

# Comparative evaluation of three types of bonded lingual retainers on the periodontal health of mandibular anterior teeth : A parallel-group randomized trial

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## Abstract

**Objectives :** To study three varied designs of bonded lingual retainers following fixed appliance therapy for their effect on the periodontal status of mandibular anterior teeth over a period of 1 year.

**Materials and Methods :** A parallelgroup randomized clinical trial was done. Those patients who have recently completed fixed appliance therapy and in whom bonded retainers are indicated were selected for this study. Thirty patients conforming to inclusion criteria were selected and allocated randomly to three groups, Group 1- Braided wire retainer, Group 2- canine & canine retainer and Group 3- Mesh retainer. Plaque, gingival & calculus indices were evaluated at 1 week (T0), 3 months (T1), 6 months (T2) and 12 months (T3). Friedman and Kruskal-Wallis tests were used for intragroup comparisons and intergroup comparisons, respectively.

**Results :** Data collected by examining 25 patients were analysed. Five dropouts were observed due to breakage of retainer. There was a statistically significant increase in all the indices within the groups ( $p=0.001$ ). A 12-month Gingival index intergroup analysis demonstrated substantial variations across the groups. Higher values for calculus index were observed with canine and canine retainer at 12 months (mean =  $1.26 \pm 0.27$ ).

**Conclusions :** The Gingival, Plaque, and Calculus Index scores increased consistently from 1 week to 12 months after retainers were placed. At 12 months, canine and canine retainer revealed higher calculus scores necessitating greater dental hygiene practices for the same.

**Keywords:** Retainers, Bonded lingual retainers, Plaque, calculus, gingival index, white spot lesions

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Date of Submission: 11-04-2023

Date of Acceptance: 25-04-2023

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## I. Introduction

The outcomes of orthodontic treatment require retention for a long period of time. Clinical scenarios that warrant the placement of retainers are lower incisor imbrication before the start of treatment, any changes being made in the intercanine width while undergoing treatment, advancement of lower incisors (as a part of treatment) and non-extraction treatment of mildly crowded cases. Removable retainers like the Hawley's retainer, Begg wraparound retainers are very commonly used from many years.<sup>1</sup> These retainers are effective but had patient compliance issues which could end up in relapse. Bonded retainers attached to the lingual surface of maxillary and mandibular incisors were introduced specially for cases requiring retention following fixed orthodontic therapy.<sup>2</sup> The first account of using acid-etch technique for placement of bonded lingual retainers was given by Kneirim.<sup>3</sup> Bonded retainers provide a lot of benefits, including a lack of occlusal interferences and low patient compliance, but they also have drawbacks, such as difficulty adjusting the retainer and the danger of tooth movement due to wire distortion.

Many Orthodontists have utilised bands on the canines soldered to wires for years. It was first made of stainless steel round wire with a greater diameter (0.030–0.032 inch) that was solely attached to the lower canines' lingual surface.<sup>4</sup> The lower incisors were shown to shift labially when these retainers were placed.<sup>5</sup> Hence an archwire segment was attached on the lingual surfaces of all mandibular incisors, commencing at the canine and ending at the opposite side canine, to assure stability of orthodontic treatment outcomes over longer periods. Smaller diameter braided/coaxial round wires and rectangular wires of smaller cross section, made of varied composition of materials and resilience, bonded to all mandibular incisors were then introduced. It was observed that a multistrand wire would be flexible and allow physiologic tooth movement.<sup>4</sup> More recently, fibre-reinforced materials and ceramic (alumina) retainers have been used.<sup>6</sup>

Bond failure is another issue with bonded retainers, with a failure rate between 6 and 20%. This could be attributed to the type of retainer, the technique of placement and patient's motivation in maintaining the same.

Bonded lingual retainers, when compared to removable type retainers have been prone to accumulate plaque and calculus. Several long term studies have been done using different designs of retainers to determine the effects of placing a bonded retainer on the periodontal tissues. Depending on the type and method of placement of the retainers, varying findings were obtained.<sup>7,8</sup> Since these retainers are present inside the mouth for long periods of time, there is a need for further clarification on their effects on their surrounding soft and hard tissues. Therefore the aim of the present study was to evaluate and compare the periodontal condition and hygiene status of patients whose mandibular anterior teeth (canine to canine) were bonded using three types of bonded retainers over a period of one year.

## II. Materials and methods

### Study design

This was a randomized (1:1:1) multi-arm, active-controlled, parallel-group trial. The Ethical Approval Committee of Manipal College of Dental sciences, Mangalore, India, granted the study's ethical clearance after patients gave their permission to participate in the study (Protocol ref No.12025). The trial was conducted following the Declaration of Helsinki guidelines and the reporting has been done using CONSORT guidelines. After initiation, no changes were made in the methods. Consent was obtained in the written format from the participants before starting the trial.

### Participants, criteria of eligibility and study setting

Subjects participating in the trial were recruited from the individuals who had recently completed fixed mechanotherapy from Manipal College of dental sciences, Mangalore. The trial with initial recruitment which was started in October 2012, was completed in December 2015. The inclusion criteria were, subjects with: 1) all mandibular incisors and canines devoid of carious lesions or restorations, 2) healthy gingival status with < 3mm probing depth 3) who had a history of good oral hygiene maintenance throughout fixed mechanotherapy and those 4) having canine guided occlusion on both sides. Study participants chosen were adults, between 18 and 24 years of age.

Patients having active carious lesions, fractures or restorations of mandibular anterior teeth, deleterious habits like nail biting, lip biting etc, occlusal interferences, existing periodontal conditions, and those with extremely poor oral hygiene during treatment were excluded.

### Intervention

The patients were allocated in blocks of three or six to one of the three groups of the study in random. Pumice was utilized to cleanse the lingual surface of lower incisors using a revolving handpiece and rubbercup. The surface was etched for 15 to 20 seconds before being washed and dried with moisture-free air until it was icy white. While bonding canine and canine retainers, just the lingual surfaces of canines needs to be etched. A light-curing adhesive primer was applied to the teeth's etched surfaces (Transbond XT, 3M, USA). Before bonding, the teeth were blasted with dry air for 2 to 5 seconds. Group 1 was given a flexible coaxial wire lingual retainer made of 0.0195 inch wire was bonded onto lingual surface of mandibular anterior teeth.

In Group 2 subjects, a ie. a retainer bonded only to the canines on both sides of the lower arch and in Group 3, a Universal retainer (Desires Orthodontics, India) in the form of a continuous mesh, covering all six teeth from canine to canine, was bonded. (Figure 1) A Flowable light cure composite resin (Filtek XT, 3M Unitek, Monrovia USA) was used to bond all the three retainers. Bonding was done by the primary investigator.

**Figure.1** The different retainers used in the present study a) coaxial wire retainer made of 0.0195 inch wire, b) canine and canine bonded retainer made of 0.0215 inch plain wire, (custom made), bonded only to canines and c) continuous mesh retainer, bonded to all teeth from canine to canine.



**Outcome**

The following parameters were assessed at the following time intervals, ie. 1 week(T0), 3 months (T1), 6 months (T2) and 1 year(T3)from the day of placement of the retainers. Plaque index (PI)<sup>9</sup>,Gingival index(GI)<sup>10</sup>&Calculus index (CI)<sup>11</sup>was evaluated on both buccal and lingual surfaces of all anterior teeth by assessing and probing the gingiva.(Figure 2) The main parameter data for six mandibular anterior teeth were averaged, and a mean value was established for each participant. White spot lesions were evaluated using Ogaard’s visual inspection scale with the following scoring criteria; Score 1 : no white spot lesion, 2 : white spot lesion covering less than one third of the tooth surface,3 : white spot lesion covering more than one third of the enamel surface, 4 : white spot lesion with cavitation.<sup>12</sup>

**Figure.2** Scoring criteria for evaluation of Plaque, Gingival and Calculus indices

Scoring	Plaque index (Silness and Løe,1964)	Interpretation
0	Absence of plaque	0 - Excellent 0.1 - 0.9 - Good 1.0 - 1.9 - Fair 2.0 – 3.0 - Poor
1	Plaque disclosed after running probe along gingival margin	
2	Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin or adjacent tooth surface which can be seen by the naked eye	
3	Abundance of soft matter within the gingival pocket or on the gingival margin or adjacent tooth surface	
Scoring	Gingival Index (Løe and Silness,1963)	Interpretation
0	Absence of inflammation	0.1- 1.0 – Mild gingivitis 1.1 – 2.0 – Moderate gingivitis 2.1 – 3.0 – Severe gingivitis
1	Mild inflammation with a slight change in colour 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 and ulceration	
Scoring	Calculus index (OHI, Greene & Vermillion,1960)	Interpretation
0	Absence of calculus	0 -0.6 Good 0.7 – 1.8 Fair 1.9 – 3.0 Poor
1	Presence of calculus covering up to one-third of the tooth surface	
2	Presence of calculus covering up to two-thirds of the tooth surface and/or the presence of separate flecks of subgingival calculus	
3	Presence of calculus covering more than two thirds of the tooth surface and/or the presence of a continuous band of subgingival calculus	

**Sample size calculation**

Sample size was determined using previous literature as reference.<sup>7</sup>With an effect size of 0.4 and a power of 95% and  $\alpha$  of 0.05 were taken, the minimum possible sample yielded was 10 subjects in each group.

**Randomization**

The primary investigator was not involved during the randomization process. An allocation ratio of 1:1:1 was suitable and block randomisation was done. An allocation sequence was determined according to the patients’ case file numbers. The sequences were put in sealed envelopes and were randomly selected by the participants.

**Blinding**

Blinding of subjects, investigator and the person analysing data were not possible.

**Statistical methods**

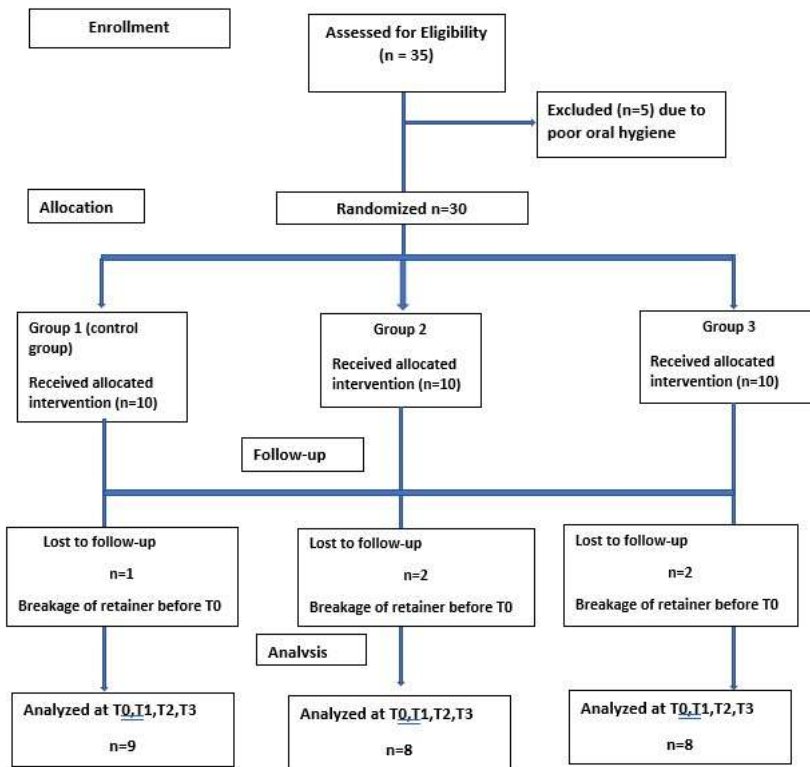
Statistical Package for Social Sciences (SPSS version 20) was made use of for performing test statistics. Descriptive statistics ie. the mean, standard deviation and confidence interval for mean were calculated for each group of samples tested. Significance of level was predetermined to a p value < 0.05.

**III. Results**

**Participant flow**

Figure 3 depicts the flowchart of eligibility assessment, randomization, allocation, and follow up. Those eligible according to the inclusion criteria, 30 patients were recruited for participation in the trial with 10 subjects in each retainer group. One patient from Group 1 and 2 patients each from Group 2 & 3 reported with breakage of retainer and hence were excluded from the study.

**Figure.3** CONSORT flow diagram of the participants' progress through different stages of the trial



**Baseline data**

Participants were comparable in terms of age, with a mean age of 21.84 ± 1.60 years. Sample consisted male and female participants with uniform distribution. (Table 1)

**Table 1** Description of Age and Gender among different groups. \*NS-Not significant

	N	Mean	Std. Deviation	ANOVA F value	p
Group 1	9	21.78	1.56	.010	.990
Group 2	8	21.88	1.64		NS
Group 3	8	21.88	1.81		
Total	25	21.84	1.60		

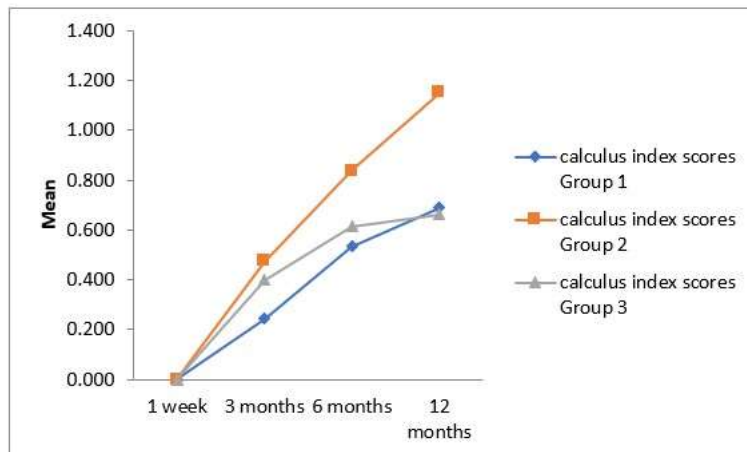
	Gender	n	percentage
Group 1	Male	4	44.4 %
	Female	5	55.6%
Group 2	Male	4	50%
	Female	4	50%
Group 3	Male	4	50%
	Female	4	50%

**Outcomes and estimation**

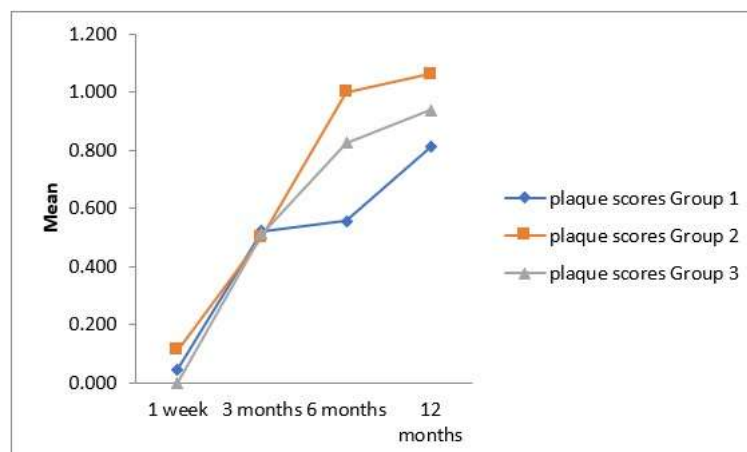
**Primary outcome**

Intragroup comparisons within each groups ie. Group 1, Group 2 and Group 3 showed significant increase in the calculus, plaque and gingival index scores from T0 to T3(p =0.001)(Graphs1,2,3). Post hoc analysis was performed to compare changes between each time intervals within all the groups.

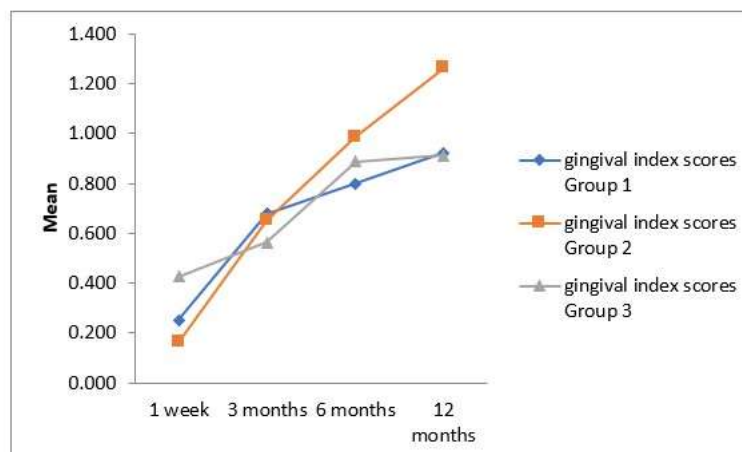
**Graph.1**Intragroup changes in Calculus index scores from T0(1 week) to T3(12 months)



**Graph.2**Intragroup changes in plaque index scores from T0(1 week) to T3(12 months)



**Graph.3** Intragroup changes in Gingival index scores from T0(1 week) to T3(12 months)



Intergroup comparison by Kruskal Wallis test showed no significant differences between three groups at any of the time intervals for calculus index( $p>0.05$ ). Hence post-hoc analysis was not performed. Intergroup comparison of plaque scores revealed significant differences between the three Groups at 6 months ( $p = 0.037$ ) (Table 2) and post hoc analysis showed significant difference at 6 months between Group 1 and Group 2 ( $p = 0.015$ ). Intergroup comparison for Gingival index showed significant differences between the Groups at 12 months (Table 2). Post hoc analysis revealed significant differences at 12 months between Group 1 and Group 3( $p = 0.003$ ) and Group 2 and Group 3 ( $p = 0.003$ ).

**Table.2 .Intergroup comparison of Gingival and Plaque index scores using Kruskal-Wallis test. (P<0.05 \*sig)**

			N	Mean	Std deviation	95% confidence interval for mean		Kruskal Wallis test value	p value
						Lower bound	Upper bound		
Gingival index	T3 (12 months)	Group 1	9	.922	.199	.770	1.075	7.900	0.019 sig
		Group 2	8	1.263	.277	1.031	1.494		
		Group 3	8	.913	.264	.692	1.133		
Plaque index	T2 (6 months)	Group 1	9	.556	.309	.318	0.793	6.583	0.037 sig
		Group 2	8	1.000	.351	.707	1.293		
		Group 3	8	.825	.191	.665	.985		

### Secondary outcome

White spot lesions or enamel decalcification were not encountered in any of the subjects during the course of the study period.

## IV. Discussion

Due of the closeness of free gingival margins to lingual retainers, biological responses are bound to occur<sup>7</sup>. Biofilms are more likely to form around resin-bonded sites, and the resulting plaque is calcified over time. Because of the cracks and niches, more biofilms are formed on multistrand retainers than on single strand retainers, as shown by Jongsma et al.<sup>13</sup> But in contrast, in this study, in all the three groups, an increase in plaque accumulation was noticed with the highest plaque scores recorded in Group 2 ie. Canine and canine bonded retainer at 6 months and 12 months. Even though dental hygiene instructions were given regularly, Stormann and Ehmer reported a 12- to 24-month period of increased plaque formation in the lower incisor area<sup>5</sup>.

At 6 months and 12 months, gingival inflammation was dramatically enhanced with regard to the mesh retainer and the spiral wire. Gingival index scores rose consistently in the canine and canine bonded retainer group, with a mean score of  $1.26 \pm 0.27$  at 12 months. Gingival recession was not encountered during the study period. This might be due to the relatively short time of the study as well as the inclusion criteria, ie. patients with healthy periodontium<sup>14</sup>. A 5 year study by Renkema et al observed no gingival recessions being encountered<sup>15</sup>. Levin et al had reported statistical findings in a comparison of groups with and without fixed orthodontic retainers in which the former showed larger values for gingival recession, , gingival index, plaque levels and bleeding on probing.<sup>14</sup>

Calculus deposition is directly dependant on the presence of retentive sites near the gingival margin. It also depends on the amount of salivary flow and also the level of oral hygiene maintainence by the patient<sup>4,16</sup>. Canine and canine retainer showed increased values for calculus accumulation ( $1.15 \pm 0.51$  at 12 months compared to spiral wire retainer ( $0.689 \pm 0.48$ ) and mesh retainer ( $0.663 \pm 0.15$ ). This might be due to retentive sites gingivally in this type of retainer which makes it difficult for patients to perform meticulous oral hygiene when the retainer is in place.

According to Artun et al, retainers bonded to each tooth prevents the toothbrush from reaching a small portion of interproximal areas.<sup>7,16</sup> Due to this, periodontal reactions to such retainers are expected to be more compared to retainers bonded to both canines only. But in contrast to the above mentioned study, this study shows increased values for all the studied parameters including the canine and canine bonded retainer. Hence it has to be assumed that the design of the wire may not be the only criteria affecting the gingival and oral hygiene

status. Oral hygiene levels, brushing techniques as well as dietary factors can play an important role in the gingival status associated with bonded retainers.

Since the results of the study suggest an increase in the plaque and calculus in all the retainer types, it can be assumed that the retainers might cause difficulty in maintaining a plaque and calculus free environment in the lower anterior region which is in contrast to the opinions by Pandis et al. The findings of the present study stresses on the importance of frequent recalls and close monitoring of patients wearing bonded retainers, a procedure often neglected by clinicians.

### **Limitations**

The duration of this study is 12 months which in comparison with previous studies for eg. Artunet al, Booth et al is short. Since the retainers can survive in the oral cavity for more than 3 years a longer follow up should be done to evaluate any detrimental effects of the retainers.<sup>7,8</sup> Also careful interpretation of the results is required since a lot of variables such as dietary factors, brushing techniques and patient motivation can affect the results. Further trials with a larger sample size and a follow up period which is longer than that of the present study is required to test the long term clinical effects of bonded lingual retainers.

### **V. Conclusions**

- The Gingival, plaque, and calculus indices significantly increased among all types of retainers over the research period.
- Canine and canine retainers were shown to have a higher tendency to accumulate calculus than wire and mesh retainers.
- The findings reinforce the importance of selection of appropriate design of bonded retainers, taking into consideration the individual hygiene status.

### **Patient consent declaration**

All participants have signed necessary consent papers, according to the authors. Patients' written permission has indeed been obtained before their images and related clinical data may be published by the journal

### **Declaration of conflicts of interest**

The authors declare that there are no conflicts of interest.

### **Financial support and sponsorship**

Nil

### **References**

- [1]. Shawesh M, Bhatti B, Usmani T, Mandall N. Hawley retainers full-or part-time? A randomized clinical trial. *Eur J Orthod.* 2010;32(2):165-70
- [2]. Kartal Y, Kaya B. Fixed orthodontic retainers: a review. *Turk J Orthod.* 2019;32(2):110-114.
- [3]. Nagani NI, Ahmed I, Tanveer F, Khurshheed HM, Farooqui WA. Clinical comparison of bond failure rate between two types of mandibular canine-canine bonded orthodontic retainers-a randomized clinical trial. *BMC Oral Health.* 2020;20(1):1-6
- [4]. Al-Nimri, K, Al Habashneh, R, &Obeidat, M. Gingival health and relapse tendency: a prospective study of two types of lower fixed retainers. *AustOrthod J.* 2009;25(2):146-150.
- [5]. Stormann I, Ehmer U. A prospective randomized study of different retainer types. *J OrofacOrthop.* 2002;63(1):42-50.
- [6]. Tacke, M. P., Cosyn, J., De Wilde, P., Aerts, J., Govaerts, E., &Vannet, B. V. Glass fibre reinforced versus multistranded bonded orthodontic retainers: a 2 year prospective multi-centre study. *Eur J Orthod.* 2010;32(2):117-123
- [7]. Artun J, Spadafora a T, Shapiro P a. A 3-year follow-up study of various types of orthodontic canine-to-canine retainers. *Eur J Orthod.* 1997;19(5):501-509.
- [8]. Booth, F. A., Edelman, J. M., &Proffit, W. R. Twenty-year follow-up of patients with permanently bonded mandibular canine-to-canine retainers. *Am J OrthodDentofacOrthop* 2008;133(1):70-76.
- [9]. Loe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontol.* 1967;38:610-616.
- [10]. Loe H SJ. Periodontal disease in pregnancy I. Prevalence and severity. *Acta Odontol.Scand.* 1963;21(6):533-551.
- [11]. Greene JC, Vermillion JR. The oral hygiene index: a method for classifying oral hygiene status. *J Am Dent Assoc.* 1960;61(2):172-179.
- [12]. Øgaard B. Prevalence of white spot lesions in 19-year-olds: A study on untreated and orthodontically treated persons 5 years after treatment. *Am J OrthodDentofacOrthop.* 1989;96(5):423-427. doi:10.1016/0889-5406(89)90327-2
- [13]. Jongsma MA, Pelser FDH, Mei HC Van Der. Biofilm formation on stainless steel and gold wires for bonded retainers in vitro and in vivo and their susceptibility to oral antimicrobials. *Clin Oral Investig.* 2013;17(4):1209-1218.
- [14]. Levin L, Samorodnitsky-Naveh GR, Machtei EE. The Association of Orthodontic Treatment and Fixed Retainers With Gingival Health. *J Periodontol.* 2008;79(11):2087-2092.
- [15]. Renkema AM, Fudalej PS, Renkema A, Kiekens R, Katsaros C. Development of labial gingival recessions in orthodontically treated patients. *Am J OrthodDentofacOrthop* 2014;143(2):206-212.
- [16]. Artun J, Spadafora a T, Shapiro P a, 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.
- [17]. Pandis N, Vlahopoulos K, Madianos P, Eliades T. Long-term periodontal status of patients with mandibular lingual fixed retention. *Eur J Orthod.* 2007;29(5):471-476.