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Clinical Survival of Indirect, Anterior Surface-Retained Fiber-Reinforced Composite Fixed Dental Prosthesis: Up to 3-Year Follow-up

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ABSTRACT

This study evaluated the performance of indirect, anterior, surface-retained, fiber-reinforced-composite restorations (ISFRCR). Between September-2011 and September-2012, 17 patients (13 females, 4 males, mean age: 40.5) received 17 indirect ISFRCRs (maxilla=4; mandible=13). All restorations were made on a plaster model using unidirectional E-glass fibers (Interlig, Angelus) in combination with a veneering resin composite (Gradia, GC) and cemented adhesively (Choice 2, Bisco). No cavity preparations were made on the abutment teeth. Before cementation, enamel surfaces were cleaned with pumice and etched with 38% H_3PO_4 for 30 s, rinsed 30 s. Then, adhesive resin was applied accordingly. Patients were followed every 3 months until May 2014. The evaluation protocol involved technical (chipping, debonding or fracture of tooth/restoration) and biological failures (caries). Survival (Kaplan Meier) and annual failure rates were calculated. Mean observation time was 34.6 months. Altogether, 5 failures were observed [survival rate: 70.5%] of which 3 were debondings and 2 delaminations of the veneering composite (chipping). All defective restorations were repaired or recemented, except one, which was remade.

INTRODUCTION

Advances in adhesion of resin-based materials to enamel and dentin, and introduction of reinforced resin composites allowed for minimally invasive applications in dentistry.

Fiber-reinforced composite (FRC) fixed dental prosthesis (FDP) is one such treatment option indicated for the replacement of missing single or multiple teeth. This metal-free therapy option has the main advantage of preserving the abutment tooth as it can be bonded to enamel without any preparations.[1] FRC FDPs can be fabricated either directly in the patient's mouth or indirectly by a dental technician at the laboratory. Clinical failures associated with such applications are usually delamination of the veneering composite on the FRC framework, fracture of the framework itself and chipping of the veneering composite.[2-10]

The indirect fabrication of FRC FDPs offer ease of working, a higher degree of conversion rate of the veneering composite[11] and a better surface finish.[2,9,10] Surface-retained indirect FRC FDPs are bonded directly onto enamel and when no retention is available, they are bonded to the cavities that have margins in enamel/dentin complex where the latter is considered more invasive. Limited information is available on longevity and clinical behaviour of indirect, surface-retained FRC FDPs.[1,10]

The objective of this study therefore was to evaluate the survival of indirect, anterior, surface-retained, fiber-reinforced-composite restorations (ISFRCR).

MATERIALS AND METHOD

STUDY DESIGN

The brands, types, manufacturers and chemical compositions of the materials used in this study are listed in Table 1.

INCLUSION AND EXCLUSION CRITERIA

Between September-2011 and September-2012, a total of 17 patients (13 females, 4 males, 29-65 years old) received 17 ISFRCRs at the Hacettepe University, Turkey. Informed written consents were received from the patients on accepting the treatment procedures. Ethical approval was obtained from the University Ethics Commission (Vote number of the local Ethical Committee no: 7OM/743; Local ethical registration number: 14/9/4). The inclusion criteria for the study were as follows: all subjects were required to be at least 18 years old having one or two missing anterior teeth, able to read and sign the informed consent document, physically and psychologically able to tolerate conventional restorative procedures, having no active periodontal or pulpal diseases, having no primary caries, not allergic to resin-based materials, not pregnant or nursing, having antagonist teeth opposing the FRC FDP to be made, willing to return for follow-up examinations as outlined by the investigators. The patients who had more absent teeth than the teeth to be replaced in the rest of the dentition were not excluded.

CLINICAL PROCEDURES, RESTORATION DESIGN AND FABRICATION

All FRC FDPs replaced one or two missing tooth and were bonded to two adjacent abutment teeth. Treatment was performed in two sessions: 1) Impression and model analysis, 2) Try-in, cementation and polishing of the FRC FDP. Impressions were made using polyvinyl siloxane material (Elite H, Zhermack, Badia Polesine, Italy), poured in plaster for model analysis. No cavity preparations were made on the abutment teeth. All FRC FDPs were made in one dental laboratory on full arch plaster casts. The model was first isolated with two coats of isolation medium. One bundle of braided pre-impregnated E-glass fiber (Interlig, Angelus, Brasil) was used to reinforce the veneering composite (Gradia, GC, Tokyo, Japan).

Before the fibers were placed on the plaster model, a thin layer of flowable composite (Grandio Flow, Voco, Cuxhaven, Germany) was applied on the lingual surface of the abutment teeth. The fiber bundle was placed in the bed of the flowable resin using metal hand instruments. Dimensions of the retainer wings varied depending on the mesio-distal and cervico-incisal length as well as the position of the cingulum but principally the width of the FRC FDP was dictated by the width of the fiber bundle, not exceeding 2 to 3 mm. The length of the retainer varied between 6 to 8 mm. FRC was positioned above the cingulum, towards the incisal one third on the palatal surface of the abutment teeth.

After photo-polymerization with a halogen polymerization unit (Degulux soft-start, Degussa-Hüls AG, Hanau, Germany, light output: 600 mw/cm^2), the framework was veneered with an indirect resin composite (Gradia, GC). The veneering resin composite was built incrementally; the construction was polymerized for the final time in a laboratory polymerization oven for 15 s (Visio Beta, 3M ESPE, Seefeld, Germany).

The fit of the FRC FDP was checked using a silicon material (Fit Checker, GC, Tokyo, Japan) and adjustments were made using slow speed hand piece with diamond burs where needed. The bonding surfaces of the abutment teeth were cleaned with pumice before cementation and rubber-dam was used where possible. Meanwhile, the cementation surface of the FRC FDP was treated with resin monomer of the corresponding resin cement using a microbrush (All-Bond3 Parts A & B for Choice 2). The resin was left unpolymerized, shielded from light, for at least 5 minutes in order to allow the resin to penetrate to the polymer matrix of the FRC framework.

Table 1. The brand, type, manufacturer, and chemical composition of the main materials used in this study.

Brand	Type	Manufacturer	Chemical composition
Choice 2	Photo-polymerized resin cement	Bisco Inc, Schaumburg, IL, USA	Glass particles (40-70 w%), amorphous silica particles (10-40 w%), bis-GMA (5-30%)
Interlig	Pre-impregnated glass fiber	Angelus, Londrina, PR, Brazil	E-glass fiber (60±5 v%), impregnated with 40±5 % resin containing bis-GMA, diurethane, barium glass
Gradia Direct	Veneering composite	Gradia Direct, Anterior, GC America, Alsip, USA	Inorganic fillers (73 w%, 64 v%), urethandimethacrylate (UDMA) 15-30%, fluoro alumino-silicate glass 30-40%, silica powder 10-20%, prepolymerized filler 20-30%, dimethacrylate 0-5%, initiators, stabilizers, pigments

Figure 1: a-c Representative photos of a) Missing tooth no. 13, b) ISFRCR replacing the 13 at 3-year follow up, c) Missing teeth no. 11,21, d) ISFRCR replacing 11,21 at 3-year follow up.

The bonding surfaces of the abutment teeth were acid-etched with 38% phosphoric acid gel for 60 s, rinsed thoroughly for at least 30 s and gently air-dried for 5 s. FRC FDPs were luted using resin cement (Choice 2, Bisco, Schaumburg, IL, USA) according to the manufacturer's instructions. After removal of excess material, the resin composite cement was photo-polymerized for 20 s from 4 surfaces (lingual, labial, mesial, distal) (Astralis 10, SN 018766, Ivoclar Vivadent, light output: 1200 mW/cm^2). The power output of the unit was measured with a radiometer (Cure-Rite, Dentsply-Caulk, Milford, USA) before cementation of each restoration. After polymerization, restoration margins were finished. Premature contacts were adjusted with fine diamond burs (60- and 40-µm grit) and finally, the restoration was polished with pointed silicon polishers (Shofu, Kyoto, Japan) and abrasive polishing brushes (Astrobrush). The patients received individual instructions regarding plaque control.

One operator applied all FRC FDPs who had experience in adhesive dentistry (>10 years since graduation).

CLINICAL EVALUATION

The evaluation protocol involved technical (chipping, debonding or fracture of tooth/restoration) and biological failures (caries). After baseline recordings, the patients were followed every 3 months up until May-2014. The patients were instructed to call upon experience of a failure.

STATISTICAL ANALYSIS

Survival analysis was performed with statistical software program (SPSS 14.0; SPSS Inc, Chicago, IL, USA) using Kaplan-Meier analysis. In addition, annual failure rate was calculated by dividing the number of failures by restorations evaluated times number of years. P values less than 0.05 were considered to be statistically significant.

RESULTS

No drop out was experienced with a recall rate of 100%. Mean observation time was 34.6 months.

Distribution of FRC FDPs is presented in Table 2. Secondary caries, endodontic complications, tooth fracture was not observed in any of the restored teeth.

Altogether, 5 technical complications were encountered until the final follow-up date [survival rate: 70.5%] (Kaplan-Meier) *(Figure 2*). Three debonding of the FRC FDPs and two delaminations of veneering composite (chipping) were observed. Annual failure rate was 0.10%.

Except one replacement in one patient who received metal-ceramic FDP, all defective FRC FDPs were repaired or recemented and remained functional until the final observation date.

Chipping type of failures were repaired using a silica-coating system (CoJet System, 3M ESPE). The composite surface was first cleaned with pumice and air-abraded with alumina particles coated with silica (CoJet Sand, 3M ESPE). Silane coupling agent (Bis-Silane, Parts A&B for Choice 2) was applied and waited for 1 minute for its reaction. Then, adhesive resin (All-Bond 3, Parts A&B) was applied with microbrush, air-thinned and photo polymerized for 20 s. Thereafter, repair was performed using resin composite (Tetric Ceram, Ivoclar Vivadent) which was photo-polymerized for 40 s from each direction.

In case of debondings, FRC FDPs were recemented using the same cement.

Slight composite colour change was observed in 4 cases which did not require polishing or replacement.

Table 2. Distribution of the ISFRCRs based on gender, location and pontic type

	N=17
Gender	
Male	4
Female	13
Location	
Maxilla	4
Mandible	13
Pontic type	
Central incisor	9
Lateral incisor	3
Canine	5

DISCUSSION

This study reports on survival rate of ISFRCRs, offering a treatment option for restoring missing teeth in a non-invasive, cheaper, and time saving manner compared to metal-ceramic or all ceramic FDPs or implant-borne reconstructions.

In this study, out of 17 restorations, 5 failures were observed yielding to a survival rate of 70.5% at a mean observation time of 34.6 months. No fractures of the frameworks were observed in any of the restorations. The fiber type used in this study was a silanized, pre-impregnated braided E-glass fiber bundle. The restorations were made using one single bundle to reinforce the framework. Since no fractures were noted, it can be stated that the used fiber type veneered with the meth-acrylate based veneering composite with 73 w% filler content could withstand chewing forces in the anterior region. The majority of the similar studies on FRC FDPs retained in cavities presented a survival rate of ≥ 72% after 2 to 5 years.[6] The survival rate of ISFRCRs in one previous study with other fiber types, veneering composites and resin cements was 93% in 31 patients up to 1 year observation time.[1] In another clinical study, in 135 patients, survival rate was reported to be 93.5 to 100 % up to 58 months, depending on the cement type.[10] Failure types were similar to this study, namely chipping, fracture or debonding.

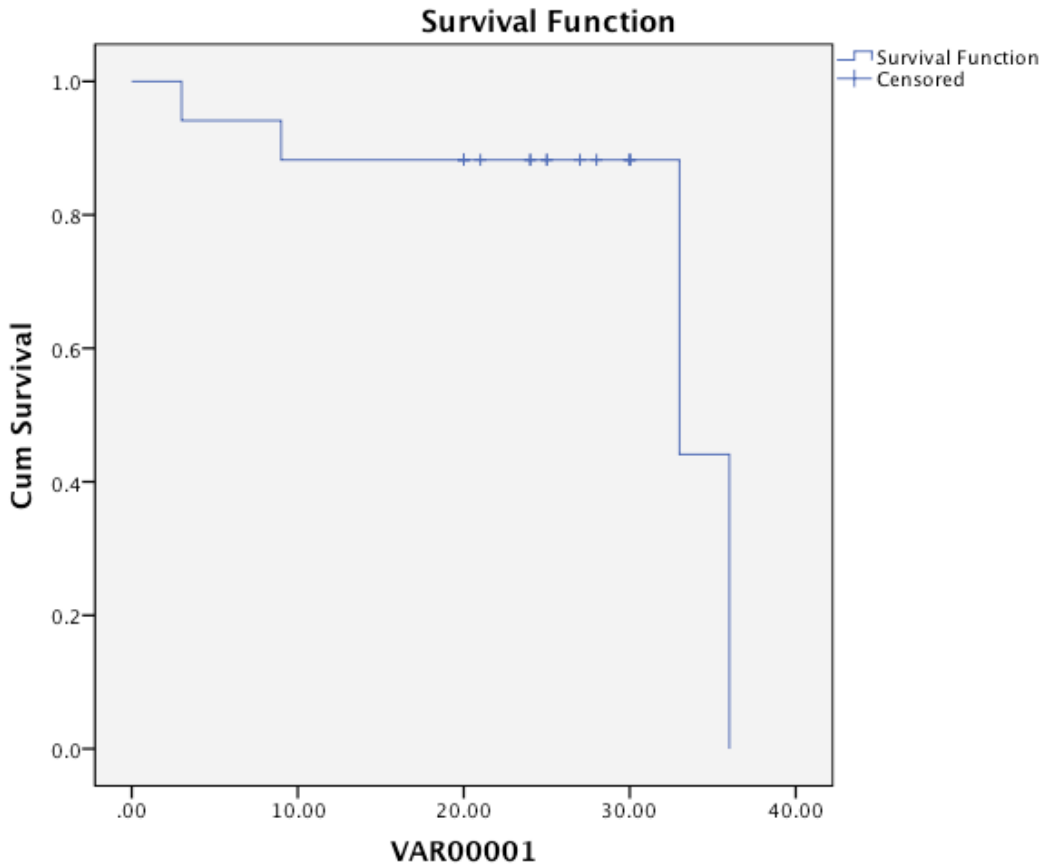

Figure 2: Event-free survival rates of anterior ISFRCR (N=17)

One comparable treatment option to ISFRCRs is metal-ceramic resin-bonded FDPs. An analysis of 60 studies on resin-bonded metal-ceramic FDPs revealed a survival rate of 74% after 4 years[11] and 73.9% for two retainer, and 94.4% one retainer all-ceramic resin-bonded FDPs[12] where also debonding was reported as the typical failure type.

In this study, no cavities were prepared meaning that the wings of the ISFRCRs laid on the palatal concavity of the abutment teeth. In the debonding cases, interestingly the cement remained on the intaglio surfaces of the ISFRCRs indicating an adhesive failure between the enamel and the resin cement. Even though excellent adhesion is achieved on enamel, apparently torque forces exceeded the adhesive forces between the cement and the enamel. After re-cementation, no failures were observed until the final follow up. It also has to be noted that in this study, insulation was not achieved with rubberdam in all restorations.

One reason for debonding in FRC FDPs could be due to better polymerization and improved degree of conversion of the veneering composite in the laboratory polymerization unit.[13] This would decrease the amount of free monomers that would react with the methacrylate based resin cement.[13]

The second failure type observed in this study was chipping of the veneering composite. Such failures could be repaired chairside using air-abrasion and silanization.[14] However, future studies should observe the incidence of chipping when multiple fiber bundles are used in the pontic area.[15] Except one replacement in one patient, who received metal-ceramic FDP, all defective restorations were repaired or recemented and remained functional until the final observation date.

In this study, slight discoloration was observed in 4 cases. Since primary outcome measure was the functional durability, no qualitative analysis was performed related to wear and discoloration parameters. In randomized clinical trials, methacrylate based resin composites showed more surface quality changes due to wear and discoloration versus ceramic materials.[16] Thus, future studies should also evaluate the colour change and surface degradation of veneering composites as this may affect optical properties especially in the anterior region.

In clinical situations where implant prognosis is questionable such as in young patients or in patients with economical limitations, ISFRCRs could be offered as an alternative, providing that repairable failures should be communicated with the patients.

CONCLUSIONS

From this study, the following could be concluded:

1. The 3-unit anterior indirect surface-retained resin-bonded fixed dental prosthesis reinforced with the E-glass fiber, could be advised as a semi-permanent treatment modality.
2. Experienced failures were due to debonding of the restoration or delamination of the veneering composite.

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DISCLOSURE

The authors declare that they have no conflict of interest.

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