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How Age Impacts Lower Arch Changes After Orthodontic Treatment: A One-Year Study

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Abstract

Background: Post-orthodontic retention is crucial for stabilizing teeth, as shifts can occur after treatment, especially in younger patients with ongoing growth. Understanding age-related differences in lower arch stability is important for improving retention strategies and reducing relapse rates. This study aimed to compare changes in the lower arch within 12 months after orthodontic treatment across different age group patients using a standardized fixed retainer (FR).

Methods and Results: A longitudinal study analyzed 30 dental cast models from patients treated for mild crowding without extractions, all of whom had an FR bonded to the lower arch. Cast models were collected one day after debonding and again one year later. Measurements included the little irregularity index (LII), arch perimeter (AP), premolar width (PW), and intercanine distance (IcD). The sample comprised 15 growing patients of 14–16 years (Group 1) and 15 adults of 19–25 years (Group 2). In the selected cast models, the male-to-female ratio was 0.58:1. Female cast models were significantly more represented than male models, with a difference of 26.6% (P=0.041). Twelve months after treatment and placement of an FR, the mean increase in LII was 0.18±0.24. Group 1 showed a greater increase in LII (0.26±0.26; Z=2.074; P=0.038) and significantly higher AP (Z=3.837; P=0.0001) and PW (Z=4.106; P=0.0001) than Group 2. No significant difference was found for IcD between Groups 1 and 2 (Z=4.106; P=0.967). A significant decrease in LII, AP, and PW was associated with increasing age (R=-0.421 [P=0.021], R=-0.618 [P=0.0003] and R=-0.657 [P=0.0001], respectively). No significant correlation was found between age and IcD.

Conclusion: Growing patients experienced notable changes in the lower arch during the first post-treatment year, emphasizing the need for tailored retention strategies. While IcD remained stable during the 12-month follow-up, the findings raise questions about the long-term effectiveness of non-extraction methods in preserving mandibular arch widths, indicating that changes may predominantly affect the posterior arch. The study results allow for improved retention strategies and reduced relapse rates, improving long-term outcomes.(**International Journal of Biomedicine. 2024;15(1):171-176.**)

Keywords: fixed retainer • little irregularity index • arch perimeter • premolar width

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Abbreviations

AP, arch perimeter; **FR**, fixed retainer; **IcD**, intercanine distance; **LII**, little irregularity index; **PW**, premolar width.

Introduction

Maintaining the stability of teeth in their ideal aesthetic and functional positions after orthodontic treatment is critical. This phase, known as orthodontic retention, is essential for preventing relapse, particularly in the lower jaw.[1] Orthodontists typically recommend either fixed or removable retainers, with fixed retainers bonded to the lingual (tongue-facing) surfaces of the lower anterior teeth to stabilize mandibular incisors. Despite its importance, orthodontists have no consensus regarding the optimal design or wire thickness for fixed retainers to maximize effectiveness.[2]

Post-treatment stability is challenging to predict, as numerous factors influence relapse. Many orthodontists recommend bonding a fixed lingual retainer to the anterior teeth immediately after appliance removal to mitigate this risk.[3]

The retention phase is now widely regarded as a necessary component of orthodontic care, and lifelong retention is often advised to preserve treatment results.[4]

Changes in the dental arches during retention are complex and not always directly linked to the anomalies treated during orthodontic intervention. Research indicates that these changes are often minor and unrelated to the corrections made during treatment.[5-7] However, relapse after extensive and complex orthodontic work remains a significant concern for both orthodontists and patients.

Retention is not a standalone phase but an integral part of the orthodontic treatment plan, requiring careful consideration of the type of retention and retainer used. Factors contributing to relapse include occlusal alignment, soft tissue pressures, continued skeletal growth, and the behavior of periodontal fibers, such as supragingival and transseptal fibers.[8-10] Effective retention involves addressing these factors by maintaining proper intercanine width, avoiding excessive transverse expansion, managing tongue posture and habits, and ensuring correct lower incisor inclination.

Although growth patterns are assessed during treatment, post-treatment skeletal growth changes are often underestimated when evaluating stability.[11,12]

This study aimed to compare changes in the lower arch within 12 months after orthodontic treatment across different age group patients using a standardized fixed retainer (FR).

Materials and Methods

This longitudinal design study was conducted at the Department of Orthodontics, UBT College, Dental School in Prishtina, Kosovo, from January 2021 to March 2022. We selected cast models of impressions taken one day after bracket debonding (T0) and another set of impressions taken 12 months later (T1) (Fig. 1 a, b). The subject's age at the end of treatment was recorded from the faculty records.

Fig. 1. *a) Dental cast at the beginning of the retention phase (T0); (b)- Dental cast at the end of the observatory period (T1)*

Casts were categorized into two groups: a growing group of 14–16 years (n=15), mean age of 14.03±0.98 years (Group 1) and an adult group of 19–25 years (n=15), mean age of 23.16±1.51 years (Group 2) (P<0.0001). Each subject had a previously bonded flat nickel-titanium retainer with a thickness of 0.010”×0.029” in a four-strand twisted configuration manufactured by Forestaden.

Sample Selection

Inclusion criteria: age between 12 and 25 years; mild crowding at the start of treatment with a Class I malocclusion; treatment completed without the extraction of any lower teeth; no cavities or restorations; no poor oral habits or occlusal interference; bilateral canine guidance; no interproximal enamel reduction or circumferential supracrestal fiberotomy performed systematically; and absence of any syndromic conditions.

Exclusion criteria: cast models at T1 showing any crown restoration, and the presence of prosthetic crowns or other prosthetic work.

Clinical Protocol and Measurements

The following measurements were taken on dental casts at baseline and 12 months later: little irregularity index (LII), arch perimeter (AP), premolar width (PW), and intercanine distance (IcD). Measurements were performed using an electronic caliper (Digital 6, Mauser, Winterthur, Switzerland) with an accuracy of 0.01mm. Two clinicians conducted each measurement twice, using randomly selected casts.

The little irregularity index (LII) was measured at the anatomical contact points between adjacent teeth. When these points touched, the measurement was considered zero. Increased irregularity or displacement resulted in a higher index score. On the dental casts, the anatomical contact areas of the mandibular incisors and the mesial contact areas of the canines were marked. The linear distances between these markings were measured, and the five values were summed. Scores under 0.25 mm indicated good alignment.

The intercanine distance (IcD) was measured as the linear distance from the cusp tip of the right mandibular canine to the cusp tip of the left mandibular canine.

The arch perimeter (AP) was measured by summing five segments: from the mesial point of the first molars to the distal point of the canines on both sides, from the distal points of the canines to the distal points of the central incisors on both sides, and across the distal points of the right and left central incisors. This measurement was taken directly on each model using a light-gauge wire that was marked at the distobuccal cusps of the first molars and then straightened. The marks on the wire were then measured with a caliper.

The premolar width (PW) was measured using a digital caliper, from the deepest fissure of the first premolar on one side of the dental arch to the deepest fissure of the opposite first premolar. Values at T0 were compared to those at T1 for each subject, with the difference recorded for all of them.

Statistical analysis was performed using the statistical software package SPSS version 22.0 (SPSS Inc, Armonk, NY: IBM Corp). The normality of the distribution of continuous variables was tested by the Shapiro-Wilk W test. The Mann-Whitney U Test was used to compare the differences between the two independent groups. The proportions difference test was applied. Spearman's rank correlation coefficient (R) was calculated to measure the strength and direction of the relationship between two variables. A probability value of P<0.05 was considered statistically significant.

Results

In the selected cast models, the male-to-female ratio was 0.58:1. Female cast models were significantly more represented than male models, with a difference of 26.6% (*P*=0.041) (Table 1). The frequency distribution for the age of the patients from the whole sample was non-normal.

Table 1.
Analysis of study groups by gender.

FR-Group	Male	Female	*P*-value
FR-Group 1	6 (40%)	9 (60%)	0.282
FR-Group 2	5 (33.3%)	10 (66.7%)	0.072
Total	11 (36.7%)	19 (63.3%)	0.041

Twelve months after treatment and placement of an FR, the mean increase in LII was 0.18±0.24. Over the T1–T0 period, patients in Group 1 showed a significantly higher LII compared to those in Group 2 (0.26±0.26 vs. 0.10±0.2, *P*=0.038) (Table 2). A greater increase in AP (0.54±0.19 vs. 0.12±0.19, *P*=0.0001) (Table 2) and PW (0.43±0.15 vs. 0.07±0.14, *P*=0.0001) values was found in Group 1 than in Group 2 (Table 2). No significant difference in IcD values was found between Groups 1 and 2 (*P*=0.967) (Table 2).

Table 2.
Analysis of orthodontic parameters in two time points (T0-T1)

Parameter / Group	Average changes (T0 – T1)	Statistics
Little irregularity index (LII)		
Group 1	0.26 ± 0.26	Z=2.074; *P*=0.038
Group 2	0.10 ± 0.21	
Arch perimeter (AP)		
Group 1	0.54 ± 0.19	Z=3.837; *P*=0.0001
Group 2	0.12 ± 0.19	
Premolar width (PW)		
FR (14-16)	0.43 ± 0.15	Z=4.106; *P*=0.0001
FR (19-25)	0.07 ± 0.14	
Intercanine distance (IcD)		
Group 1	0.34 ± 0.31	Z=0.041; *P*=0.967
Group 2	0.35 ± 0.31	

As noted earlier, the observation period lasted 12 months post-retention. None of the indices showed significant differences between the two study groups at baseline (T0) in the mandibular arch. All participants began the trial with similar mandibular alignment according to the cast models.

Analysis using a non-parametric correlation test 12 months (T1) after treatment showed a significantly strong negative correlation between age and several parameters. A significant decrease in LII, AP, and PW was associated with increasing age (R=-0.421 [*P*=0.021], R=-0.618 [*P*=0.0003] and R=-0.657 [*P*=0.0001], respectively). No significant correlation was found between age and IcD (Table 3, Figure 2).

Table 3.
Correlation between orthodontic parameters with age and gender by study groups at T1.

Orthodontic parameters (T1)	Spearman R	
	Age	Gender
LII	R (30) = -0.421; *P*=0.021	R (30) = 0.004; *P*=0.982
AP	R (30) = -0.618; *P*=0.0003	R (30) = -0.020; *P*=0.914
PW	R (30) = -0.657; *P*=0.0001	R (30) = -0.062; *P*=0.744
IcD	R (30) = 0.031; *P*=0.870	R (30) = -0.045; *P*=0.811

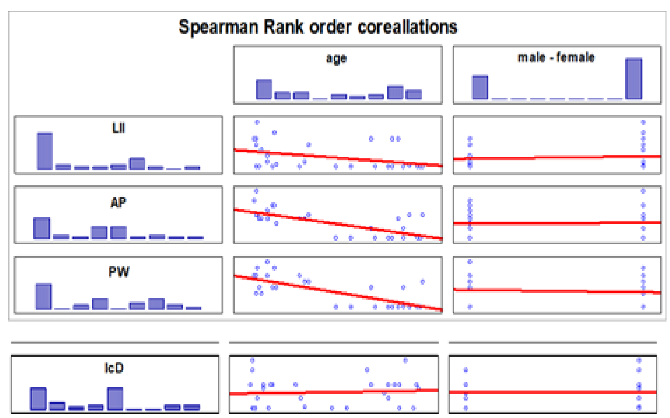

Fig. 2. *Correlation between orthodontic parameters with age and gender by study groups at T1.*

Discussion

Our study revealed that younger patients (14-16 years) exhibited a significantly larger mean increase in mandibular incisor irregularity (little irregularity index) than did adults (19–25 years) within the 12-month retention period. Despite using nickel-titanium fixed retainers, unwanted tooth movements occurred, including changes in intercanine and premolar dimensions, particularly in the younger group. This underscores the influence of growth-related factors on post-treatment stability and highlights the need for age-specific retention strategies to mitigate relapse risks.

Interestingly, intercanine distance remained stable in both groups during the study period, consistent with findings in mild crowding cases treated without extractions. This suggests that careful treatment planning and proper maintenance of intercanine width can contribute to stability during retention.

This study has some limitations. The relatively small sample size and focus on patients with mild crowding may restrict the generalizability of the findings. Additionally, the age range of 14–25 years excludes older adults or younger children who may exhibit different retention outcomes. The use of cast models rather than digital scans could introduce measurement variability. Finally, the follow-up period was limited to 12 months, which may not fully capture longer-term stability or the effects of factors such as third molar eruption or dentofacial aging.

Unwanted tooth movements, such as unexpected torque changes between mandibular incisors or opposing inclinations of contralateral canines, have been reported in patients with mandibular fixed retainers, even without bond failure or wire breakage.[13,14] These movements may result from the retainer becoming active, causing undesired tooth migration. Overexpansion of the intercanine space beyond its pretreatment width further increases the risk of relapse, regardless of age.[15] Additionally, skeletal changes, such as extreme vertical patterns, deep bites, anterior open bites, and late growth in Class III or post-orthognathic surgery patients, significantly influence post-treatment alignment but are often overlooked.[11,12]

Park et al.[4] reported small but measurable post-retention increases in mandibular irregularity and decreases in arch length, intercanine width, and intermolar width. Like our findings, they noted that adolescents experienced greater irregularity than adults, although most subjects retained clinically acceptable levels. They also highlighted that the severity of the original anomaly, rather than age alone, plays a key role in mandibular arch changes, with Class I patients showing significantly less change than Class II patients.

Forde et al.[16] observed a 0.77 mm increase in irregularity when using a bonded, 3-strand stainless steel wire for retention. In contrast, our study used a softer nickel-titanium retainer, likely reducing the impact of retainer rigidity. Changes in arch perimeter are mainly linked to major treatment adjustments.

Felton et al.[17] noted that 70% of dental arches reverted to their pretreatment shape during the post-retention period, although the methods for measuring these changes were not specified. The authors concluded that customizing arch forms appears to be necessary in many cases to obtain optimum long-term stability.

Orthodontic literature provides limited guidance on the most effective fixed retainer for long-term stability. Most follow-up studies focus on mandibular arch changes in non-extraction or premolar extraction cases. de la Cruz et al.[18] found that post-retention arch changes are moderately linked to treatment modifications, with minimal changes in cases of modest adjustments and more significant changes following substantial treatment modifications. The patient's pretreatment arch form appeared to be the best guide to future arch form stability.

Post-treatment mandibular irregularity increased slightly overall, but growing patients showed significantly greater changes than adults. Haruki and Little[19] reported higher irregularity in adolescents than in younger patients (2.75 mm vs. 1.53 mm) starting treatment earlier. Late crowding, often linked to growth and third molar eruption, aligns with mandibular vertical growth potential, as noted by Driscoll-Gilliland et al.[20] and Al Yami et al.[21] Extending retention for adolescents into their mid-20s may help manage these changes. Stability differences often depend more on anomaly type than age, with Class II patients showing greater instability than Class I patients.[22]

Katsaros et al.[13] reported that the flexible spiral wire retainers bonded on the six mandibular anterior teeth might cause unexpected movements of anterior teeth to such an extent that retreatment is necessary. The authors concluded that clinicians should consider this possibility when planning the retention strategy.

A study of 80 patients with more than 2 years of retention period after completing orthodontic treatment found a negative correlation between age and post-treatment stability, with higher pretreatment index scores—regardless of age or anomaly—associated with reduced stability, particularly in arch length.[23] In contrast, our study showed stable intercanine distance during the 12-month retention period, consistent with previous findings.[24]

Our study, which focused on cast models of Class I patients with mild crowding, found that the intercanine distance remained stable with minimal decrease during the 12-month follow-up. This stability may be attributed to favorable factors associated with this treatment approach. However, multiple factors, such as periodontal and gingival health, soft tissue dynamics, occlusal relationships, and growth, can influence post-treatment stability. Teeth tend to revert to their pre-treatment positions due to periodontal and gingival, soft tissue, occlusal and growth factors. Normal dentofacial aging further adds variability.[25]

Bonded fixed retainers, while effective for maintaining alignment, pose challenges such as increased plaque buildup and gingival inflammation, as noted in our previous study.[26] These retainers can complicate oral hygiene routines, highlighting the need for careful monitoring and patient education and for orthodontists to focus on mechanical retention strategies and educate patients on maintaining optimal oral hygiene to ensure long-term stability. The greater increase in mandibular irregularity observed in younger patients (12-18 years), compared to adults, suggests the need for extended retention periods for adolescents to counteract potential relapse due to continued skeletal growth.

Conclusion

Growing patients experienced notable changes in the lower arch during the first post-treatment year, emphasizing the need for tailored retention strategies. While IcD remained stable during the 12-month follow-up, the findings raise questions about the long-term effectiveness of non-extraction methods in preserving mandibular arch widths, indicating that changes may predominantly affect the posterior arch. The study results allow for improved retention strategies and reduced relapse rates, improving long-term outcomes.

Ethical Considerations

This study was approved by the Ethics Committee at UBT College (Protocol N # 06-PA-30-XV-3/2021) and the Ethical Committee at the Dental Chamber in Kosovo (N # 23/2021).

Competing Interests

The authors declare that they have no competing interests.

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