

# Effectiveness of Two Types of Fixed Lingual Retainers in Preventing Mandibular Incisor Relapse

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## ABSTRACT

**Objective:** To compare and evaluate the relapse tendency of two types of fixed lingual retainers using Little's irregularity index for a follow-up of one year.

**Study Design:** Randomised clinical trial.

**Place and Duration of Study:** Department of Orthodontics, Dr. Ishrat Ul Ebad Khan Institute of Oral Health Sciences and Dow Dental College in Dow University of Health Sciences, Karachi, Pakistan, from November 2017 to March 2019.

**Methodology:** A total of 54 patients were recruited and divided into two groups by random allocation. Subjects who have completed fixed appliance (MBT) orthodontic treatment and non extraction cases with moderate crowding in the lower arch were included. Subjects with caries, restoration, fracture or missing lower anterior teeth were excluded. Group 1 received fiber reinforced composite (FRC) retainers and group 2 received multistranded stainless steel (MSW) retainers. They were recalled after every three months interval for one year. Relapse tendency of retainers using Little's irregularity index was evaluated at each visit.

**Results:** Comparison of relapse tendency between two retainers showed statistically significant results ( $p<0.05$ ). The mean difference of CPD between two retainers at T0 was found to be 0.09 mm ( $p=0.01$ ). At T1, it was determined to be 0.3 mm ( $p=0.022$ ), and at T2 it was found to be 0.3 mm ( $p=0.008$ ). At T3 and T4, it was found to be 0.5 mm ( $p<0.001$ ) and 0.5 mm ( $p=0.002$ ), respectively. All mean differences were statistically significant.

**Conclusion:** Fiber-reinforced retainers are more effective in preventing the mandibular incisor relapse. The results of the study also suggest that the irregularity of the dentition increases with the passage of time.

**Key Words:** Retention, Relapse, Fiber reinforced composite, Fixed retainers.

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## INTRODUCTION

Throughout the history of orthodontics, various methods have been sought out to ensure the stability of corrections achieved after treatment. Maintaining the long term stability post-treatment is one of the major challenges for the orthodontists. Retention is the mandatory phase that facilitates the dentition to maintain the newly acquired position; otherwise, will revert back to their pretreatment position called relapse. Post-orthodontic records have been evaluated in a number of studies; and they reported pronounced relapses in various occlusal traits, specifically in the alignment and stability of mandibular anterior teeth.<sup>1</sup>

Relapse usually occurs as a result of age changes due to ongoing dentofacial growth and development or post-

orthodontic occlusal changes. Stability of the teeth is also affected by the forces from periodontal ligament and gingival fibers that encircle the teeth and continuous pressure from soft tissue structures that tend to pull the teeth to their former positions.<sup>2</sup> Adversely, prolong treatment duration often results in poor patient compliance. This has led a belief in orthodontists that permanent retention is the absolute solution that can maintain the long term effects after completing the orthodontic treatment and thus resist the tendency of the teeth to relapse. These outcomes can be achieved by a fixed lingual retainer inserted for an optimal duration of time.<sup>3</sup> When using fixed lingual retainers, stainless steel wire is widely used with variable diameter; however, fiber reinforced composite can be used as a substitute.<sup>4</sup> Fiber reinforced composite (FRC) materials are composed of multiple fibers made up of carbon, polyaramid, polyethylene and glass. They are indicated for multiple applications such as periodontal splinting, fixed orthodontic retainers, restorations, endodontic post and cores and bridges.<sup>5</sup> They cling to the surfaces of teeth by chemical adhesion and transmit the forces to the glass fibers, thus strengthening the resistance offered by the bonding

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agent.<sup>6</sup> Moreover, the difference of physical properties in the bonding interface of two materials, *i.e.* composite resin and wire is also eliminated. These are well tolerated by the patients. Their biocompatibility is a striking feature, especially in allergic patients as they are nickel-free as compared to stainless steel wires.<sup>7</sup> They are lighter in weight as they reduce the bulk of the material and are contoured easily along the lingual surfaces of the teeth. They also offer greater esthetics as they are invisible and no metal component is present in their structure. Furthermore their complete detachment occurs infrequently and are easy to fix. However, they allow limited physiological tooth movement as they create a rigid splint which may lead to their high failure rate.<sup>8</sup> To the best of authors' knowledge, a couple of studies have been conducted on these latest materials. Hence, their reliability is yet questionable.<sup>9,10</sup>

Little's irregularity index is a valid method used to evaluate irregularity in mandibular anterior region. It measures the horizontal contact point displacements of six anterior teeth; and thus determines the relapse tendency. The objective of this study was to compare and evaluate relapse tendency of two fixed lingual retainers using Little's irregularity index for a follow-up of one year.

## METHODOLOGY

It was a parallel group, randomised controlled clinical trial, approved by the Institutional Review Board, Dow University of Health Sciences (Ref: IRB-941/DUHS/Approval/2017/162); and registered under the protocol ID NCT03881813 (<https://clinicaltrials.gov/>). The study was conducted at the Department of Orthodontics, Dr. Ishrat UI Ebad Khan Institute of Oral Health Sciences and Dow Dental College from November 2017 to March 2019. A total of 54 subjects were recruited<sup>11</sup> using PASS version 11, based on two sample proportions with 95% confidence of interval and 80% power of test with estimated population size of 60 patients in six months. Convenience sampling technique was followed. Fifty-four subjects were randomly divided through computer generated software into two groups, *i.e.* 27 subjects in each group. Subjects who have completed fixed appliance (MBT) orthodontic treatment and non-extraction cases with moderate crowding in the lower arch were included. However, subjects with caries, restoration, fracture or missing lower anterior teeth were excluded.

After selection of subjects debonding of the brackets and bands, deep scaling and curettage was performed for each individual. Prior to the bonding of fixed retainer, all composite remnants were removed and enamel surfaces were cleaned with tungsten carbide bur in slow speed hand piece. Two types of fixed lingual retainers were bonded in the mandibular arch from canine-canine

to all the six anterior teeth by a single operator. Group 1 subjects received fiber reinforced composite (FRC) retainers (INOD, U.P. Fiber Splint, 2mm); while group 2 (control group) subjects received multistranded stainless steel wire (MSW) retainers (0.0175 inch, All Star Orthodontics).

In group 1 subjects, the mandibular anterior dental region was well isolated by cheek retractors, cotton rolls and suction tip. Inter-canine distance was measured by dental floss; and correct length of fiber ribbon was cut by scalpel blade. The ribbon was pretreated with adhesive primer (3M ESPE). Lingual surfaces of six anterior teeth were etched with 37% phosphoric acid gel (Meta Biomed) for 30 seconds, were washed sufficiently and air dried. Then adhesive primer (3M ESPE) was applied with applicator brush and light cured with a light emitting diode (Otholux; 3M) for 15 seconds on each tooth. It was followed by the application of flowable composite resin (3M ESPE). Eventually fiber ribbon was conformed to the lingual surfaces of six anterior teeth with plastic instrument, excess composite was removed and each tooth was light cured for 15 seconds. Further composite resin was applied with applicator for finishing. Finally, each tooth was light cured for 10 seconds. Oral hygiene instructions were delivered. Group 2 subjects who received multistranded SS retainer, same isolation and bonding protocols were followed. Subjects were followed for one year.

Data collection procedure was divided into five phases: T0 (insertion of retainers), T1 (3 months after insertion), T2 (6 months after insertion), T3 (9 months after insertion), and T4 (12 months after insertion). At each visit, impressions were taken and models were poured. Little's irregularity index was assessed by measuring the sum of contact point displacements (in millimeters) measured from the mesial aspect of canine on the right side to the mesial aspect of the canine on the left side<sup>12</sup> in the lower arch, by using digital caliper of 0.01 mm accuracy (Figure 1). Three measurements were taken



Figure 1: Measurement of relapse tendency by Little's Irregularity index in mm.

and mean was drawn. It was measured by the principal investigator and then was reevaluated by two colleagues to avoid errors. The measurement error and reliability between the three observers were checked using intraclass correlation, which found good agreement (ICC >0.70).

SPSS version 21 was used for data analysis. The relapse tendency (CPD) of the retainers were assessed by using repeated measure ANOVA; and pair-wise comparison was done using Post-hoc test (Bonferroni test) with p-value  $\leq 0.05$  and 95% confidence interval as significant. Normality of the data was checked by Shapiro-Wilk test. The data was found to be non-normal, therefore, the mean comparison of the relapse tendency (Contact point displacement) between two retainers was evaluated by using Mann-Whitney test.

## RESULTS

Out of 54 subjects, 2 were lost to follow-up; so data was analysed on 52 subjects. The mean age of subjects were  $21.5 \pm 3.6$  with the range of 14-30 years. Out of 52 subjects, 8 (15.4%) were males, while 44 (84.6%) were females. Twenty-six (50%) fiber reinforced composite (FRC) and 26 (50%) multistranded stainless steel wire (MSW) retainers were inserted. Out of 52 cases, 38 (73.1%) were class I malocclusion treated, while 14 (26.9%) were class II treated cases.

Little's irregularity index (Contact point displacement) was evaluated at five different intervals after every three months for the two types of retainers (Table I). However, contact point displacement (CPD) with respect to time interval ( $p<0.001$ ) and type of retainer ( $p<0.001$ ) was found significant by using repeated measure ANOVA.

**Table I:** Evaluation of contact point displacement (CPD) in two types of fixed retainers.

Time	Type of retainer	Median (IQR)	Mean difference (p-value)*
T0	FRC	0.03 (0.06)	0.09 (0.01)*
	MSW	0.13 (0.15)	
T1	FRC	0.1 (0.19)	0.3 (0.022)*
	MSW	0.22 (0.94)	
T2	FRC	0.19 (0.25)	0.3 (0.008)*
	MSW	0.44 (1.08)	
T3	FRC	0.2 (0.33)	0.5 (<0.001)*
	MSW	1 (1.45)	
T4	FRC	0.3 (0.34)	0.5 (0.002)*
	MSW	1.1 (1.61)	

P-value calculated using Mann-Whitney test. Significant at  $\leq 0.05$

FRC = Fiber reinforced composite; MSW = Multistranded stainless steel.

**Table II:** Comparison of contact point displacement (CPD) at different time intervals with baseline (T0).

Type of retainer	Mean difference (P-Value)*	T1	T2	T3	T4
FRC	0.26 (>0.99)	0.35 (0.817)	0.41 (0.392)	0.56 (0.061)	
MSW	0.44 (0.153)	0.57 (0.017)	0.87 (<0.001)	0.95 (<0.001)	

Post-hoc test (Bonferroni), significant at  $\leq 0.05$

FRC = Fiber reinforced composite; MSW = Multistranded stainless steel.

The mean difference of CPD between two retainers at T0 was found to be 0.09 mm ( $p=0.01$ ). At T1, it was determined to be 0.3 mm ( $p=0.022$ ) and at T2 it was found to be 0.3 mm ( $p=0.008$ ). At T3 and T4, it was found to be 0.5 mm ( $p<0.001$ ) and 0.5 mm ( $p=0.002$ ) respectively. All mean differences were statistically significant (Table I).

When CPD at T1 was compared with baseline T0 for FRC retainer, mean difference was found to be 0.26 ( $p>0.99$ ). For MSW retainer mean difference was found to be 0.44 ( $p=0.153$ ). The mean differences were statistically insignificant. The mean difference of CPD of FRC at T2 when compared with T0 was determined to be 0.35 ( $p=0.817$ ), which was statistically insignificant and for MSW was determined to be 0.57 ( $p=0.017$ ), which was statistically significant. For FRC, the mean difference of CPD, compared between T3 vs. T0 was detected to be 0.41 ( $p=0.392$ ), which was statistically insignificant and for MSW found to be 0.87 ( $p<0.001$ ), which was statistically significant. The mean difference of CPD for FRC at T4 vs. T0 was determined to be 0.56 ( $p=0.061$ ), which was statistically insignificant and for MSW found to be 0.95 ( $p<0.001$ ), which was statistically significant (Table II).

## DISCUSSION

The objective of the study was the evaluation of relapse tendency of two retainers in the mandibular anterior region via Little's irregularity index. In FRC retainers, the CPD at T0, T1, T2, T3 and T4 was found to be 0.03 mm, 0.1 mm, 0.19 mm, 0.2 mm and 0.3 mm, respectively. Similarly, in MSW retainers CPD at T0, T1, T2, T3 and T4 was reported to be 0.13 mm, 0.22 mm, 0.44 mm, 1 mm and 1.1 mm, respectively. It has been observed that irregularity (CPD) increases with the passage of time with both the retainers. Multiple studies have reported increased irregularity of anterior dentition in the mandibular arch, despite lingual retainers possibly due to continual growth of jaw, masticatory forces and soft tissue pressure.<sup>13,14</sup> Furthermore, according to Little's irregularity index, CPD values of 0 or less than 1 mm indicates perfect alignment, 1-3 mm shows minimal irregularity, 4-6 mm shows moderate irregularity, 7-9 mm refers to severe irregularity and 10 mm or greater than 10 mm means very severe irregularity.<sup>15</sup> Accordingly, all values fall in the category of perfect alignment except T3 and T4 of MSW retainers. Values of CPD at T3 and T4 of MSW retainer showed minimal irregularity. The mean differences of CPD between the two retainers at all points were statistically significant ( $p<0.05$ ).

In the present study, relapse tendency was found significantly greater in MSW as compared to FRC retainers. The possible reason of this finding is the increased rigidity of FRC material which allows limited physiological tooth movement; and the splinting effect causes increased strain levels, specially at the interdental areas

under masticatory loads resulting in decreased relapse;<sup>16,17</sup> whereas, MSW is flexible enough to allow greater tooth movement, ultimately resulting in greater amount of relapse. MSW undergoes deformation and distortion due to traumatic forces which cause increased stress concentration resulting in increased movement of teeth.<sup>18</sup> In addition to this in this study, fixed retainers were repaired/rebonded immediately after the bond failure; thus, minimising the irregularity of the dentition due to bond failure.

The earlier literatures report the comparison of relapse tendency between removable and stainless steel fixed retainers. Al Nimri *et al.* reported significant incisor irregularity with round SS retainer as compared to multistranded SS retainer bonded to lower anterior teeth for a follow-up duration of one year.<sup>19</sup> A previous study by O'Rourke *et al.* reported that there is significant difference in incisor irregularity when compared between multistranded fixed retainer and vacuum formed removable retainer over six months duration and minimal changes over a duration of 12 and 18 months.<sup>20</sup> According to this study, MSW retainer appeared to be more effective in preventing relapse.

The current study is highly novel that serves as a baseline, and provides a favourable reference to future studies in this domain. It is a randomised clinical trial, therefore, minimises bias. The prospective nature of the study permits to evaluate the results in a reliable and accurate manner. However, limitations include small sample size which could not be increased as the study was conducted on post-orthodontic patients; and it was difficult to convince them to visit for the follow-ups. Moreover, follow-up duration was restricted to one year.

It is recommended to conduct similar studies in future with increased sample size. Comparison of different fixed retainer types should be assessed for increased follow-up duration of at least 2 to 3 years to achieve improved results and it would be a fascinating prosecution.

## CONCLUSION

There are significant differences in the relapse tendency between the two types of fixed lingual retainers after fixed appliance orthodontic treatment. There is greater amount of relapse observed with multistranded stainless steel wire retainer as compared to fiber reinforced composite retainer. Thus, fiber reinforced retainers are more effective in preventing the mandibular incisor relapse. The results of this study also suggest that the irregularity of the dentition increases with the passage of time.

## ETHICAL APPROVAL:

Ethical approval was obtained by the Institutional Review Board, Dow University of Health Sciences (Ref: IRB-941/

DUHS/Approval/2017/162) prior to initiation of research work.

## PATIENTS' CONSENT:

Informed consents were obtained from all the patients to publish the data concerning their cases.

## CONFLICT OF INTEREST:

Authors declared no conflict of interest.

## AUTHORS' CONTRIBUTION:

NIN: Principal investigator and a major contributor in data collection and analysis, manuscript writing and literature search.

IA: Co-investigator and supervisor, assisted in the selection of title, analysis and interpretation of data and final approval.

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