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Bleeding on Probing Associated with Two Different Bonded Fixed Retainers: A 12-Month Evaluation

Jeta Kiseri Kubati[1*], Diona Panxhaj[1], Gabriela Kjurchieva Cuckova[2], Luis Pablo Cruz-Hervert[3]

[1]*Orthodontic Department, Dental Faculty, UBT Kolegji, Prishtina, Kosovo*
[2]*Orthodontic Department, Ss. Cyril and Methodius University in Skopje Faculty of Dentistry, Skopje, North Macedonia.*
[3]*Faculty of Dentistry, National Autonomous University of Mexico, Mexico City, Mexico*

Abstract

Background: Orthodontic retention is critical to preserving treatment results and preventing relapses. Fixed retainers, while effective, have been associated with plaque accumulation and gingival inflammation. This study assessed bleeding on probing (BOP) in patients using different retainer designs. The aim is to compare the periodontal impact—specifically bleeding on probing—of two different designs of fixed retainers bonded to the mandibular anterior teeth over 12 months.
Methods and Results: Sixty patients (age 16–25) completing orthodontic treatment were randomly assigned to receive either a flat (FR) or round (RR) NiTi retainer. BOP was assessed at 3, 6, 9, and 12 months using a standardized periodontal probe. Data were analyzed using SPSS 22.0 with Chi-square and Mann–Whitney U tests, considering $P<0.05$ as significant.
At 3 months, the FR group showed significantly lower BOP than the RR group ($P = 0.024$). Differences at 6 and 9 months were not statistically significant. At 12 months, BOP was again significantly higher in the RR group ($P = 0.001$). Intra-group changes over time were not significant for either group. The FR group consistently presented lower BOP means at all time points.
Conclusion: Flat fixed retainers resulted in significantly lower BOP at early and late follow-up, suggesting a potentially more favorable periodontal response. Long-term monitoring and individualized hygiene reinforcement remain essential in retainer management.(**International Journal of Biomedicine. 2026;16(2):253-258.**)

Keywords: orthodontic retention • bonded fixed retainers • bleeding on probing • periodontal response

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Introduction

Orthodontic retention is a key part of modern care and is planned for nearly every patient, regardless of age, malocclusion, or appliance. This is because relapse is likely without retention, and long-term aesthetic and functional stability is increasingly emphasized.[1,2] Many orthodontists recommend lifelong retention to maintain treatment results, since teeth may relapse due to occlusal forces, soft-tissue pressures, and ongoing craniofacial growth.[3] Retention is typically provided with bonded lingual fixed retainers or removable vacuum-formed retainers, often worn canine-to-canine in either arch, with selection tailored to the treatment plan, malocclusion, age, and other factors.[4] Fixed retainers differ in design and materials, ranging from stainless steel and nickel-titanium to newer CAD/CAM-milled and fiber-reinforced composites.[5] Despite these advancements, all types share a common limitation: they lie against the tooth surface and may disrupt proper oral hygiene practices. This physical presence often promotes plaque and calculus accumulation in the retainer region, which may compromise periodontal health over time and eventually provoke bleeding on probing (BOP) during the retention phase.[6]

There is ongoing debate about the long-term effects of fixed retainers on oral hygiene and periodontal outcomes. While some studies show increased plaque retention and gingival inflammation, others report no significant periodontal damage, even with prolonged use.[7,8] For example, Levin et al. observed higher rates of plaque accumulation, gingival recession, and BOP in patients with fixed retainers.[9] Conversely, Rody et

al.[10] and Booth et al.[11] reported no significant periodontal impact after years of fixed retention.

Given this conflicting evidence, our study aimed to compare periodontal outcomes, specifically BOP, between two different designs of bonded fixed retainers.

The objective was to investigate whether the design and dimension of these retainers affect BOP of lingual surfaces of the lower incisor region in the mandible, after orthodontic treatment during the first years of retention. Our null hypothesis was that all fixed retainers provoke similar periodontal responses after long-term use. Our working hypothesis is that the flat prefabricated NiTi retainer has a more favorable impact on periodontal health than the round multistranded NiTi retainer.

Material and Methods

This study received ethical approval from the Ethical Committee of the Kosova Dental Chamber (Approval No. 04/L-150-23-12/2021). Throughout the process, we adhered to the ethical principles outlined in the Declaration of Helsinki to ensure the study was conducted with respect and integrity.

Study Design and Participants

A total of 60 subjects (aged 16–25 years), who had recently completed fixed orthodontic treatment at the UBT College Dental Faculty, Orthodontic Department (Kosovo), were enrolled at the start of their retention phase. All participants signed an informed consent form. In individuals younger than 18, written informed consent to participate was obtained from their parents or legal guardians. Participants were randomly allocated into two groups, each receiving a different type of fixed retainer bonded to the lingual surfaces of the six lower anterior teeth (canine to canine) (Figure 1):

- Group 1 (n=30) received a flat, prefabricated nickel-titanium retainer (FR) (0.010″×0.029″, four-strand twist) manufactured by FORESTADENT, Germany.
- Group 2 (n=30) received a multistranded round nickel-titanium retainer (RR) (ø0.44mm/17″), manufactured by DENTAURUM, Germany.

(a) (b)

Fig. 1. *(a) FR- Flat retainer; (b) RR- Round retainer.*

All retainers were bonded by the same experienced orthodontist, using a standardized protocol.

Inclusion criteria: Patients completing full fixed appliance treatment with no mandibular extractions during treatment or the 12-month follow-up; intact lower anterior segment (no caries/restorations/crowns/bridges); no parafunctional habits or occlusal interferences; no IPR or supracrestal fiberotomy; and no syndromic conditions. Exclusion criteria: Missed follow-up visits, prosthetic treatment during the study period, smoking, or functional habits (e.g., bruxism or tongue thrust).

Procedure and Clinical Assessment

All bonding procedures followed a uniform protocol, including tooth cleaning, etching, and adhesive application over retainer wire. The primary outcome was BOP, evaluated in the intercanine region (from tooth 33 to 43) at 3, 6, 9, and 12 months. At each follow-up appointment, patients were reminded and encouraged to maintain proper oral hygiene. BOP was assessed using a periodontal probe (NC 15, HuFriedy), and the number of teeth with BOP among the six lower anterior teeth was recorded. Bleeding on probing was visually assessed as the proportion of sites that were bleeding 30 s after 6 sites per tooth were probed[12] (Figure 2).

Fig. 2. *Measurement of BOP indices after (a) 3months, (b) 6 months, (c) 9 months, and (d) 12 months of observation period with bonded flat retainer.*

Statistical Analysis: All data collected in the study were analyzed using SPSS software, version 22.0 for Windows, and the findings were presented in tables and graphs. Categorical variables (such as yes/no responses) were summarized using frequencies and percentages, while numerical data (e.g., age or clinical measurements) were described using means, medians, ranges (minimum and maximum values), and standard deviations to indicate variability. Prior to conducting group comparisons, the Shapiro–Wilk test was used to assess whether the numerical data followed a normal distribution. For statistical analysis, the Chi-square test was applied to

examine associations between categorical variables, and odds ratios (OR) were calculated to estimate the likelihood of outcomes between groups. Differences in proportions were assessed using a test for proportion differences. For numerical variables that did not meet the assumption of normality, the Mann–Whitney U test was used. All tests were two-sided, and results were considered statistically significant if $P<0.05$.

Results

Gender Distribution

In the FR (flat retainer) group, 11 participants were male (36.7%), and 19 were female (63.3%), resulting in a male-to-female ratio of 0.58:1. In the RR (round retainer) group, 7 participants were male (23.3%), and 23 were female (76.7%), with a male-to-female ratio of 0.30:1. Chi-square test results showed no significant association between gender and group allocation ($\chi^2 = 1.269$; df = 1; $P = 0.259$) (Table 1)

Table 1.

Analysis of study groups by gender.

Gender	Groups		Statistics*
	FR	RR	
Total (n=60)			
Male	11 (36.7%)	7 (23.3%)	$\chi^2 = 1.269$ df = 1 $P = 0.259$
Female	19 (63.3%)	23 (76.7%)	
Difference test:	$P = 0.0410$	$P = 0.0001$	
*Mann-Whitney U Test			

Bleeding on probing was assessed on the six lower anterior teeth (intercanine region). For each participant, the number of teeth showing bleeding during probing was recorded. The presence of bleeding was analyzed at each of the four follow-up visits for both groups (FR and RR).

Data Distribution and Statistical Approach

The distribution of BOP values at all four time points did not follow a normal distribution, as confirmed by the Shapiro-Wilk test:

- 3 months: W = 0.9088, $P = 0.0003$
- 6 months: W = 0.9278, $P = 0.0016$
- 9 months: W = 0.9048, $P = 0.0002$
- 12 months: W = 0.8902, $P = 0.0001$

As a result, non-parametric statistical tests were applied for both intra-group (within FR or RR groups over time) and inter-group (FR vs. RR at each time point) analyses of BOP (Graph 1).

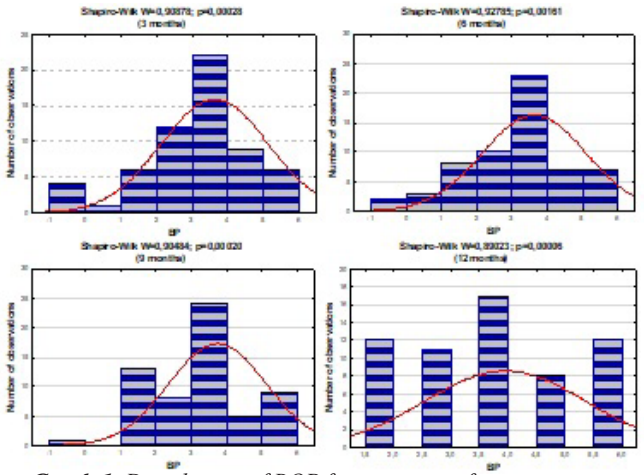
Intragroup Comparison of BOP

In the FR group, the lowest BOP was observed at 3 months (mean: 3.20±1.58; median: 3.00). A slight increase was noted at 6 and 9 months, with a median of 4.00 at both time points. By 12 months, BOP slightly decreased again (mean: 3.37±1.21). No significant difference was observed across time points (Friedman Test, $\chi^2 = 0.622$, $P = 0.891$).

In the RR group, BOP values were fairly stable during the first three time points, with a median of 4.00. At 12 months, BOP increased noticeably (mean: 4.53±1.33; median: 5.00). The increase was borderline non-significant across time points (Friedman Test, $\chi^2 = 7.758$, $P = 0.051$). (Table 2 and Graph 2).

Intergroup Comparison of BOP

Intergroup comparisons were made at each of the four follow-up time points (Table 3, Graph 3). At 3 months, BOP was significantly higher in the RR group than the FR group ($P = 0.024$). At 6 and 9 months, no statistically significant differences were observed. At 12 months, BOP was again significantly higher in the RR group ($P = 0.001$), indicating a possible long-term periodontal impact of the round retainer.

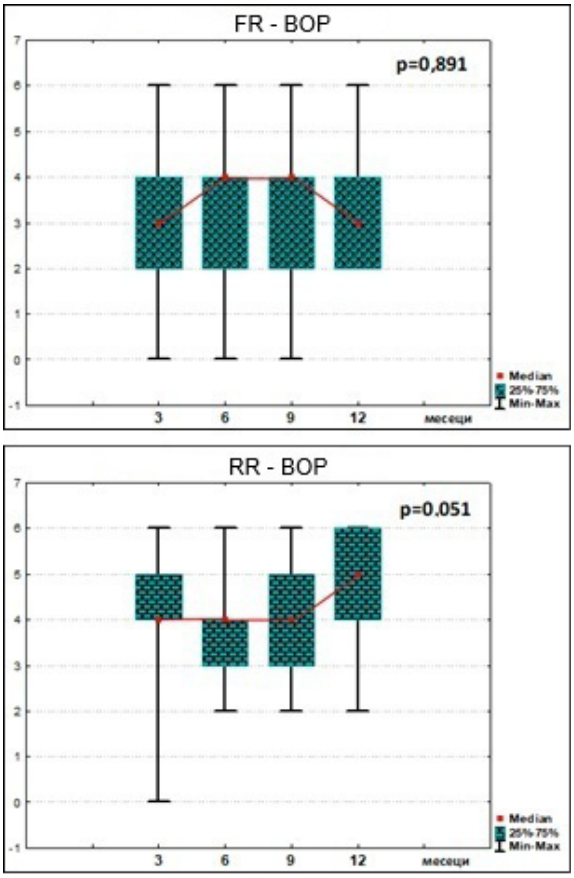


Graph 1. *Distribution of BOP frequencies at four time points.*

Table 2.

Intragroup comparison of BOP at four time points.

Intragroup comparison	Bleeding on probing - BOP					Statistics*
	n	Mean± SD	(Min/ Max)	Median (IQR)	Mean Rank	
FR						
3 months	30	3.20±1.58	0.00/6.00	3.00 (2.00-4.00)	2.42	χ^2=0.622 df=3 P=0.891
6 months	30	3.40±1.73	0.00/6.00	4.00 (2.00-4.25)	2.58	
9 months	30	3.47±1.36	0.00/6.00	4.00 (2.00-4.00)	2.58	
12 months	30	3.37±1.21	2.00/6.00	3.00 (2.00-4.00)	2.42	
RR						
3 months	30	4.07±1.31	0.00/6.00	4.00 (3.75-5.00)	2.50	χ^2=7.758 df=3 P=0.0.51
6 months	30	3.87±1.13	2.00/6.00	4.00 (3.00-4.25)	2.27	
9 months	30	4.03±1.38	2.00/6.00	4.00 (3.00-5.00)	2.40	
12 months	30	4.53±1.33	2.00/6.00	5.00 (4.00-6.00)	2.93	
*Friedman Test; IQR - Interquartile Range.						



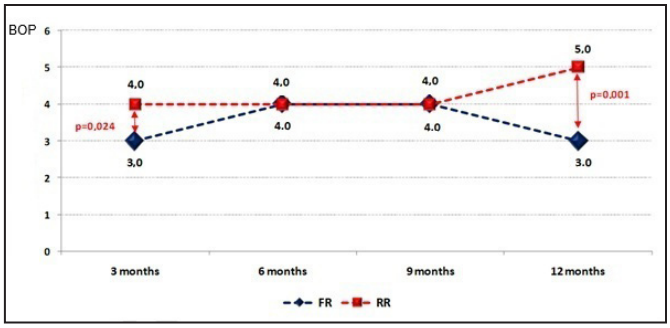
Graph 2. *Intragroup comparison of BOP at four time points (FR and RR groups)*

Table 3.

Intergroup comparison of BOP at four time points.

Intergroup comparison	Bleeding on probing (BOP)						
	n	Mean± SD	Min/ Max	IQR			Statistics*
				Q1	Q2	Q3h	
3 months							
FR	30	3.20±1.58	0.00/6.00	2.00	3.00	4.00	Z=-2.262 *P*=0.024
RR	30	4.07±1.31	0.00/6.00	3.75	4.00	5.00	
6 months							
FR	30	3.40±1.73	0.00/6.00	2.00	4.00	4.25	Z=-0.997 *P*=0.375
RR	30	3.87±1.13	2.00/6.00	3.00	4.00	4.25	
9 months							
FR	30	3.47±1.36	0.00/6.00	2.00	4.00	4.00	Z=-1.478 *P*=0.179
RR	30	4.03±1.38	2.00/6.00	3.00	4.00	5.00	
12 months							
FR	30	3.37±1.21	2.00/6.00	2.00	3.00	4.00	Z=-3.238 *P*=0.001
RR	30	4.53±1.33	2.00/6.00	4.00	5.00	6.00	

Mann-Whitney U Test; IQR - Interquartile Range; Q2- Median.



Graph 3. *Comparison of the BOP median value by study groups at four time points.*

Discussion

This study aimed to examine how two types of bonded fixed nickel-titanium orthodontic retainers—flat and round—affect bleeding on probing over a 12-month period. The first hypothesis, that both retainer types induce a periodontal response, can be accepted. The second hypothesis—that flat retainers lead to a milder periodontal response than round ones—can only be partially supported. Our findings demonstrated significantly higher BOP in the RR group compared to the flat retainer (FR) group at 3 months (P = 0.024) and again at 12 months (P = 0.001). No statistically significant differences were observed at 6 and 9 months. These results align with previous research by Levin et al. (9), who found higher BOP in patients with bonded retainers than in those without, although they did not differentiate between types of retainers. Levin et al. (9) also noted that participants' younger age might mask stronger differences observed in older populations. Hence, placing bonded retainers as far from the gingival margin as possible is advised to reduce plaque retention and bleeding risk.

In our study, BOP was recorded as a "yes" or "no" response, regardless of bleeding severity or speed following probing. While this binary system allowed for standardized data collection, it did not account for differences in bleeding intensity or onset. Future studies should consider using a graded scale (e.g., mild, moderate, severe) to capture the variability in clinical presentation. Our findings are consistent with Knaup et al.,[13] who observed higher BOP, plaque index (PI), and gingival index (GI) in patients with 0.0175-in round retainers than in those with digitally printed flat retainers—similar to the FR used in our study. Storey et al.[14] also reported increased periodontal indices, including BOP, with 0.0195-in round stainless steel retainers at 1-year follow-up. These findings support the notion that wire type and thickness can influence periodontal health, even when the design is the only difference. However, Buzzatta et al.[15] emphasized that existing studies comparing flat and round retainers are limited by small sample sizes, short follow-ups, and variability in wire type and bonding method. In contrast, other studies found no significant differences in periodontal health between flat and multistranded wires, which may reflect inconsistencies in study design, patient behavior, or measurement tools.[16,17]

Although many studies assess periodontal health in patients with bonded retainers, very few specifically evaluate retainer designs that allow or obstruct interproximal flossing. This is an important gap, as numerous studies have reported that bonded fixed retainers may contribute to increased plaque and calculus accumulation and gingival inflammation. Conversely, several studies have not found any negative impact on periodontal parameters. Factors such as periodontal phenotype, brushing habits, oral hygiene motivation, and toothbrush type all play critical roles. For instance, Corbett et al.[18] found no clinical difference in gingival health between flat and round retainers over a 2–4 year period. The authors speculated that the lack of difference may be due to patients being better educated about the potential oral hygiene challenges associated with retainers, thus improving compliance—especially in the mandibular arch. Similarly, J. Artun[7] found no negative effects of bonded retainers on teeth or surrounding hard/soft tissues, even after up to 8 years of wear. Nevertheless, it is widely acknowledged that fixed retainers complicate daily hygiene routines. Therefore, patients must be thoroughly instructed in proper retainer care, including the use of interdental cleaning devices.[19]

The patient's motivation is a crucial factor in maintaining hygiene while using bonded retainers. Improper bonding (e.g., on every anterior tooth) can impede toothbrush access, reduce the effectiveness of flossing, and ultimately lower compliance and oral health.[20,21]

Limitations

This study has several limitations, including a relatively small sample size, a 12-month follow-up period, and a monocentric design, which may limit the generalizability of the findings. Additionally, variations in individual oral hygiene practices and the absence of long-term assessments beyond one year may have influenced the observed periodontal outcomes.

However, close monitoring protocols are essential for patients with bonded fixed retainers. Periodontal parameters tended to rise in both groups during the 12-month observation period, underscoring the need for regular follow-ups and reinforced oral hygiene instruction.

AI Statement

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Author Contributions

Jeta Kiseri Kubati: Investigation, Methodology, Data curation, Writing – original draft.
Diona Panxhaj: Methodology, Data analysis/Interpretation
Gabriela Kjurciceva Cuckova: Methodology, Writing – original draft
Luis Pablo Cruz-Hervert: Supervision, Data interpretation, Formal analysis, Writing – review and editing.

All authors have approved the final article.

Competing Interests

The authors have declared no conflict of interest.

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***Corresponding author:** Jeta Kiseri Kubati. E-mail: jeta.kubati@ubt-uni.net.*