

# Effect of Retainers on Periodontal Health- A Review

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### Abstract

In the recent years the demand and expectations from orthodontic treatment have increased drastically. The orthodontist's aim is to deliver the best treatment possible with the most functional, esthetic and stable results. It is a well-known fact that orthodontic treatment is prone to relapse as teeth have a tendency to go back to their pretreatment position due to elastic recoil of gingival fibres, soft tissue forces and continuing dentofacial growth<sup>1,2</sup>. Therefore, to maintain the teeth in their corrected position, retainers are an essential part of orthodontic treatment.

However, the continuing presence of the retainer wire and the undercuts, creates areas that are difficult to clean, thus favouring plaque and calculus accumulation which can deteriorate the periodontal health of surrounding tissues<sup>3</sup>. Recently, fiber reinforced composites have been introduced as fixed retainers as they can be used in patients with nickel allergy.

Many studies have assessed periodontal health with retainers using various clinical scores such as, probing depth, clinical attachment loss, bleeding on probing, and radiographs for assessment of alveolar bone loss which quantifies the amount of plaque and calculus accumulation, gingival recession and marginal bone loss<sup>5-9</sup>. Fixed retainers have been associated with an increased incidence of recession, plaque retention, and bleeding on probing and therefore meticulous oral hygiene and regular monitoring is essential to avoid detrimental effects on periodontium in the long run.

**Keywords:** Orthodontic treatment, retainers, relapse, periodontal health, biomarkers

### Introduction

In recent years, there has been a dramatic increase in the demand for orthodontic treatment from both adolescents and adults. Moreover, patient's expectations for treatment outcomes continue to rise day by day. Therefore, orthodontist aims to deliver the best treatment possible with the most functional, esthetic and stable results. Risk of relapse is one of the main concerns of an orthodontist that can occur after removal of orthodontic appliance as a result of periodontal, occlusal, soft tissue forces and continuing dentofacial growth<sup>1</sup>.

As a result most of the orthodontists usually recommend long periods of retention. Fixed retainers bonded to the lingual/palatal surface of incisor teeth have been widely used, eliminating the

need for patients' cooperation. The drawback of placing fixed retainers is the tendency for plaque and calculus to accumulate along the retainer wire leading to a greater incidence of increased pocket depth, bleeding on probing and gingival recession<sup>2,3,10,15</sup>.

The majority of published studies have focused on bacterial plaque accumulation and clinical periodontal health assessment in the presence of retainers using traditional diagnostic methods such as periodontal indices and radiographic methods<sup>4,5</sup>.

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Moreover, recently various enzymes of tissue degradation released from the damaged cells in response to periodontal infection have been isolated from the gingival crevicular fluid (GCF) correlating with the severity of periodontal destruction<sup>5,6</sup>. These biomarkers are AST (Asparatate Aminotransferase), ALT (Alanine Aminotransferase) and ALP (Alkaline Phosphatase) etc. Recent studies have shown that these biomarkers can be easily quantified in the saliva as well. The use of saliva offers an edge over GCF as it is faster, easier and more convenient to collect and does not require specialized instruments for measurement.

The literature is replete with numerous studies on the effect of retainers on periodontal tissue health.

### Types of Retainers & Their Effect on Periodontal Health

**Çifter M, Çelikel ADG and Çekici M<sup>7</sup>** conducted a study to evaluate the effects of vacuum-formed retainers (VFRs) on periodontal health. Plaque index (PI), calculus index (CI) bleeding on probing (BOP), gingival index (GI), Probing depth (PD), amount of gingival recession (GR) and clinical attachment loss (CAL) were measured at the debonding appointment. Test group patients were recalled for periodontal measurements at 1, 6 and 12 months after VFR use. Plaque and gingival indices decreased steadily throughout the evaluated period, with no significant differences between 6 and 12 month interval. Bleeding on probing, calculus index, probing depth and clinical attachment loss scores increased during the period examined.

**Moslemzadeh SH, Sohrabi A, Rafighi A and Farshidnia S<sup>8</sup>** conducted a randomized clinical trial to compare the gingival health between Hawley retainer (HR) and vacuum-formed retainers (VFR). Gingival index (GI) was used to evaluate gingival health at the two time intervals. It was concluded that all the three retainers were equally effective in maintaining the results of orthodontic treatment and gingival health was also not compromised with any particular retainer.

**Manzon L, Fratto G, Rossi E, and Buccherib A<sup>9</sup>** conducted a prospective cohort study to compare plaque accumulation, periodontal health with Essix and Hawley retainer over a 6 month period. Periodontal health was assessed using Plaque index (PI), calculus index (CI), bleeding on probing (BOP) and gingival index (GI). Plaque and calculus accumulation on or in the retainer was also assessed. The results indicated that patients with essix retainers had higher scores of plaque, calculus and gingival indices and increased amount of plaque and calculus deposits on the retainers. Frequent monitoring visits (3 months) and adequate oral hygiene instructions are essential to overcome this disadvantage.

**Artun J<sup>11</sup>** evaluated if spiral wire bonded retainers accumulated more plaque and calculus than plain wire retainers and their effect on periodontal tissues. 108 patients were divided into three experimental groups and two reference groups depending on the period of retention. Different indices were used to score accumulation of plaque and calculus, prevalence of caries, and gingival health along the retainer wire, along the gingival margin and interdentally. The findings indicated that there was more plaque and calculus accumulation along the retainer wire gingivally than incisally for canine to canine bonded retainers. Higher plaque and gingival index scores were noted for patients with canine to canine bonded retainers. He concluded that accumulation of plaque and calculus occasionally along the retainer wire causes no apparent damage to the adjacent hard and soft tissues.

**Artun J, Spadafora AT, Shapiro PA, McNeill RW and Chapko MK<sup>12</sup>** conducted a clinical trial to assess the amount of plaque and calculus accumulation between different bonded canine-to-canine retainer designs and its effect on the enamel and gingival tissues adjacent to the retainer wires. 44 patients were randomly assigned to 4 groups. 1 group received retainers made of thick plain wire bonded only to the canines, 2nd group received retainers made of thick spiral wire bonded only to the canines, 3rd group received thin flexible spiral wire bonded to each tooth in the anterior segment and 4th group received removable retainers. Plaque index (PI), calculus index, Gingival index (GI) and caries assessment were scored along the retainer wire and gingival margin both incisally and gingivally. These parameters were measured at the time of retainer placement and 4 months after retainer placement. The results showed that there was significantly more plaque found interproximally along the retainer wire and along the gingival margin.

**Heier EE, De Smit AA, Wijgaerts IA and Adriaens PA<sup>13</sup>** evaluated the effect of bonded versus removable retainers on periodontal health. 36 patients were divided into two experimental groups. After retainer placement, patients were instructed about proper oral hygiene maintenance. Gingival health was assessed using modified gingival index, bleeding on probing and gingival crevicular fluid flow. Plaque and calculus accumulation were recorded using Plaque index (PI) and Dental Calculus index (DCI) respectively. These parameters were recorded at 1, 3 and 6 months after retainer placement. The results revealed a reduction in gingival inflammation between 1 and 3 months, followed by a small increase between 3 and 6 months after retainer placement. A limited amount of gingival inflammation was found in both the groups. Slightly more plaque and calculus accumulation was present on the lingual surfaces of the fixed retainer group. A tendency towards increased scores at the 6 month follow up indicated a need for repeated motivation regarding oral hygiene.

**Artun J, Spadafora T and Shapiro PA**<sup>14</sup> conducted a 3 year follow up study to test the tendency for plaque and calculus accumulation along the various types of canine to canine bonded retainers. The subjects were screened for plaque and calculus accumulation at two intervals i.e. prior to appliance removal and 3 years after retainer insertion using plaque index, calculus index, gingival index and probing attachment level. The authors concluded that bonded canine to canine retainers can effectively maintain incisor alignment after orthodontic treatment with no adverse effects on adjacent hard and soft tissues.

**Störmann I and Ehmer U**<sup>16</sup> conducted a prospective randomized study to compare different types of fixed retainers with respect to periodontal problems. 103 patients received three different types of retainers. Patients were recalled at 1, 3, 12 and 24 months after retainer placement. Plaque index, irregularity index, bleeding on probing were recorded at baseline and at all the recall visits. Increased plaque accumulation was seen with all retainer types with no significant difference between retainer types.

**Pandis N, Vlahopoulos K, Madianos P and Eliades T**<sup>2</sup> conducted a study to evaluate the effect of long and short term mandibular fixed retention on the health of surrounding periodontal tissues. 32 patients had received mandibular fixed retainer 9.5 years ago were recalled for a comprehensive periodontal examination. An equal number of patients who had received mandibular fixed retainer 3 and 6 months prior were also included in the study and designated as the control group. All patients were asked to avoid visiting general dentist 1 month prior to the recall appointment. Clinical parameters like plaque index (PI), gingival index (GI), calculus index (CI), probing pocket depth, marginal recession, and bone level at the mandibular six anterior teeth were recorded for both the groups. The results showed that no significant difference was found for PI and GI scores for both the groups but the long-term group presented higher calculus accumulation, greater marginal recession and increased probing depth. A significantly higher prevalence of deep pockets (more than or equal to 4 mm) and marginal recession was found for the long-term retention group. The authors concluded that the appropriateness of lingual fixed retainers as a standard retention plan for all patients is questionable and emphasized the importance of application of retention protocols only after a thorough consideration of periodontal tissue anatomy and oral hygiene status. The authors also recommend close monitoring of patients with fixed retainers through frequent recalls.

**Levin L, Samorodnitzky-Naveh GR and Machtei EE**<sup>17</sup> conducted a study to evaluate the association between fixed retainers with gingival health. 92 subjects with fixed retainer for 4.57 years were included in the study. Periodontal parameters measured were plaque index (PI), gingival index (GI), gingival recession, probing depth (PD), and bleeding on probing (BOP) at six sites per tooth in the anterior sextants. Localized gingival recession, PD, PI, GI, and BOP were significantly greater in teeth with a fixed retainer than in those without a fixed retainer. Fixed retainers placed in a more gingival position had greater gingival recession and adjacent inflammation compared to retainers placed more incisally. The authors concluded that fixed retainers were associated with an increased incidence of recession, plaque retention, and bleeding on probing and meticulous oral hygiene and regular monitoring is essential to avoid detrimental effects on periodontium.

**Booth FA, Edelman JM and Proffit WR**<sup>18</sup> conducted a study on 60 patients with a fixed retainer for 20 years after treatment and the periodontal health effects was evaluated. Gingival health was assessed with the help of gingival index and intraoral photographs. The results revealed that there was no statistically significant difference in the gingival score of patients with or without retainers. Statistically significant better gingival health scores were seen for mandibular anterior region as compared to maxillary arch. The authors concluded that the orthodontist can safely and confidentially recommend permanent retention to maintain mandibular alignment and with good oral hygiene, periodontal health is not a concern.

**Al-Nimri K, Al Habashneh R and Obeidat M**<sup>19</sup> conducted a prospective study to compare plaque accumulation and gingival health of two types of bonded lingual retainers. One group received round wire retainer made of 0.036 inch stainless steel wire bonded to lower canines only and the other group received 0.015 inch multistranded wire retainers bonded to all the six lower anterior teeth. All patients were recalled after at least 12 months and oral hygiene index (OHI), plaque index (PI), gingival index (GI), irregularity index and number of breakages were recorded. The results indicated that there was no statistically significant difference in PI and GI between the two groups. There was a tendency for more plaque to accumulate along the distal surfaces of lower anterior teeth in multistranded group as compared to round wire group. Although multistranded retainers show a greater tendency for plaque accumulation, the gingival health was not compromised as compared to round retainers.

**Tacken MPE, Cosyn J, Wilde PD, Aerts J, Govaerts E and Vannet BV**<sup>20</sup> conducted a 2 year prospective study to compare the periodontal implications of glass fiber reinforced (GFR) retainers with multistranded bonded orthodontic retainers. 184 patients received bonded lingual GFR retainers. Parameters such as modified gingival index, bleeding on probing and plaque index were used to assess periodontal health at 6, 12, 18 and 24 months after retainer placement. At the end of each assessment, oral hygiene instructions were reinforced and any plaque/calculus noted was mechanically removed. Patients with GFR had significantly more gingival inflammation than those with multistranded retainers. The authors concluded that multistranded retainers should remain the gold standard in orthodontic retention and the use of GFR retainers in clinical practice should be discouraged because of their detrimental effects of periodontium.

**Torkan S, Oshagh M, Khojastepour L, Shahidi S and Heidari S**<sup>21</sup> evaluated the clinical and radiographic effect of two fixed retainers on periodontal health. 30 patients 1 to 3 weeks before removal of the orthodontic appliance received either a fiber reinforced retainer or a multistranded flexible wire retainer. The patients were evaluated at two intervals i.e. at the time of retainer placement and 6 months after retainer placement. They were evaluated for any bone loss using periapical radiographs and clinically with various indices such as plaque index, calculus index, gingival index and bleeding on probing. The patients were instructed to undertake meticulous oral hygiene using both superfloss and interdental brushes along with tooth brushing. The results showed all scores to deteriorate at 6 months follow up visit in both the groups, with worst scores noted in the fiber reinforced group. There was a significant increase in calculus accumulation in mandibular arch after 6 months of retainer placement in both the groups. 60% of the maxillary and mandibular periapical radiographs in the fiber reinforced group showed PDL widening however, the results were not statistically significant. It was concluded that multistranded stainless steel wire retainers inflicted less detrimental effects on the periodontium as compared to fiber reinforced composite retainers.

**Corbett AI, Leggitt VL, Angelov N, Olson G, Carusoe JM**<sup>22</sup> conducted a study to compare the periodontal health of anterior teeth with two different types of fixed retainers for 2 to 4 years. Periodontal health was assessed using six parameters i.e. plaque index, gingival crevicular fluid volume, calculus index, pocket probing depth, gingival recession and bleeding on probing. An oral hygiene questionnaire with four

questions regarding the frequency of brushing and flossing, ease of flossing and comfort of retainers was given to each subject at the time of clinical examination. The results showed that there was no statistically significant difference between the two retainer groups regarding periodontal parameters assessed.

**Dietrich P, Patcas R, Pandis N and Eliades T**<sup>23</sup> conducted a retrospective study to the effect on gingival health after a mean period of 7 years in retention. Periodontal health was assessed using variables like plaque index (PI), gingival index (GI), probing depth (PD) and bleeding on probing (BOP). GI was not significantly correlated with PI. 46% of the patients had at least one periodontal site with a PD of more than 3 mm, but the overall BOP of the bonded teeth to the retainer for each participant was 22.3 per cent. 68.3 per cent of patients experienced no failure of the upper bonded retainer. It was concluded that maxillary bonded fixed retainers did not have any significant negative effect on the periodontal health despite a slight increase in plaque accumulation.

**Juloski J, Glisic B and Vandevska-Radunovic V**<sup>24</sup> conducted a retrospective longitudinal cohort study to compare the prevalence of mandibular gingival recession in orthodontically treated patients 5 years after retention. Patients were evaluated at T0 (before treatment), T1 (4-6 weeks after debonding) and T5 (5 years after debonding) for the presence of gingival recession or calculus accumulation with the help of good quality dental casts and intraoral photographs. Gingival recession were also measured on the dental cast with the help of calipers. Intraoral photographs were used to confirm the presence or absence of gingival recession. The results revealed that the prevalence of gingival recession increased gradually throughout the observation periods in all the groups. Significantly more amount of calculus accumulation was noted at T5. The authors concluded that long term presence of retainers did not increase the incidence of gingival recession but favors more calculus accumulation.

**Storey M et al**<sup>25</sup> conducted a prospective, multicentre randomized controlled clinical trial to evaluate the periodontal health implications of upper and lower bonded retainers (BRs) versus upper and lower vacuum-formed retainers (VFRs) over a period of 12 months. All participants receiving retainers were advised to use a daily fluoride mouthrinse and to visit their dentist every 6 months for routine dental examinations and participants with BRs were instructed to clean around their retainers with interdental brushes or superfloss. Periodontal health was assessed using calculus index (CI), gingival index (GI), and plaque index (PI). All measurements were

made at 4 time points i.e. at the time of debonding (T0), 3 months after debonding (T1), 6 months after debonding (T2), and 12 months after debonding (T3). The results revealed that the gingival health was worse with BRs after 3 months in the maxillary arch and after 6 months in the mandibular arch. Statistically significant increase in intercanine plaque scores was noted with BRs compared to VFRs at 3 months after debonding and the median calculus scores for BRs continued to increase in the mandibular intercanine region throughout the study period. The authors concluded that after 12 months of retention, BRs were associated with a greater accumulation of plaque and calculus and gingival inflammation compared to VFRs.

**Al-Moghrabi D et al**<sup>26</sup> conducted a randomized control trial to compare the stability of orthodontic treatment and periodontal health over a 4 year period in patients with fixed and removable retainers. Patients with removable retainer were asked to wear the retainer full time for the first six months followed by night time wear for next six months and alternate nights for 12-18 months thereafter. Periodontal health was assessed using parameters like gingival inflammation, calculus and plaque levels, clinical attachment level and bleeding on probing. Significant gingival inflammation and elevated plaque levels were common periodontal findings in both the groups. It was concluded that fixed retainers were more effective in maintaining mandibular alignment at a 4 year follow up although gingival inflammation was noted in both the groups.

### **Role of Biomarkers in Diagnosing Gingival & Periodontal Problems With Fixed Retainers**

**RodyJr WJ et al**<sup>4</sup> conducted a clinical study to evaluate if biomarkers of inflammation and periodontal remodeling such as Matrix metalloproteinase-9 (MMP-9), Interferon gamma (IFN- $\gamma$ ), and interleukin-10 (IL-10) were differentially expressed in gingival crevicular fluid (GCF) of patients wearing different types of orthodontic retainers over an extended period of time. 31 patients with retention for an average of 5.6 years were divided into 3 groups. Group 1 consisted of 10 patients with mandibular fixed retainer bonded only to canines; group 2 consisted of 11 patients wearing removable Hawley type retainer on daily basis and group 3 as the control group consisting of 10 postorthodontic patients without retainers. Periodontal health was assessed using clinical parameters and GCF biomarker analysis which was carried out at two sites per subject i.e. the lingual side of a lower central incisor and the lingual side of a lower second premolar. Clinical parameters used were probing depth, bleeding on probing, plaque accumulation indices. GCF was collected from the two sites using

Periopaper strips which were immediately sent to the laboratory for biomarker analysis done with the help of a customized Quantibody Array. They concluded that increased GCF levels of MMP-9 from lower incisor region in fixed retainer group indicate subclinical inflammation which could be of clinical significance in the long run.

**RodyJr WJ et al**<sup>6</sup> conducted a cross sectional study to analyze and compare the gingival crevicular fluid (GCF) biomarker levels and the periodontal effects of different orthodontic retainers. Group 1 patients received plain 0.028 inch round wire bonded only to canines, group 2 patients received multistranded retainer bonded to all six mandibular teeth in the anterior segment and group 3 patients received lower removable retainer. Oral hygiene instructions were given regarding regular brushing and flossing to all patients. Periodontal health was assessed using probing depth (PD), gingival recession, plaque index and bleeding on probing. GCF was collected from mandibular central incisor with the help of periopaper and was analyzed for the activity of 10 biomarkers (receptor activator of nuclear factor kappa-B ligand (RANKL), macrophage colony stimulating factor (M-CSF), interleukin-1 beta (IL-1 $\beta$ ), interleukin-1 receptor antagonist (IL-1RA), interleukin-8 (IL-8), interleukin-6 (IL-6), matrix metalloproteinase-3 (MMP-3), matrix metalloproteinase-9 (MMP-9), osteopontin (OPN), and osteoprotegerin (OPG). The results revealed that plaque accumulation and gingivitis differed significantly among groups, with the highest median values in multistranded retainer subjects. The authors concluded that the presence of retainers bonded to all anterior teeth seems to increase plaque accumulation and gingivitis and a positive correlation was found between periodontal health and GCF biomarker levels.

### **Conclusion**

Fixed retainers are associated with an increased incidence of recession, plaque and calculus retention, and bleeding on probing and therefore meticulous oral hygiene and regular monitoring is essential to avoid detrimental effects on periodontium.<sup>17</sup>

The importance of maintaining adequate oral hygiene around the retainers should be communicated to the patients. Clinicians should therefore carefully decide the retention protocol depending on the patient's ability and motivation to maintain oral hygiene. This should be clubbed with frequent recalls and professional scaling to obtain ideal results with retainers. Multistranded retainers should remain the gold standard in orthodontic retention and the use of Fiber reinforced retainers in clinical practice should be discouraged because of their detrimental effects of periodontium<sup>2,20</sup>.

## References

- Wellington JR and Wheeler TT: Retention management decisions: A review of current evidence and emerging trends. *Seminars in Orthodontics* 2017; 23:221–228.
- Pandis N, Vlahopoulos K, Madianos P: Long-term periodontal status of patients with mandibular lingual fixed retention. *Eur J Orthod* 2007; 29(5): 471–476.
- Levin L, Samorodnitzky-Naveh GR, Machtei EE: The association of orthodontic treatment and fixed retainers with gingival health. *J Periodontol* 2008; 79(11): 2087–2092.
- Rody WJ, Jr., Akhlaghi H, Akyalcin S: Impact of orthodontic retainers on periodontal health status assessed by biomarkers in gingival crevicular fluid. *Angle Orthod* 2011; 81:1083-1089.
- Dabra S, China K, Kaushik A: Salivary enzymes as diagnostic markers for detection of gingival/periodontal disease and their correlation with the severity of the disease. *J Indian Soc Periodontol* 2012; 16:358-64.
- Rody Jr WJ, Elmaraghy S, McNeight AM, Chamberlain CA, Antal D, Dolce C, Wheeler TT, McGorray SP, Shaddox LM: Effects of different orthodontic retention protocols on the periodontal health of mandibular incisors. *Orthod Craniofac Res.* 2016; 19(4):198-208
- Çifter M, Gümrüçelikel AD, Çekici A: Effects of vacuum-formed retainers on periodontal status and their retention efficiency. *Am J Orthod Dentofacial Orthop.* 2017; 152(6):830-835.
- Moslemzadeh SH, Sohrabi A, Rafiqhi A, Farshidnia S: Comparison of Stability of the Results of Orthodontic Treatment and Gingival Health between Hawley and Vacuum-formed Retainers. *J Contemp Dent Pract* 2018; 19(4):443-449.
- Manzon L, Fratto G, Rossi E, Buccheri A: Periodontal health and compliance: A comparison between Essix and Hawley retainers. *Am J Orthod Dentofacial Orthop.* 2018; 153(6):852-860.
- Zachrisson BU: Clinical experience with direct-bonded orthodontic retainers. *Am J Orthod.* 1977; 71(4):440–8.
- Artun J: Caries and periodontal reactions associated with long term use of different types of bonded lingual retainers. *Am J Orthod* 1984; 86:112-8.
- Artun J, Spadafora AT, Shapiro PA, McNeill RW, Chapko MK: Hygiene status associated with different types of bonded, orthodontic canine-to-canine retainers. A clinical trial. *J Clin Periodontol.* 1987; 14(2):89-94.
- Heier EE, De Smit AA, Wijngaerts IA, Adriaens PA: Periodontal implications of bonded versus removable retainers. *Am J Orthod Dentofacial Orthop* 1997; 112(6): 607-616
- Artun J, Spadafora AT, Shapiro PA: A 3-year follow-up study of various types of orthodontic canine-to-canine retainers. *Eur J Orthod.* 1997; 19(5):501–9.
- Watted N, Wieber M, Teuscher T, Schmitz N: Comparison of incisor mobility after insertion of canine-to-canine lingual retainers bonded to two or to six teeth. A clinical study. *J Orofac Orthop.* 2001; 62(5):387-96.
- Störmann I, Ehmer U: A prospective randomized study of different retainer types. *J Orofac Orthop.* 2002; 63(1):42–50.
- Levin L, Samorodnitzky-Naveh GR, Machtei EE: The association of orthodontic treatment and fixed retainers with gingival health. *J Periodontol* 2008; 79(11): 2087–2092.
- Booth FA, Edelman JM, Proffit WR: Twenty-year follow-up of patients with permanently bonded mandibular canine-to-canine retainers. *Am J Orthod Dentofacial Orthop.* 2008; 133(1):70-6.
- Al-Nimri K, Al Habashneh R, Obeidat M: Gingival health and relapse tendency: a prospective study of two types of lower fixed retainers. *Aust Orthod J.* 2009; 25(2):142–6.
- Tacken MP, Cosyn J, De Wilde P, Aerts J, Govaerts E, Vannet BV: Glass fibre reinforced versus multistranded bonded orthodontic retainers: a 2 year prospective multi-centre study. *Eur J Orthod.* 2010; 32(2):117–23.
- Torkan S, Oshagh M, Khojastepour L, Shahidi S, Heidari S: Clinical and radiographic comparison of the effects of two types of fixed retainers on periodontium—a randomized clinical trial. *Prog Orthod.* 2014; 15:47.
- Corbett AI, Leggitt VL, Angelov N, Olson G, Caruso JM: Periodontal health of anterior teeth with two types of fixed retainers. *Angle Orthod.* 2015; 85(4):699-705
- Dietrich P, Patcas R, Pandis N, Eliades T: Long-term follow-up of maxillary fixed retention: survival rate and periodontal health. *Eur J Orthod.* 2015; 37(1):37-42.
- Juloski J, Glisic B, Vandevska-Radunovic V: Long-term influence of fixed lingual retainers on the development of gingival recession: A retrospective, longitudinal cohort study. *Angle Orthod.* 2017; 87(5):658-664.
- Storey M, Forde K, Littlewood SJ, Scott P, Luther F, Kang J: Bonded versus vacuum-formed retainers: a randomized controlled trial. Part 2: periodontal health outcomes after 12 months. *Eur J Orthod.* 2018; 40(4):399-408.
- Al-Moghrabi D, Johal A, O'Rourke N, Donos N, Pandis N, Gonzales-Marin C, Fleming PS: Effects of fixed vs removable orthodontic retainers on stability and periodontal health: 4-year follow-up of a randomized controlled trial. *Am J Orthod Dentofacial Orthop.* 2018; 154(2):167-174.

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