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EFFECTS OF FIXED VS REMOVABLE ORTHODONTIC RETAINERS ON PERIODONTAL HEALTH

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ABSTRACT

Objective: To assess the effects of fixed and removable orthodontic retainers in a mandibular arch on periodontal health.

Methodology: This study was carried out at AFID from November 2018 to November 2020. Sixty-four patients, 42 females (65%) and 22 males (34%) with a mean age of 19.46 ± 2.01 years were selected and given either vacuum formed retainer (VFR) or bonded retainer wire (BRW) in mandibular arch and divided into two equal groups. Only the mandibular arch was used to measure two clinical variables (Gingival index and calculus index) at four different time intervals, immediately after de-bonding (T_0), at 6 months (T_1), at 12 months (T_2) and at 24 months (T_3) to assess the effects of two retainer groups on Periodontal health.

Results: No significant difference was found between gingival index and calculus index scores at T_0 among VFR group and BRW group ($p > 0.05$) while statistically significant differences were found in gingival index scores at T_1 ($p = 0.025$) and calculus index scores at T_1 and T_3 ($p = 0.015$, $p = 0.048$ respectively) among the two retainer groups.

Conclusion: Fixed bonded retainer wire is capable of causing gingival inflammation and calculus aggregation, indicated by mild increase in gingival and calculus scores, in comparison to vacuum formed retainer. Although no adverse effects were observed on overall periodontal health with both retainers. This does not guarantee future disease progression, so careful monitoring of oral hygiene on follow-up visits should be a prime concern of orthodontists.

Keywords: Calculus Indicator; Fixed Appliance; Gingival Indicator; Oral Health; Removable Appliance.

INTRODUCTION

After completion of orthodontic treatment, retention of the achieved results poses a great challenge to orthodontist. Prolonged retention may be prescribed to counter post-treatment related changes due to unstable positioning of teeth, physiological recovery or changes occurring due to advancing age.¹ The etiology of orthodontic relapse is quite complex and multifactorial.² Retainers are very important to obtain long term and stable results after a successful period of orthodontic correction. Previous studies reported higher relapse rate in mandibular arch as compared to maxillary arch during post retention period.² Data suggesting choice of retainer type (removable or fixed) and duration of retainer wear, after correction of mal-occlusion with fixed mechanotherapy is still debatable. To avoid unwarranted developmental changes, most clinicians prefer retention period longer than 1 year or even life-long retention is given to specific patients.³⁻⁵

One of the most commonly used removable retain-

ers is Vacuum-formed retainer (VFR) (Essix™ Ace plastic, 120 mm in diameter; Dentsply, Islandia, NY) which is made of clear and thermoplastic material. Several types of bonded fixed retainers of different sizes, cross-sections and materials have been recommended by various orthodontists in the past. The flexible multi-stranded wire bonded to each anterior tooth is currently considered the gold standard.² This fixed retainer is usually preferred because strands deliver extra mechanical retention while flexible nature of the wire allows physiological tooth mobility.⁶

Orthodontic retainers which are fixed type are non-compliance dependent, inappreciable and worn continuously. On the contrary, removable orthodontic retainers are compliance dependent, worn temporarily by the patient and are visible to the naked eye. Long-term use of removable and fixed retainers calls for assessment of their effects on periodontal health. Retainers are well known for plaque promotion and aggregation as they interfere with the self-cleansing effect of oral cavity that may result in deterioration of periodontal soft and hard tissues.⁷

Bonded lingual fixed retainer offers retention without any occlusal interference in the mandibular arch. This type of fixed retainer is not often suitable in the maxillary arch as opposing incisors mostly occlude over the wire or adhesive. Hence, in our study, only mandibular arch was selected to study its effects on the periodontal tissues.

Many studies have been conducted previously which assess their reactions on periodontal health but none compared the effects of removable and fixed type retainer over a duration longer than 1 year. Thus, in our study we assessed the two main clinical features (the gingival status and calculus deposition) stipulating progression of any disease form as a consequence of retainer wear and followed for a period of 2 years which has not been carried out for this much duration previously.^{8,9} Additionally, long term impact of fixed or removable retainers on the periodontium has been subject of little prospective analysis and compliance levels when given prolonged removable retention, is unclear.¹⁰ The objective of this study was to assess the changes in the periodontium seen in mandibular arch with use of fixed and removable retainers after completion of fixed orthodontic therapy and a null hypothesis was formulated that no difference exists between the removable retainer and bonded retainer wire when used in the mandibular arch.

METHODOLOGY

A preliminary permission was taken from the ethical review committee of Armed Forces Institute of Dentistry, preceding the study. This longitudinal prospective study was carried out over a period of 2 years extending from November 2018 to November 2020.

Power analysis (G Power, Version 3.1.9.7, Kiel, Germany) showed that a sample size of 64 (32 in each group) would give more than 95% power keeping $\alpha = 0.05$ and effect

size at 0.84 based on values from previous study¹¹. Sixty-four patients (42 females and 22 males, mean age 21 years) who presented to the department of orthodontics at AFID were included in the study based on following inclusion criteria: (1) patients who underwent orthodontic treatment (2) patients with no history of systemic disease or periodontitis (3) patients given Vacuum formed Retainer /Fixed Retainer. (4) and patient with good oral hygiene at the time of presentation. Subjects with improper oral hygiene, active periodontal disease requiring restorative/surgical treatment were excluded from the study. Consecutive sampling technique was employed and the subjects were divided into following two groups:

Group 1: Bonded Retainer wire (BRW) in mandibular arch which is 0.016-inch preformed coaxial archwire Ortho-Care (UK) Ltd. 1 Riverside Estate Saltaire. West Yorkshire

Group 2: Vacuum formed retainer (VFR) (Essix™ C+). In Group 1 patients, fixed multi-stranded stainless steel (0.016-inch coaxial) arch wires were placed passively against lingual surfaces of lower six anterior teeth without interproximal contouring by a single blind investigator. All the retainer wires were bonded using same etching agent (3M Unitek), same adhesive primer (Transbond™ XT primer; 3M Unitek) and same light cured composite (Transbond™:3M Unitek, Monrovia, California, USA).

The Vacuum formed retainer (Essix™) were made using vacuum machine that adapts heat-softened plastic by negative pressure, creating a vacuum that pulls the plastic onto a working study cast and the final product was trimmed to cover all fully erupted teeth. The two most common materials used in making of VFRs are polyethylene co-polymers and polypropylene polymers. Patients of group 2 were given VFR (made up of polyethylene co-polymers) in both arches but more attention has been giv-

en to mandibular anterior teeth. Retainers were to be worn for a maximum time initially for 6 months and after that only night time wear was advised for the rest of 18 months. Retainer wear chart was also handed over to these patients in order to assess their compliance.

Oral hygiene instructions were delivered at the time of retainer placement to all the patients. Special instructions regarding maintenance around the retainer wire were given to the patients with bonded fixed retainers and were advised to report back immediately in case of retainer bond failure. Patients of both the groups were followed for a period of 2 years after retainers bonding while insertion and measurements were recorded by the same calibrated blind investigator (Dr. S.U) immediately at debonding session (T_0), 6 months (T_1), 12 months (T_2) and 24 months (T_3) post retainer placement.

Two clinical measurements were taken to evaluate periodontal health, these include; Gingival index of Sillness and Loe¹² and the Calculus index of Greene and Vermillion¹³. All measurements were recorded for the buccal, lingual, mesial and distal surfaces of anterior six teeth of mandible as these are potentially most affected areas.

For both group 1 and 2, following clinical variables were assessed by the investigator. Gingival index (GI) was estimated after lightly drying the gingiva and visualizing clinically, the signs of inflammation. The average score of all aforementioned surfaces was recorded according to the following scale mentioned in Table 1a at T_0 , T_1 , T_2 and T_3 time points.

Calculus index (CI) was evaluated for the same surfaces, estimated visually by recording coronal extension of calculus deposits in sub-gingival and supra-gingival region. The scoring was done by taking average value at T_0 , T_1 , T_2 and T_3 time points based on scale shown in Table 1b.

Table 1a. Scoring system for gingival index¹²

Score	Characteristics
0	Absence of inflammation
1	Mild inflammation, with a slight change in color and subtle change in texture; no bleeding on probing
2	Moderate inflammation with a moderate glazing, redness, oedema, and hypertrophy; bleeding on pressure
3	Severe inflammation with marked redness and hypertrophy tendency to spontaneous bleeding, ulceration

Table 1b. Scoring system for calculus index¹³

Score	Characteristics
0	Absence of calculus
1	Presence of calculus covering up to 1/3rd of the tooth surface
2	Presence of calculus covering up to 2/3rd of the tooth surface and/or the presence of separate flecks of subgingival calculus
3	Presence of calculus covering more than 2/3rd of the tooth surface and/or the presence of a continuous band of subgingival calculus

The averaged data of all six mandibular teeth (central incisors, lateral incisors and canines) was obtained and a mean value was calculated for each subject. Data was then analyzed using SPSS (IBM, Version 26.0, USA) statistical software. The Shapiro-Wilks test was used to determine normality of the data. As the data was not normally distributed, comparisons of different variables between the two groups were undertaken using Mann-Whitney U-test for the

indices (gingival and calculus) keeping level of significance at 0.05. Demographic clinical and radiographic data were analyzed using conventional descriptive statistics.

RESULTS

Demographic, clinical and radiographic distribution of both the groups (BRW and VFR) is shown in Table 2. No significant difference was observed between the two

groups in terms of age, sex and features of mal-occlusion.

Table 3 shows comparison of periodontal measurements among the two groups at different time points (T₀, T₁, T₂, T₃) using GI and CI. Gingival index scores at T₁ were statistically significant (P = 0.025) whereas no significant difference was observed at T₀, T₂ and T₃, indicating stable gingival values after T₁. Mean values, though statistically insignificant, were comparatively higher for BRW than VFR. This could be suggestive of more inflammatory signs in case of fixed bonded retainer.

Calculus index scores at T₀ were zero for both BRW and VFR groups with no significant difference among the two groups. After 6 months at T₁, the difference became statistically significant (p=0.015) and at T₃, it maintained its significance (p=0.048). The calculus scores were higher throughout for BRW group. CI values of the two groups at T₂ stage reverted back to being insignificant; however, the score was comparatively raised for BRW.

Table 2: Demographic, clinical and radiographic characteristics of the two groups in the study

Variables		Overall sample n = 64	BRW n = 32	VFR n = 32
Age (y) at T0 Mean (SD)		19.46 (2.01)	19.37 (2.12)	19.56 (1.93)
Gender	Male	22	11	11
	Female	42	21	21
Skeletal Pattern	Class I	20	12	08
	Class II	36	17	19
	Class III	08	03	05

BRW= Bonded retainer wire, VFR= Vacuum formed retainer, SD=Standard Deviation

Table 3: Comparison of periodontal measurements by gingiva index (GI) and calculus index scores between the two groups at T₀ (debond), T₁ (6 months post debond), T₂ (12months post debond) and T₃ (24 months post debond)

Indices	T ₀			T ₁			T ₂			T ₃		
	BRW Mean (SD)	VFR Mean (SD)	P	BRW Mean (SD)	VFR Mean (SD)	P	BRW Mean (SD)	VFR Mean (SD)	P	BRW Mean (SD)	VFR Mean (SD)	P
Gingival index	1.02 (0.83)	1.29 (0.52)	0.650	0.92 (±0.91)	0.46 (0.87)	0.025*	0.93 (±0.97)	0.59 (±0.72)	0.082	1.29 (±0.45)	1.01 (±0.31)	0.051
Calculus index	0.00 (±0.07)	0.00 (0.00)	0.104	0.04 (±0.06)	0.00 (±0.04)	0.015*	0.04 (±0.09)	0.02 (±0.07)	0.568	0.06 (±0.09)	0.02 (±0.06)	0.048*

BRW = bonded retainer wire, VFR = Vacuum formed retainer, SD = Standard Deviation, P= significance level, * = <0.05,

DISCUSSION

To assess the progression of pathology or patient's compliance regarding oral hygiene maintenance, indices are generally used to assess pathological or physiological changes occurring in oral cavity, however, these can be augmented as a research tool with the objective to characterize periodontal status of an individual to estimate treatment efficacy when comparisons are made prior to and after initiation of therapy or upon any change in hygiene maintenance^{12,14}. There are apprehensions associated to potential adverse effects of lingual bonded retainers on the surrounding periodontal tissues over a long period of retention.

The result of current study showed significant difference ($p=0.025$) in gingival scores 6 months post-debond (T_1) retainer placement. Although the mean scores reduced but reduction was more for VFR (from 1.29 ± 0.52 to 0.46 ± 0.87) than BRW (from 1.02 ± 0.83 to 0.92 ± 0.91). The reason appears to be the gingival inflammation as a result of increased plaque retention associated to BRW as compared to fitted VFR. However, on 12 months (T_2) and 24 months (T_3) follow-up, no significant difference was observed for gingival health even though the scores concomitantly increased. This data suggests that oral hygiene was acceptable in both the groups on termination of active orthodontic treatment which may be attributed to reinforced oral hygiene improvement measures on every follow-up visit but certain deterioration is evident with time. Similarly, Knaup et al. reported statistically insignificant change in GI values after placement of bonded retainers.¹⁵ whereas, Pandis et al. demonstrated no significant changes in GI over a short term (3 to 6 months) and long term (9 to 11 years) follow-up periods.¹⁴

The CI scores at T_0 were zero for both the groups but after six months period, the difference between the two groups appeared sta-

tistically significant ($P=0.015$) with more increase in CI scores for BRW (from 0.00 ± 0.07 to 0.04 ± 0.06). This is suggestive of plaque retentive areas that progressed to calculus deposition in BRW group. By 12 months, calculus deposits mildly increased in both the groups but the difference was statistically insignificant. Subjects of both the groups were advised proper oral hygiene maintenance on every follow-up visit, progression of calculus deposition is indicative of compliance insufficiency. After 24 months (T_3), the deposits continued to worsen in BRW group while no further increase in CI scores were observed in the VFR group. This indicates that with-holding of calculus is connected more to BRW that provides suitable areas to microbial flora to accumulate and colonize, which further calcify and increase availability for more colonization.¹⁶ This can negatively impact periodontal health, thus meticulous fabrication, adaptation and bonding of retainer wire is of paramount importance as suggested by Pandis et al.¹⁴

The findings of current study by fareena. et.al are in agreement with findings of studies by Rody et al., Heier et al., Xiao et al. that reported enhanced plaque and calculus accumulation with fixed retainer when compared with removable retainer.^{9,17,18} Similarly, a randomized control trial reported substantial amount of calculus deposition associated to BRW but this was only a one year follow-up study.⁸ Millet et al. highlighted that with VFR, the overall gingival health is much better than with BRW.¹⁹ On the other hand, Booth et al. found no significant difference in gingival index scores in BR (bonded retainer).²⁰ Likewise, Al-Moghrabi et al. reported zero CI scores after completion of study with the use of bonded retainers.²¹ Furthermore, most of the studies have supported the tendency of calculus aggregation around fixed retainer and better overall oral hygiene in patients who used VFRs as retainers but also reported no demonstrable adverse effects on periodontal health between the two retainer

groups.^{20,22-26} Contrasting results were seen in studies by Gokce et al., Levin et al. and Cesar et al. that correlated poor periodontal conditions with fixed retainers.²⁷⁻²⁹

The noticeable limitation in progression of gingival inflammation after follow-up visits at T_2 and T_3 suggests that patient motivation regarding oral health and hygiene reinforcement play a pivotal role in keeping periodontium healthy. Patients should be encouraged and motivated to strictly adhere to oral hygiene regime on each follow-up visit and ultrasonic cleaning can be performed on calculus formation to prevent its negative sequel on periodontal tissues.

In the present study oral hygiene control or improvement by professional means was not possible to be carried out on review appointments, which can serve as a contributing factor to debris formation, independent of the retainer type used. Further researches need to be carried out that evaluate different type of retainers and their impact on periodontal tissues over a prolonged duration and their subsequent effect on stability and retention.

CONCLUSION

This study suggests that retention with fixed bonded retainer wire in the mandibular anterior region results in minute increase in gingival and calculus indices indicating enhanced potential of debris aggregation and development by showing increased gingival inflammation and calculus formation, in comparison to the removable vacuum-formed retainer. Although no major unpleasant changes were observed on the periodontal tissues but these do have inherent capability to result in a future disease process. As review visits helped in minimizing progression to some extent, clinicians should therefore consider careful monitoring of patient's oral health that could adversely affect overall periodontium to a clinically significant proportion.

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Author's Contribution

FG conceived the idea, wrote the manuscript, and supervised the study. ATM contributed in the analysis and interpretation of the data. AJ contributed in designing the study, and the proofreading of the manuscript. RJ contributed to the literature review for the study. HZS and SM helped in data collection. Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

Authors declared no conflict of interest

Grant Support and Financial Disclosure

None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.