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CLINICAL AND COMPARATIVE STUDY TO EVALUATE THE EFFECT OF DIFFERENT LINGUAL RETAINERS ON PERIODONTAL HEALTH AND STABILITY USING ONE-STEP AND TWO-STEP BONDING TECHNIQUES

Dr Harsheeta Trivedi[1*], Dr Karamdeep Singh Ahluwalia[2], Dr Vijay Agarwal[3], Dr Hari Narayan Choudhary[4], Dr Shivangi Chauhan[5], Dr Karuna Najiar[6]

[1*]Post Graduate, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, MVGU, Jaipur, Rajasthan, India. ORCID ID: 0009000044703275
[2]Professor, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, MVGU, Jaipur, Rajasthan, India
[3]Professor and Head, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, MVGU, Jaipur, Rajasthan, India
[4]Reader, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, MVGU, Jaipur, Rajasthan, India
[5]Sr. Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College,MVGU Jaipur, Rajasthan, India
[6]Post Graduate, Department of Orthodontics and Dentofacial Orthopaedics, Jaipur Dental College, MVGU, Jaipur, Rajasthan, India

ABSTRACT

Background: The retention phase in orthodontics involves the mechanical stabilisation of teeth to facilitate the reorganisation of alveolar bone, musculature, and periodontal tissues. Protocols are determined by the initial malocclusion, ranging from self-stabilising cases, such as corrected crossbites, to high-risk scenarios like diastema closures and severe rotations that often require permanent stabilisation.

Objectives: This study assesses the long-term effects of fibre-reinforced composite (FRC) and multistranded stainless steel (SS) retainers on periodontal health, as well as the impact of one-step versus two-step bonding techniques on failure rates.

Methods: Sixty participants were selected and divided into four groups (n=15 each) based on the retainer material and adhesive used. Periodontal parameters, including the Gingival Index (GI) and Plaque Index (PI), were assessed at different time points: baseline (T0), 1 month (T1), and 3 months (T2).

Statistical analysis included the Friedman test, Wilcoxon signed-rank post-hoc tests, Kruskal-Wallis test, the Mann-Whitney U-test and Chi-square test.

Results: A significant Reduction in GI and PI scores was observed across all groups post-debonding ($p < 0.01$). Intergroup analysis revealed no statistically significant difference in bond failure rates between materials or adhesive protocols ($p < 0.05$).

Conclusions: Both materials and bonding protocols demonstrate clinical efficacy. One-step Universal adhesives can also serve as alternatives for orthodontic retention.

KEYWORDS: Orthodontic Retainers, Stainless Steel, Composite Resins, Dental Bonding, Treatment Failure, Mandible, Tooth Movement Techniques, Periodontal Index.

INTRODUCTION

The retention phase in orthodontics involves the mechanical stabilisation of teeth to facilitate the reorganisation of alveolar bone, musculature, and periodontal tissues.1 It aims for "Absolute Retention"—the point of physiological equilibrium where dental stability is maintained without artificial support. Biological integration is the primary goal, while mechanical retention remains essential to provide the necessary time for bone remodelling to occur. Protocols are determined by the initial malocclusion, ranging from self-stabilising cases, such as corrected crossbites, to high-risk scenarios like diastema closures and severe rotations that often require permanent stabilisation.3

In adult patients, retention strategies must be particularly robust to counter age-related reduction in periodontal support and increased soft-tissue pressures.4 However, fixed retainers often act as plaque traps, triggering chronic gingival inflammation, recession, and bone loss. This study compares the longitudinal periodontal effects and bond failure rates of multistranded stainless steel wires versus
fibre-reinforced splints. These materials are
evaluated using both one-step and two-step bonding techniques to determine the most effective protocol for maintaining post-treatment stability without compromising periodontal health.

2. MATERIALS AND METHODS

2.1 Study Design and Ethical Approval

The planned study was conducted at the Department of Orthodontics and dentofacial orthopaedics, Jaipur Dental College ,MVGU. Patients were informed about the study, and the details were explained. Written consent was taken from those patients.

2.2 Sample Selection and Group Allocation

A sample of 60 patients and were divided into four groups. Steps involved were:

1. Upon the conclusion of active fixed orthodontic therapy characterised by the successful attainment of levelling and alignment goals, eligible patients were recruited for the study according to the established inclusion criteria.
2. A sample of 60 patients was selected and divided into four groups, each consisting of 15 patients.
3. Group I -consisted of patients with a fibre splint retainer wire, with one-step bonding agent, which was bonded on the lingual side of lower anteriors.
4. Group II- consisted of patients, fibre splint retainer wire with two step bonding agent was bonded on the lingual side of lower anteriors .
5. Group III – consisted of patients with a multistranded stainless steel retainer with one-step bonding agents that was bonded on the lingual side of lower anteriors.
6. Group IV consisted of patients with a multistranded stainless steel retainer with two-step bonding agents, which was bonded on the lingual side of the lower anteriors.
7. Gingival index, plaque index and bleeding on probing were checked before the placement and 1,3 months after the placement. Also, the failure rate of bonding will be compared with other groups.
8. Patients were asked to report immediately if there was any failure of retainers.

Inclusion criteria

1. Patients who were willing to participate in the study and provided consent.
2. Individuals with no history of systemic illness or pre-existing periodontal disease. 3. Absence of any extracted or missing teeth in the anterior segment.
4. Patients aged between 18 and 30 years at the time of the study.
5. No prior history of orthodontic intervention
6. Patients treated using a Pre-adjusted Edgewise Appliance (PEA) with an MBT 0.022-inch slot system made of stainless steel.

Exclusion criteria

1. Patients unwilling or unable to come for follow-up appointments.
2. Individuals presenting with a high caries index.
3. Pregnant women- potential physiological changes in periodontal tissues.
4. Patients having neuromuscular disorders affect oral hygiene maintenance or appliance stability.
5. Children with disabilities.

2.3 Statistical Analysis

All results with respect to this study were tabulated, and the data were analysed using SPSS (version 25; IBM Corp., Armonk, N.Y.). Time-dependent changes in periodontal parameters were analysed using the Friedman and Wilcoxon tests to evaluate differences within the groups.

The Kruskal-Wallis and Mann-Whitney U-tests were used to compare periodontal parameters among and between the groups.

The failure rates were evaluated using the chi-square test.

3. RESULTS

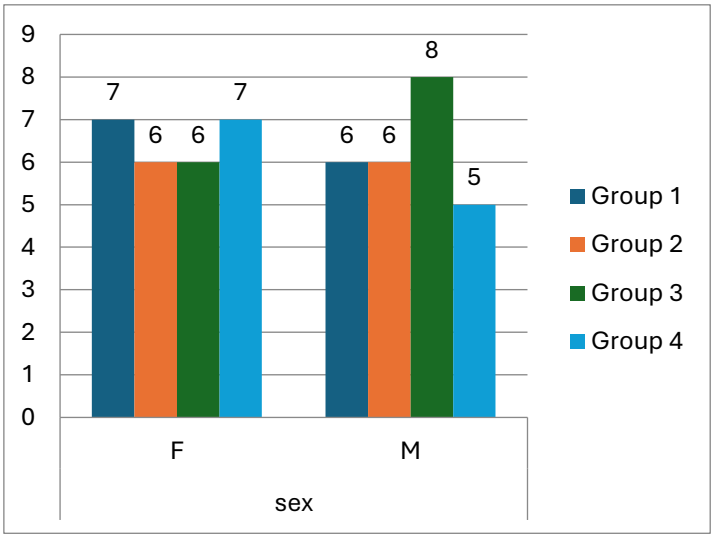

Figure 1. Number of males and females in each group

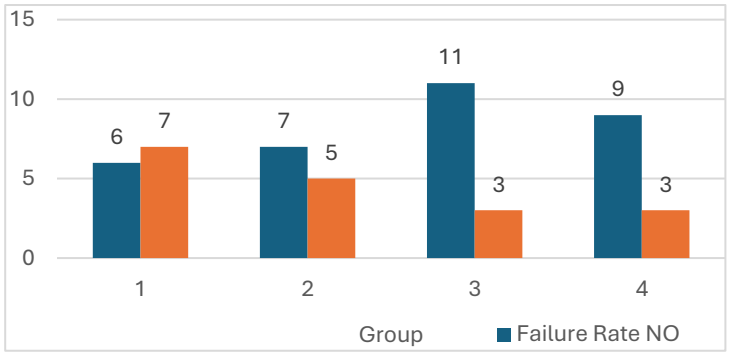

Figure 2. Intergroup failure rates

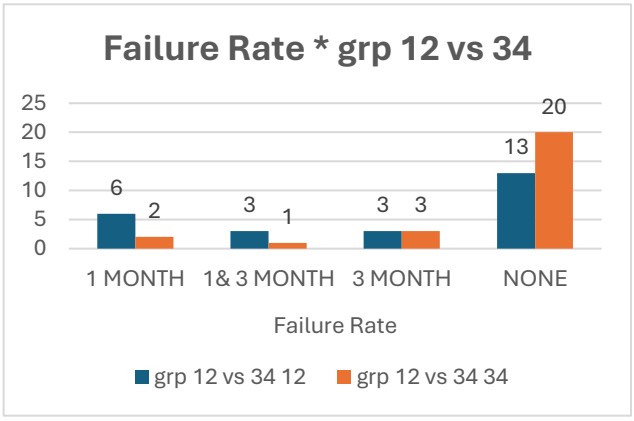

Figure 3. Intergroup failure rates comparison between group 1 and 2 vs group 3 and 4

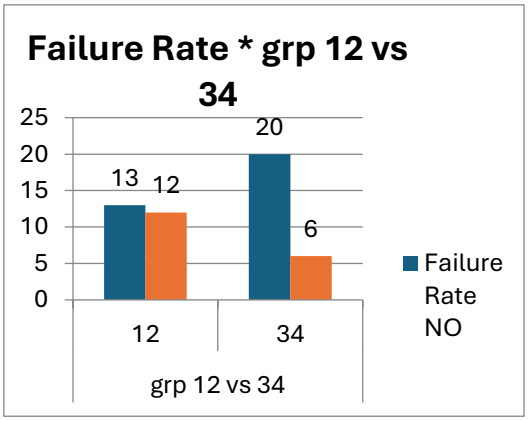

Figure 4. Intergroup failure rates comparison between groups 1 and 2 vs groups 3 and 4

Intragroup comparison tables for GI & PI at before,1 month &3 month (friedman & Wilcoxon test):- GROUP 1

Table 1. Intra group comparison of GI & PI between before, 1M and 3M of group 1

	N	Mean	Std. Deviation	Minimum	Maximum	Median	Mean rank	Chi-Square value	p-value of Friedman Test
GI before	13	1.306154	0.3170578	0.8100	1.8000	1.170000	2.92	24.154	0.000**
GI 1M	13	1.153846	1.1794670	0.5300	5.0000	0.830000	2.08		
GI 3 M	13	0.593846	0.2449333	0.3500	1.0000	0.510000	1.00		
PI before	13	1.056923	0.2132832	0.6400	1.5500	1.080000	3.00	24.154	0.000**

PI 1 M	13	0.614615	0.1695393	0.3900	0.8200	0.670000	1.92		
PI 3M	13	0.441538	0.1924771	0.2600	1.0000	0.370000	1.08		

There was a statistically highly significant difference seen ($p<0.01$) in GI & PI between before, 1M and 3M with higher values at before .
GROUP 2

Table 2. Intra-group comparison of GI & PI between before, 1M and 3M of group

	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Median**	**Mean rank**	**Chi-Square value**	**p-value of Friedman Test**
GI before	12	1.134167	0.3824671	0.3300	1.7500	1.200000	3.00	24.000	0.000**
GI 1M	12	0.794167	0.2888050	0.3000	1.3000	0.830000	2.00		
GI 3 M	12	0.570000	0.2150264	0.2200	1.1000	0.560000	1.00		
PI before	12	0.918333	0.3626627	0.1900	1.5000	0.915000	2.96	20.723	0.000**
PI 1 M	12	0.596667	0.2258050	0.1600	1.0000	0.540000	1.92		
PI 3M	12	0.415833	0.1130131	0.1900	0.5400	0.450000	1.13		

There was a statistically highly significant difference seen ($p<0.01$) in GI &PI between before, 1M and 3M, with higher values at before.
GROUP 3

Table 3. Intra group comparison of GI & PI between before, 1M and 3M of group 3

	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Median**	**Mean rank**	**Chi-Square value**	**p-value of Friedman Test**
GI before	14	1.173571	0.3825744	0.3300	1.8700	1.215000	3.00	27.527	0.000**
GI 1M	14	0.735714	0.2725581	0.3000	1.1400	0.665000	1.96		
GI 3 M	14	0.525714	0.1827446	0.2600	1.0000	0.460000	1.04		
PI before	14	0.950714	0.3495594	0.1800	1.5800	0.950000	2.86	20.109	0.000**
PI 1 M	14	0.544286	0.2004884	0.2000	1.0000	0.505000	1.96		
PI 3M	14	0.381429	0.1051634	0.2000	0.5200	0.370000	1.18		

There was a statistically highly significant difference seen ($p<0.01$) in GI &PI between before, 1M and 3M with higher values before.
GROUP 4

Table 4. Intra group comparison of GI & PI between before, 1M and 3M of group 4

	N	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Median**	**Mean rank**	**Chi-Square value**	**p-value of Friedman Test**
GI before	12	1.335000	0.2943251	1.0100	1.8500	1.320000	2.92	22.167	0.000**
GI 1M	12	0.887500	0.4202624	0.5000	2.0000	0.810000	2.08		
GI 3 M	12	0.567500	0.2283588	0.3700	1.2600	0.500000	1.00		

PI before	12	1.111667	0.2982017	0.6200	1.5700	1.170000	3.00	24.000	0.000**
PI 1 M	12	0.635833	0.1969522	0.4200	0.9700	0.590000	2.00		
PI 3M	12	0.398333	0.1110146	0.2600	0.5600	0.350000	1.00		

There was a statistically highly significant difference seen ($p<0.01$) in GI & PI between before, 1M and 3M, with higher values at before

Intergroup Comparison using Kruskal-Wallis Test:

Table 5. Inter group comparison of GI and PI at before, 1M, 3M, Bto1M, B to3M and 1Mto3M in 1, 2, 3 and 4 groups Kruskal-Wallis Test

		N	Mean	Std. Deviation	Median	Mean Rank	Chi-square value	p-value of Kruskal-Wallis Test
GI before	1	13	1.306154	0.3170578	1.17	27.15	1.071	0.784#
	2	12	1.134167	0.3824671	1.2	23.50		
	3	14	1.173571	0.3825744	1.215	24.46		
	4	12	1.335000	0.2943251	1.32	29.04		
GI 1M	1	13	1.153846	1.1794670	0.83	29.58	1.898	0.594#
	2	12	0.794167	0.2888050	0.83	25.96		
	3	14	0.735714	0.2725581	0.665	21.86		
	4	12	0.887500	0.4202624	0.81	27.00		
GI 3 M	1	13	0.593846	0.2449333	0.51	26.00	0.861	0.835#
	2	12	0.570000	0.2150264	0.56	29.04		
	3	14	0.525714	0.1827446	0.46	23.64		
	4	12	0.567500	0.2283588	0.50	25.71		
GI Bto1M	1	13	0.152308	1.2490673	0.54	28.65	2.604	0.457#
	2	12	0.340000	0.2248232	0.295	20.04		
	3	14	0.437857	0.2195512	0.43	27.04		
	4	12	0.447500	0.2222253	0.49	27.88		
GI Bto3M	1	13	0.712308	0.1300739	0.73	27.96	2.444	0.485#
	2	12	0.564167	0.3266763	0.605	20.50		
	3	14	0.647857	0.3028373	0.675	26.11		
	4	12	0.767500	0.2356471	0.655	29.25		
GI 1Mto3M	1	13	0.560000	1.2082701	0.2	28.42	2.100	0.552#
	2	12	0.224167	0.1687095	0.195	24.38		
	3	14	0.210000	0.2025605	0.16	22.14		
	4	12	0.320000	0.2456161	0.25	29.50		
PI before	1	13	1.056923	0.2132832	1.08	27.23	2.282	0.516#
	2	12	0.918333	0.3626627	0.915	22.58		
	3	14	0.950714	0.3495594	0.95	23.71		
	4	12	1.111667	0.2982017	1.17	30.75		
PI 1 M	1	13	0.614615	0.1695393	0.67	26.77	1.384	0.709#
	2	12	0.596667	0.2258050	0.54	27.50		
	3	14	0.544286	0.2004884	0.505	22.11		

	4	12	0.635833	0.1969522	0.59	28.21		
PI 3M	1	13	0.441538	0.1924771	0.37	26.15	0.369	0.947#
	2	12	0.415833	0.1130131	0.45	27.92		
	3	14	0.381429	0.1051634	0.37	24.39		
	4	12	0.398333	0.1110146	0.35	25.79		
PI Bto1M	1	13	0.442308	0.1729718	0.42	27.65	3.641	0.303#
	2	12	0.321667	0.1940868	0.36	19.50		
	3	14	0.406429	0.2112821	0.415	26.04		
	4	12	0.475833	0.2050924	0.465	30.67		
PI Bto3M	1	13	0.615385	0.1941484	0.63	25.15	4.053	0.256#
	2	12	0.502500	0.2846729	0.51	20.71		
	3	14	0.569286	0.2891224	0.645	25.54		
	4	12	0.713333	0.2401641	0.72	32.75		
PI 1Mto3M	1	13	0.173077	0.1432588	0.16	26.50	2.392	0.495#
	2	12	0.180833	0.1499975	0.125	23.92		
	3	14	0.162857	0.1509676	0.165	22.82		
	4	12	0.237500	0.1274309	0.175	31.25		

There was a statistically non-significant difference seen for the values between the groups ($p>0.05$) for all values in the 1, 2, 3 and 4 groups.

Table 6. Intergroup failure rates comparison

		Group				**Total**
		1	2	3	4	
Failure Rate	NO	6	7	11	9	33
	yes	7	5	3	3	18
Total		13	12	14	12	51

Intergroup failure rates (group 1&2 vs 3&4)

Table 7. Intergroup failure rates comparison between group 1&2 vs group 3&4

Count					
		Group 12 vs 34			**Total**
		12	34		
Failure Rate	NO	13	20		33
	yes	12	6		18
Total		25	26		51
Chi-Square Tests					
	Value	df	p value	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Chi-Square	3.467a	1	.063		

Intergroup failure rates (group 1&3 vs 2&4)

Table 8. Intergroup failure rates comparison between group 1&3 vs group 2&4

Count					
		Group 13 vs 24		**Total**	
		13	24		
Failure Rate	NO	17	16	33	
	yes	10	8	18	
Total		27	24	51	
Chi-Square Tests					
	Value	df	p value	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Chi-Square	.076a	1	.782		

4. DISCUSSION

4.1 Retention & Retainers

The way orthodontists keep teeth in place after treatment has changed dramatically over the past century and a half. In the early days, patients had to contend with heavy metal plates and thick bands — effective enough in principle, but far from comfortable or discreet. The real turning point came in the 1970s, when advances in acid etching and dental bonding opened the door to an entirely new generation of retention devices. Suddenly, it became possible to hold teeth in position without the bulk, without compromising a patient's appearance, and without getting in the way of everyday speech.

The Hawley retainer represents the older philosophy — a removable plate made from vulcanite with a gold wire running across the front teeth. It did the job, but modern practice has largely moved on. Today, vacuum-formed clear retainers and thin wires bonded directly to the back of the teeth are far more common. These bonded lingual retainers offer what clinicians describe as "absolute retention" — they stay in place around the clock without the patient having to remember to wear anything, and nobody can even tell they are there.

4.2 Adhesives

None of this would work without the adhesive technology holding everything together. Early bonding systems required precise technique and multiple steps, leaving little room for error. The field has since evolved toward simpler, more forgiving materials. Modern universal adhesives can be used in a variety of ways. Clinicians can choose to etch the tooth surface beforehand or rely on the adhesive to do that work on its own. This flexibility is captured in the term "multi-mode," meaning a single product adapts to different clinical needs without requiring an entirely different protocol.

What makes these adhesives genuinely superior is what goes into them. Nano-scale filler particles give the material structural strength at a microscopic level, while a specialised molecule called 10-MDP forms a chemical bond with the tooth that actively resists moisture over time a critical quality for a retainer expected to stay firmly in place for years.

4.3 Discussion of Results

To understand how different combinations of retainers and adhesives perform in real patients, a clinical study was designed and conducted under strict ethical oversight. The research began by screening 200 potential participants, of whom 140 could not be included some had not given consent, others had relocated, and a number became unreachable during enrolment. The 60 patients who qualified were randomly divided into four equal groups of 15, each receiving a different combination of retainer type and bonding system.

Two groups received fibre-reinforced composite retainers. Group I had theirs bonded with a one-step adhesive, while Group II used a two-step system. The remaining two groups received multistranded stainless steel retainers — Group III with a one-step adhesive and Group IV with a two-step adhesive. This design allowed the researchers to compare retainer materials directly against each other, and also to examine whether the adhesive choice made a meaningful difference regardless of retainer type.

Over the three-month follow-up period, some participants dropped out or became unresponsive, reducing the final study group to 51 patients — 26 women and 25 men. The adjusted group sizes were 13 in Group I, 12 in Group II, 14 in Group III, and 12 in Group IV.

Each patient was assessed at three defined time points: immediately before their fixed braces were removed (T-0), one month after retainer placement (T-1), and again at the three-month mark (T-2). At every visit, three measures of gum health were recorded. The Gingival Index captured the overall condition of the gum tissue. The Plaque Index tracked bacterial buildup on the tooth surfaces. Bleeding on probing indicated whether the gums were inflamed enough to bleed when gently examined.

All data were entered into SPSS version 25 and analysed using non-parametric tests, chosen because the groups ended up slightly unequal in size after attrition and because several outcome measures use ordinal rather than continuous scales.

To track how gum health changed across the three time points within each group, the Friedman test was applied, with results presented in (Table 1,2,3,4). Where this test identified a statistically significant overall change,

Wilcoxon signed-rank post-hoc tests were used to identify exactly which pairs of time points — baseline to one month, one month to three months, or baseline to three months — drove the difference. These pairwise comparisons are reported in (Table 1,2,3,4). Groups 1, 2, 3, and 4: For all four groups (Tables 1,2,3,4), the Friedman Test showed a statistically highly significant difference ($p < 0.01$) in both GI and PI scores over time. The highest values for plaque and gingival inflammation were recorded at the baseline, with significant improvements seen at the 1-month and 3-month follow-ups.

For the comparison of periodontal parameters among the four experimental groups, the Kruskal-Wallis test was applied, with the Mann-Whitney U-test used to identify specific significant differences between any two groups. Furthermore, the failure rates of the different retainer types were evaluated and compared using the Chi-square test. Statistical significance for all tests was predetermined at a p-value of less than 0.05 ($p < 0.05$). According to Table 5, there was no statistically significant difference between Groups 1, 2, 3, and 4 for GI and PI scores at any time interval ($p > 0.05$, Table 5).

Evaluation of Failure Rates

The frequency of retainer bond failures was a key part of this study.

- General Comparison: Table 6 shows that there was no statistically significant difference in the number of failures between the four groups.
- Material Comparison (FRC vs. Stainless Steel): When comparing the Fibre-Reinforced Composite groups (1 & 2) against the Multistranded Stainless Steel groups (3 & 4), the differences were statistically non-significant ($p > 0.05$, Table 7).
- Adhesive Comparison (One-Step vs. Two-Step): Similarly, comparing the One-step bonding agent groups (1 & 3) against the Two-step bonding agent groups (2 & 4) showed no statistically significant difference in failure frequency ($p > 0.05$, Table 8).

4.4 Comparison with other studies

The question of whether a fibre-reinforced composite or multistranded stainless steel makes a better retainer has occupied researchers for decades, and the evidence on both sides is worth examining closely. Some of the earliest systematic observations, made by Lumsden and Saidler in 19995, suggested that neither material is inherently more prone to failure than the other, though they did flag an important practical caveat: fibre-reinforced composite is considerably more demanding to place correctly, and patients fitted with it need to be monitored more closely during the first six months. This sensitivity to technique has had real consequences in clinical practice.

Tacken and Cosyn, writing in 20106, found that fibre-reinforced composite failed at rates they considered clinically unacceptable when compared to stainless steel, and they recommended that multistranded wire continue to be treated as the gold standard. Iqbal Nagani and colleagues, in a 20209 study, came to a similar conclusion specifically for the lower arch, where stainless steel showed substantially lower rates of bond failure.

More recently, however, the evidence has begun to shift. Sobouti and colleagues in 20168 found that while stainless steel did fail less often in numerical terms, the gap between the two materials was not statistically meaningful. Sfondrini and colleagues, in a 20147 study tracking patients over a full year, reached a similar conclusion — and in some tooth segments actually recorded higher failure rates for the metallic wire. The most comprehensive recent synthesis of this evidence, a systematic review and meta-analysis published by Rekabi and Meshkinfam in 202313, confirmed that there is no statistically significant difference in failure rates between fibre-reinforced composite and 0.0175-inch multistranded stainless steel wire when assessed across the available literature. The group-level survival data from the present study are consistent with these findings and are summarised in (Tables 6, 7, 8).

The move toward more straightforward bonding techniques has gained solid backing from a number of recent clinical trials. Ozlu and Yazicioglu12, in their 2023 research, demonstrated that self-etch primers can be used successfully when bonding mandibular retainers — and that they hold up particularly well in real-world clinical situations where keeping the area dry and free of saliva is genuinely difficult. This is no small consideration, given how challenging moisture control can be in the lower front region of the mouth during routine practice.

Building on this, Cokakoglu and Kizildag11 in 2023 went a step further by showing that one-step adhesive systems produce outcomes that are effectively on a par with the more involved traditional multi-step approaches, both in terms of how often the retainer bond holds and in terms of the patient's gum health over time. Their work suggests that clinicians can confidently use a one-step adhesive regardless of which specific bonding technique they prefer to work with a reassuring finding for busy clinical settings.

How a retainer interacts with the surrounding gum tissue over months and years is just as important as whether it stays bonded to the tooth. Al-Maaitah14 and colleagues, in a 2023 study, examined this question by comparing multistranded wires with newer rectangular wire alternatives, and found no meaningful differences in gingival health, plaque accumulation, or calculus levels between the two. They did note that some wire designs may have a slight edge in keeping teeth aligned precisely, but when it came to tissue health and overall clinical acceptability, both materials performed equally well.

4.5 Clinical significance

Our three-month study period states that both fibre-reinforced composite and multistranded stainless steel retainers showed comparable survival rates and were equally well tolerated by the surrounding periodontal tissues. Across all four groups, Gingival Index and Plaque Index scores fell significantly between baseline and the follow-

up visits, with the reduction reaching high statistical significance ($p < 0.01$). These points strongly support the effectiveness of the professional cleaning and oral hygiene counselling provided at the outset of the study. Patients who receive clear guidance and a clean starting point tend to maintain better tissue health regardless of which retainer they are wearing.

Equally telling is what was not found: when the four groups were compared directly against one another, no statistically significant differences emerged in any of the periodontal parameters measured ($p > 0.05$). In practical terms, this means that neither the retainer material nor the adhesive system used appeared to place patients at any greater or lesser risk to their gum health over the period studied. These findings are consistent with the recent work of Rekabi and Meshkinfam in 202313 and Sobouti and colleagues in 20168, both of whom concluded that aesthetic fibre-reinforced composite retainers can match the clinical performance of stainless steel provided the clinician applies the technique with care and precision.

The data on bonding systems carry an equally straightforward implication for day-to-day practice. One-step adhesive protocols proved just as dependable as two-step systems, with no statistically significant difference in bond failure frequency recorded across any of the study groups. This aligns with the conclusions drawn by Ozlu and Yazicioglu in 202312 and Cokakoglu and Kizildag in 202311, and it has a direct practical value: in clinical environments where achieving a perfectly dry field is consistently challenging, a one-step system that performs comparably to more complex alternatives represents a genuine efficiency gain without any sacrifice in reliability.

Both the more traditional approach of multistranded stainless steel with a two-step adhesive and the more contemporary combination of fibre-reinforced composite with a one-step system stood up well over three months. Rather than prescribing one approach over another, the evidence from this study supports giving clinicians the freedom to select the combination that best suits their working environment, their patients' needs, and their own clinical confidence.

4.6 Limitations of the study

1. Three months is long enough to capture how a retainer performs in its early weeks, but not long enough to reveal how materials and adhesive bonds hold up under the cumulative stress of everyday chewing over time. Differences between the groups may only become apparent after a year or two, and longer follow-up studies are needed before any definitive conclusions about durability can be drawn.
2. Fifty-one patients is a reasonable number for a pilot study, but the cohort may not be large enough to detect small yet genuinely meaningful differences between the four groups. If one material or bonding system does carry a modest clinical advantage over another, a study of this scale might simply not be sensitive enough to pick it up.
3. Patients who know they are being monitored as part of a clinical trial tend to look after their teeth more carefully than usual, and the improvements seen in gingival and plaque scores likely reflect this to some degree. Whether the same results would be seen in everyday clinical practice, outside the structure of a formal study, is difficult to say with certainty.
4. All procedures were carried out by a single practitioner, which keeps the technique consistent but means the results partly reflect one individual's skill and experience. Since a fibre-reinforced composite is particularly sensitive to how it is handled during placement, outcomes may differ when the same procedures are performed by clinicians with different levels of familiarity with the material.
5. Certain everyday patient habits, including eating hard foods and grinding or clenching the teeth, place greater mechanical demands on retainer bonds than normal function does, and these could not be controlled within the study. Their influence on bond failures across the groups cannot be entirely separated from the effect of the materials and adhesives being compared.
6. The study was conducted entirely at Jaipur Dental College, drawing from a relatively similar patient population in terms of background and lifestyle. While this consistency is useful, it means the findings may not apply equally to patients from different regions or health systems, and replication across multiple centres would be needed to confirm how broadly these conclusions hold.

5. CONCLUSION

This study set out to compare how well fibre-reinforced composite and multistranded stainless steel retainers hold up in practice, testing each material against both a one-step and a two-step bonding protocol to see whether the choice of adhesive system made any meaningful difference to the outcome.

Fibre-reinforced composite has long been viewed with some caution due to its technique sensitivity, which proved just as reliable as conventional metal wire over the three-month observation period. For patients who value the appearance of their smile even after their braces come off, this is an encouraging finding: an aesthetic retainer need not come at the cost of clinical performance, provided it is placed with care.

Perhaps equally significant for busy clinical practice is what the study found regarding bonding systems. The simplified one-step, all-in-one adhesive performed on par with the more involved two-step approach, with no increase in failure rates and no negative impact on gum health. This means that clinicians working in environments where chair time is limited, or where achieving a perfectly dry field is a persistent challenge, can adopt a more streamlined bonding technique without compromising the quality of care they deliver to their patients.

What stands out most clearly across all four groups, however, is the consistent and significant improvement in periodontal health indices from baseline through to the three-month follow-up. This improvement was not driven

by any particular retainer or adhesive it was seen uniformly, regardless of which combination patients received. The most straightforward interpretation is also the most clinically important one: thorough oral hygiene instruction at the point of transition from active treatment to passive retention, combined with a professional clean at the outset, does more for a patient's gum health than the specific materials chosen to retain their teeth. The retainer holds the teeth in place; the hygiene habits protect the tissue around them.

Taken together, these findings validate both traditional and contemporary approaches to orthodontic retention and offer clinicians a well-supported basis for choosing the combination that best fits their clinical setting, their patients, and their own experience without fear that departing from older conventions will lead to worse outcomes.

Clinical Trial Registry

This study was conducted as part of postgraduate institutional research, and was not registered with a clinical trials registry prior to patient enrolment, as registration was not a requirement of the Institutional Ethics Committee at the time of protocol approval. The study was conducted in full accordance with the ethical principles of the Declaration of Helsinki, with prior ethics committee clearance and written informed consent obtained from all participants.

Conflicts Of Interest

The authors declare no conflicts of interest.

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Author Contributions

1.Dr Karamdeep Singh Ahluwalia and Dr Vijay Agarwal: contributed to study conception, design, and manuscript drafting.

2.Dr. Harsheeta Trivedi and Dr. Karuna Najiar: contributed to data acquisition , investigation and statistical analysis.

3.Dr. Hari Narayan Choudhary and Dr. Shivangi Chauhan: contributed to data interpretation and critical revision of the manuscript.

4.Dr Karamdeep Singh Ahluwalia and Dr Vijay Agarwal: contributed to study conception, design, and manuscript drafting.

5.Dr Harsheeta Trivedi and Dr Karuna Najiar: contributed to data acquisition, cephalometric tracing, and statistical analysis.

6.Dr Hari Narayan Choudhary and Dr Shivangi Chauhan: contributed to data interpretation and critical revision of the manuscript.

All authors read and approved the final manuscript.

Data Availability Statement

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

Use Of Artificial Intelligence

"Grammarly" was used solely for grammatical corrections during manuscript preparation. The tool was not used for data analysis, interpretation, or generation of scientific content. The authors reviewed and take full responsibility for the content of the manuscript.

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Ethics Approval

Institutional Ethics Committee, Jaipur Dental College, MVGU, Jaipur — Ref. No. MVGU/RO/2024/1059, dated 17th September 2024

Confirmation of Informed Consent

Written informed consent was obtained from all participants, or their guardians, for inclusion in the study.

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