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Original Article

# Retrospective evaluation of fiber-reinforced periodontal splints and resin bridges in the anterior region

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## Abstract

**Aim:** The aim of this study was to evaluate the clinical performance of fiber-reinforced periodontal splints (FRSs) and adhesive bridges (FRBs) in treating anterior single-tooth defects.

**Methodology:** Sixty-five patients who received FRSs and FRBs from 2001 to 2012 were recalled and evaluated clinically. The FRS and FRB restorations of the patients were clinically evaluated in terms of anatomical form, marginal adaptation, marginal coloration, secondary caries, and retention, according to the modified United States Public Health Service (USPHS) criteria. The current restoration statuses of the patients from 5 to 10 years post-treatment were photographed and recorded. Patient satisfaction level was assessed using a visual analogue scale (VAS), and periodontal pocket depth was measured. Clinical follow-up data were obtained and analyzed with the Chi-Square test.

**Results:** When each of the modified USPHS criteria was compared with the baseline values, statistically significant differences were observed between the groups. There were statistically significant differences when the categories were evaluated according to initial values ($p<0.05$). When the clinical evaluation criteria were compared with each other, no statistically significant differences were found ($p>0.05$). While the most successful results were obtained in the FRB group, most of the restoration losses and repairs occurred in the FRS group. According to the data obtained, 38% of restorations were lost and all restorations had been intact for at least 5 years. All lost restorations were in FRS restorations. The recall rate was 49% (n=32). Twenty (62.5%) of 32 patients rated their satisfaction with the restorations as being between 90 and 100, 8 (25%) as being between 80 and 90, and 4 (12.5%) as being between 70 and 80 on the VAS scale. The pocket depths of the patients at 5- and 10-years post-restoration were 2.3–3.8 mm and 2.4–5.2 mm, respectively.

**Conclusion:** Fiber-reinforced restorations performed due to the loss of anterior single teeth and periodontal tissue can serve patients clinically for at least 5 years. FRB and FRS restorations can be considered alternative treatments that can further delay the more expensive implant and prosthetic treatment options for years.

**Keywords:** adhesive bridge, fiber-reinforced composite, periodontal splint

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## Introduction

The use of composites has increased due to the fact that minimally invasive dentistry has replaced traditional mechanical cavity preparation techniques for restorative materials, and patients generally prefer tooth-colored esthetic materials. Current conventional composite resin materials can cause restorations to fail due to their low fracture strength. As a result of failure, undesirable complications, such as discoloration, secondary caries, tenderness, and microleakage, may develop because of marginal incompatibility (1). Studies to improve the mechanical properties of conventional composite resins are aimed at the development of a resin matrix or inorganic fillers. However, since no significant progress has been made in efforts to improve the resin matrix structure, more focus has been placed on filler technology (2), which aims to increase the mechanical properties of the materials by adding fibers of different sizes, such as carbon, glass, and polyethylene, into a composite material (3).

The basic principle of fiber reinforcement depends on the ability to effectively transmit the force to which the composite structure is subjected to the fibers via the resin matrix surrounding these fibers (4). Fiber-reinforced composite resins are highly filled composite resins that are reinforced by embedding fiber yarn in their structure. With the development of fiber-reinforced composite resins, many applications have been found in the field of restoration (5). Fiber-reinforced composite resins have a variety of uses, including splinting of teeth, restoration of endodontically treated teeth, post-core applications, and construction of large composite restorations (6,7). The most common use of fiber-reinforcement described in the dental literature is tooth splinting (8). Splinting is a common practice for stabilizing periodontally affected teeth (9). Splinting teeth to each other allows the stronger teeth to support the weaker teeth by allowing force distribution from moving teeth to their immobile neighbours. This extends the life of mobile teeth, provides stabilization for the reconstruction of the periodontium, and improves comfort, function, and esthetics (10,11).

Historically, different methods have been used for splinting mobile teeth, and the most conservative of these methods involves the use of adhesives and composite resins (12). In the past, direct stabilization and splinting of teeth using the adhesive technique also required wires, pins, or grid meshes. Since these materials could only be mechanically locked around the resin restoration, some clinical problems, such as traumatic occlusion, progression of periodontal disease, and secondary caries, could arise while creating shear planes and stress concentrations that would cause composite breakage and premature failure (13). The introduction of fiber-reinforced technology aims to prevent problems that arise with old-style splinting methods (14). Another application area of fiber-reinforced composites is anterior bridge applications for the treatment of anterior single tooth deficiency. Anterior tooth loss creates serious psychological and social problems for patients. Replacing a single tooth lost to caries or trauma is also a challenge for the clinician. Some restorative options have been proposed in such clinical situations, including implants, fixed metal-ceramic or ceramic prostheses, and resin-bonded fixed partial prostheses (15). Common alveolar defects in edentulous areas and periodontal diseases of adjacent teeth make both implants and fixed partial denture restorations difficult. Fiber-reinforced composite resin-bonded splint bridge (FRB) is a partial fixed prosthesis combined with an FRB splint adjacent to the mobile tooth, and in such single-tooth deficiencies, composite resin can be used pontically. This approach can provide a simple, comfortable, cost-effective, non-invasive, and esthetic rehabilitation program (16,17).

In this study, we retrospectively evaluated the clinical performance of fiber-reinforced resin splints and fiber-reinforced adhesive bridges in cases where a single anterior tooth was missing.

## Materials and Methods

This study was approved by the Non-Interventional Clinical Trials Evaluation Committee of the Selçuk University, Faculty of Dentistry, with the meeting decision dated 2 May 2017, and numbered 2017/10. From 2001 to 2012, 65 patients (36 women and 29 men aged 32 to 70 years) were treated with various periodontal and/or esthetic combined splint restorations in the Department of Restorative Dentistry. According to the 1999 American Academy of Periodontology (APP) Classification, patients with anterior teeth and anterior tooth mobility diagnosed with chronic periodontitis were included, and among these individuals, patients with the following criteria were excluded from the study:

- Under the age of 18
- Unable to read and sign the informed consent document
- Presence of concurrent psychological disorders
- Pregnant women
- Presence of a history of restoration or bleaching
- Loss of more than two teeth in the anterior segment of a jaw
- Patients with a missing canine tooth or those with mobile canine teeth in one jaw in both anterior regions

According to the 1999 International Workshop (Working Group) Classification, patients diagnosed with severe chronic periodontitis who were treated in the Periodontology Department of the Faculty of Dentistry were given routine oral hygiene training and initial periodontal treatments, including dental surface cleaning, root resurfacing, and local medication. Subsequently, dental surface cleaning and root surface correction were applied at intervals of 4 to 6 weeks

until the oral hygiene of the patient stabilized, and gingival bleeding stopped. Patients who were eligible for periodontal splint treatment were directed to the Restorative Dentistry Clinic.

After periodontal therapy was performed, 65 patients who were referred to the Restorative Dentistry Clinic for their treatment were divided into three treatment groups: Group 1 – fiber-reinforced periodontal splint treatment (FRS), Group 2 – adhesive bridge (AB), and Group 3 – adhesive bridge + fiber-reinforced periodontal splint treatment (FRB). It was preferable for all these restorations to be done by a single clinician in terms of standardization of the study. Based on the data obtained from the automation system (Turcasoft Software, Samsun, Turkey), the control processes of all patients and the restoration repair processes or the transition to implant/prosthesis processes were recorded. In retrospective follow-ups, 32 of the 65 patients could be reached. Clinical examinations of the patients who could be reached were performed by a different clinician. Variables related to the patients included in the study are presented in Table 1.

In this study, a retrospective evaluation of the clinical performance of FRS, AB, and FRB involving a total of 65 patients was performed according to the United States Public Health Service (USPHS) modified criteria for 34 restorations administered to 32 patients who could be reached.

## Statistical analysis

The Chi-Square test was performed to statistically analyze the data using SPSS 21.0 software (IBM Corp, Armonk, NY, USA) ($p<0.05$).

**Table 1.** Variables related to the patients included in the study.

| Variable | n | Percentage |
|---|---|---|
| **Recall Rate of Patient** | | |
| *Initial number of patient* | 65 | |
| *Followed* | 32 | %49,23 |
| **Gender** | | |
| *Female* | 17 | %53 |
| *Male* | 15 | %47 |
| *Total* | 32 | %100 |
| **Age** | | |
| *18-25* | 0 | %0 |
| *25-45* | 1 | %3 |
| *>46* | 31 | %97 |
| *Total* | 32 | %100 |
| **Location** | | |
| *Maxilla* | 18 | %53 |
| *Mandibula* | 16 | %47 |
| *Total* | 34 | %100 |
| **Pontic Material** | | |
| *Composite Resin* | 3 | %50 |
| *Acrilic Resin* | 0 | %0 |
| *NaturalTooth* | 3 | %50 |
| *Total* | 6 | %100 |

# Results

Patient data, including age, gender, location of restoration, and pontic materials used, are provided in Table 1, and the statistical analysis of the data evaluated according to the modified USPHS criteria is shown in Table 2. Of the 65 patients who received treatment, 32 could be contacted, resulting in a recall rate of 49.23%. When the criteria were evaluated according to the initial values, the differences were found to be statistically significant ($p<0.05$).

Table 2. Evaluation findings of restorations from 5 to 10 years post-treatment according to the modified USPHS criteria

| Modified USPHS criteria | | 5 years follow-up | | 10 years follow-up | |
|---|---|---|---|---|---|
| | | FRS (%) | FRB(%) | FRS(%) | FRB(%) |
| *Anatomic Form* | Alfa (A) | 11(%39,3) | 4(%66,7) | 2(%40) | 2(%100) |
| | Bravo (B) | 6%(21,4) | 2(%33,3) | 1(%20) | |
| | Charlie (C) | 11(%39,3) | | 2(%40) | |
| *Marginal Adaptation* | Alfa (A) | 11(%39,3) | 5(%83,3) | 1(%20) | 2(%100) |
| | Bravo (B) | 6%(21,4) | 1(%16,7) | 2(%40) | |
| | Charlie (C) | 11(%39,3) | | 2(%40) | |
| *Marginal Discoloration* | Alfa (A) | 8(%28,6) | 4(%66,7) | | 1(%50) |
| | Bravo (B) | 9(%32,1) | 2(%33,3) | 3(%60) | 1(%50) |
| | Charlie (C) | 11(%39,3) | | 2(%40) | |
| *Secondary Caries* | Alfa (A) | 15 (%53,6) | 5(%83,3) | 3(%60) | 2(%100) |
| | Charlie (C) | 13 (%46,4) | 1(%16,7) | 2(%40) | |
| *Retantion* | Alfa (A) | 17 (%60,7) | 5(%83,3) | 2(%40) | 2(%100) |
| | Bravo (B) | | 1(%16,7) | 1(%20) | |
| | Charlie (C) | 11 (%39,3) | | 2(%40) | |
| *Number of total restoration* | | 28 | 6 | 5 | 2 |

There were no statistically significant differences in the comparisons of the criteria among themselves ($p>0.05$). For the FRS group at 5 years post-treatment, the anatomical form, marginal adaptation, marginal discoloration, and retention scores were 60.7%, and the secondary caries score was 53.6%; these values show that the clinical performance of the restorations was acceptable. In the FRB group, the secondary caries score was 83.7%, and the scores of the other categories were 100%. In all categories at 10 years post-treatment, 60% of the FRS group and 100% of the FRB group were considered acceptable. At 5 and 10 years of follow-up, losses for FRS restorations were 39.5% and 40%, respectively, while there was no loss in FRB restorations. Of the 32 patients evaluated, 20 (62.5%) rated their satisfaction with the restorations (measured using a visual analogue scale [VAS]) as being between 90 and 100, 8 (25%) as being between 80 and 90, and 4 (12.5%) as being between 70 and 80. The lowest satisfaction scores in the evaluation were in the 70-80% range.

## Discussion

Esthetic restorations of mobile front teeth that have lost their support periodontally are very difficult. In this retrospective study, we applied fiber-reinforced resin splint to periodontally mobile front teeth, fiber-reinforced adhesive bridges in the absence of anterior single tooth, and additional combined esthetic restorations in fiber-reinforced resin splints due to migration and gaps in the teeth due to mobility. Under the confines of this retrospective clinical evaluation, these fiber-reinforced restorative approaches have been shown to be a fairly minimal approach to maintaining anterior teeth with periodontal loss in the mouth and produce acceptable results for all groups over a period of 5-10 years.

In addition, 62.5% of the patients evaluated their satisfaction with these restorations as between 90 and 100. It was observed that the lowest satisfaction rate in the evaluation was 70-80%. The rate of 65 patients who were followed up initially to come to the clinic and participate in the evaluation was determined as 49.32%.

Liu et al. in a study in which patients with periodontal problems evaluated combined splint restorations in the esthetic area retrospectively, they obtained acceptable results between 69.2% and 100% according to the modified USPHS criteria (16).

Piovesan et al. in a retrospective evaluation of fiber-reinforced fixed prostheses, survival rate was found to be 94.75% (13). In the past, splinting was performed with wires, pins, or meshes placed directly in the restorative resin (18). Ribbond (Ribbond Inc, Seattle, WA, USA), the splint material used in this clinical study, is made of ultra-high molecular weight polyethylene fiber designed with lock stitching. Thus, it provides excellent bonding properties by returning the loads to the resin effectively and without stress

throughout the fabric without transferring the stress. In the treatment of single tooth deficiencies, there are alternative treatment options such as implants, removable prostheses, traditional bridges, bridges made using anchor elements, and adhesive bridges based on minimally invasive preparation principles (19).

Patients seek a fast, esthetic, and functional solution for anterior tooth deficiencies. Directly applicable fiber-reinforced composite bridges offer patients a cost-effective, minimally invasive and stable solution in a single session (20). Kumbuloğlu et al. evaluated the performance of fiber-reinforced composite splints in the treatment of mandibular anterior teeth with periodontal problems and concluded that direct splints made with E-glass fiber material were successfully applied for up to 4.5 years (21).

In this study, the anatomical form, marginal adaptation, marginal discoloration, and retention scores were 60.7%, secondary caries scores were 53.6% in the FRS group over 5 years, and these values show that the clinical performance of the restorations is within acceptable limits. In all categories over 10 years, 60% of the FRS group and 100% of the FRB group were considered acceptable. When these data are evaluated, it has been observed that FRS restorations can be used for at least 5 years and FRB restorations are less in number than FRS restorations, but clinically they are quite successful both in 5 years and in a long period such as 10 years. In the 5- and 10-years clinical follow-up, 39.5% and 40% loss was recorded in FRS restorations, respectively, while there was no loss in FRB restorations. Restoration failures in FRS restorations can be attributed to the periodontal damage and inadequate oral hygiene in these patients.

Twenty (62.5%) of the 32 patients evaluated their satisfaction with the restorations as 90-100. The lowest satisfaction was observed to be 70-80% in the evaluation. It can be thought that these restorations are very welcomed as they enable patients to use their teeth esthetically and functionally again and provide a relief in terms of chewing functions.

## Conclusion

From the results of this study, the patients' transition to more aggressive treatments was prevented for between 5 and 11 years, and further treatments were facilitated by preserving the teeth in the mouth for a longer time and reducing alveolar crest resorption, and the patient could be offered a restoration type that matches their own natural esthetics. FRB and FRS have been found to be satisfactory alternative non-invasive treatment modalities that can be applied rapidly in a short period. However, more clinical studies are needed for this type of restoration.

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