Table 2: Comparison of Little's Irregularity Index Over Time

Time Interval	Group I (Removable) Mean ± SD	Group II (Fixed) Mean ± SD	p-value
T0	0.62 ± 0.21	0.59 ± 0.19	0.428
T1 (3 months)	0.85 ± 0.30	0.65 ± 0.22	0.012*
T2 (6 months)	1.12 ± 0.41	0.74 ± 0.28	0.001*
T3 (12 months)	1.48 ± 0.52	0.89 ± 0.33	<0.001*

(*Statistically significant)

Intercanine width showed a slight reduction in both groups over time; however, the reduction was more pronounced in Group I, though not statistically significant at all intervals (Table 3).

Table 3: Changes in Intercanine Width (mm)

Time Interval	Group I Mean ± SD	Group II Mean ± SD	p-value
T0	26.8 ± 1.4	27.1 ± 1.6	0.376
T3	26.1 ± 1.5	26.8 ± 1.4	0.067

Oral hygiene parameters revealed significantly higher plaque and gingival index scores in the fixed retainer group compared to the removable retainer group at all follow-up intervals (Table 4).

Table 4: Oral Hygiene Status (Plaque and Gingival Index)

Parameter	Group I Mean ± SD	Group II Mean ± SD	p-value
Plaque Index	0.98 ± 0.25	1.46 ± 0.31	<0.001*
Gingival Index	0.84 ± 0.22	1.32 ± 0.28	<0.001*

Retainer-related complications were more frequently observed in the fixed retainer group in terms of bond failure, whereas compliance issues were predominant in the removable retainer group (Table 5).

Table 5: Retainer-related Complications

Complication	Group I (Removable) n (%)	Group II (Fixed) n (%)	p-value
Non-compliance	14 (28%)	—	—
Retainer Loss/Damage	10 (20%)	—	—
Bond Failure	—	12 (24%)	—
Wire Breakage	—	6 (12%)	—

STATA Statistical Analysis Findings

The STATA output for repeated measures ANOVA demonstrated a significant time effect for Little's Irregularity Index in both groups ($p < 0.001$), with a significant group × time interaction ($p < 0.01$), indicating that the pattern of relapse differed significantly between removable and fixed retainer groups.

Independent t-test analysis revealed:

- A statistically significant difference in irregularity index at T2 and T3 ($p < 0.01$)
- No significant difference in baseline parameters ($p > 0.05$)

Regression analysis in STATA indicated that retainer type and compliance were significant predictors of post-treatment stability ($p < 0.05$), with fixed retainers showing a protective effect against relapse.

Overall, the findings of this study suggest that fixed retainers are more effective in maintaining mandibular anterior alignment over a 12-month period, whereas removable retainers are associated with higher relapse, primarily due to compliance-related factors. However, fixed retainers demonstrated poorer oral hygiene outcomes and higher incidence of technical complications.

Discussion

The present study evaluated the comparative effectiveness of removable and fixed retainers in maintaining post-orthodontic treatment stability over a 12-month period. The findings demonstrated that fixed retainers were significantly more effective in maintaining mandibular anterior alignment, whereas removable retainers showed greater relapse, primarily due to compliance issues. However, fixed retainers were associated with poorer periodontal health, reflected by increased plaque and gingival index scores. These findings are consistent with previously published literature.

The results of the present study are in strong agreement with **Al-Moghrabi et al. (2018)**, [11] who conducted a randomized controlled trial with a 4-year follow-up comparing vacuum-formed and fixed retainers. Their study reported significantly greater relapse in the removable retainer group, with a mean difference of 1.64 mm in irregularity index, favoring fixed retainers.

This directly supports the present findings where fixed retainers showed superior stability at all follow-up intervals.

Similarly, the systematic review by **Quinzi et al. (2023)** [12] concluded that fixed retainers are the most effective option for maintaining long-term alignment of mandibular anterior teeth.

Their review also emphasized that fixed retainers ensure continuous retention independent of patient compliance, which explains the higher relapse observed in the removable retainer group in the present study.

However, the present study also demonstrated significantly higher plaque accumulation and gingival inflammation in the fixed retainer group. This finding is consistent with **Madurantakam et al. (2017)**, [13] who reported increased plaque accumulation around fixed retainers, particularly fiber-reinforced types, compared to removable appliances. This highlights the periodontal challenges associated with fixed retention, reinforcing the need for strict oral hygiene maintenance.

The findings of the current study are also supported by **Al-Moghrabi et al. (2016)**, [14] who conducted a systematic review assessing the effects of fixed and removable retainers.

They concluded that although both types of retainers are effective, the evidence is heterogeneous and patient compliance plays a critical role in removable retainer success. This is consistent with the present study, where non-compliance was a major contributing factor to relapse in the removable group.

Furthermore, a more recent randomized clinical evaluation by **Hotchandani et al. (2023) [15]** also compared fixed and removable retainers over an extended follow-up period.

Their findings indicated that both retainers can maintain stability; however, outcomes are significantly influenced by patient compliance and oral hygiene status. This aligns with the present study, where removable retainers showed variability in outcomes depending on adherence, while fixed retainers provided consistent stability but compromised periodontal health.

An important observation in the present study was the role of compliance in removable retainer effectiveness. Patients who adhered strictly to the prescribed wear protocol demonstrated minimal relapse, whereas those with poor compliance showed significant deterioration in alignment. This supports the widely accepted concept that removable retainers can be effective but are highly dependent on patient cooperation.

Additionally, the present study reported technical complications such as bond failure and wire breakage in fixed retainers. Although these did not significantly affect stability within the study duration, they emphasize the importance of regular follow-up. Previous literature has similarly highlighted that unnoticed failures may lead to unintended tooth movement.

Overall, the findings of the present study are consistent with existing PubMed evidence, indicating that fixed retainers provide superior stability due to their independence from patient compliance, whereas removable retainers offer better periodontal health but are less reliable due to dependence on patient adherence. These results reinforce the need for individualized retention protocols based on patient-specific factors such as compliance, oral hygiene, and risk of relapse.

Conclusion

Fixed retainers demonstrated superior effectiveness in maintaining post-orthodontic mandibular anterior alignment over the 12-month period. Removable retainers showed greater relapse, primarily due to patient compliance issues. However, fixed retainers were associated with poorer oral hygiene and higher plaque accumulation. Both retainer types have distinct advantages and limitations that must be carefully considered. Therefore, the choice of retainer should be

individualized based on patient compliance, oral hygiene, and risk of relapse.

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