Fiber Reinforced Composite Space Maintainers: Methods of Clinical Application: Case Report

Fiberle Güçlendirilmiş Kompozit Yer Tutucular: Klinik Uygulama Yöntemleri

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Geliş Tarihi/*Received:* 23.12.2014
Kabul Tarihi/*Accepted:* 02.04.2015

This case report was presented as a poster at Congress of 6th International Scientific İstanbul University, Faculty of Dentistry, 21-23 November 2013, İstanbul/Turkey.

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ABSTRACT The introduction of fiber-reinforced composites (FRCs) in dentistry enabled the development of tooth substance saving, esthetic and cost-effective treatment approaches. FRC space maintainers can be accepted as an alternative to traditional band-loop type space maintainers with their various advantages. The aim of this article is to present clinical applications of two different FRCs as space maintainers and discuss the advantages/disadvantages over the traditional band and loop types. FRCs as space maintainers was prepared by direct and indirect method in 3 patients in this case reports. Results at the end of 6th month showed acceptable clinical performance. There were no fiber fractures, caries or gingival inflammation with the space maintainers. Semi-fixed space maintainer showed retention loss after 4 months. After 6 months, due to the failure of the FRC space maintainers irreversibly, according to the patients' ages traditional band and loop space maintainers were applied. Correct patient selection and proper treatment planning will increase success of FRC space maintainers.

Key Words: Space maintenance; composite dental resin

ÖZET Diş hekimliğinde fiberle güçlendirilmiş kompozitlerin kullanılması diş dokularının korunmasını, estetik ve düşük maliyetli tedavilerin yapılmasını sağlamıştır. Fiberle güçlendirilmiş kompozit yer tutucular sahip oldukları avantajlar nedeniyle geleneksel bant-loop yer tutuculara alternatif kabul edilmiştir. Bu olgu sunumunun amacı iki farklı fiberle güçlendirilmiş kompozitin yer tutucu uygulamalarında bant-loop yer tutucularına göre avantaj ve dezavantajının karşılaştırılmasıdır. Fiberle güçlendirilmiş kompozit yer tutucular direkt ve indirekt yöntemle üç hastada uygulanmıştır. Altı ay sonunda kabul edilebilir bir klinik performans göstermiştir. Diş çürüğü, diş eti iltihabı ve fiberde kırık görülmemiştir. Dört ay sonrasında retansiyon kaybı görülmüştür. Altı ay sonrasında fiberle güçlendirilmiş kompozit yer tutucularda hasar meydana geldiği için, geleneksel bant-loop yer tutucu uygulanmıştır. Doğru hasta seçimi ve uygun tedavi planlaması fiberle güçlendirilmiş kompozit yer tutucuların başarısını artıracaktır.

Anahtar Kelimeler: Yer koruma; kompozit dental rezin

Turkiye Klinikleri J Dental Sci Cases 2015;1(2):115-20

Composites that are reinforced with polyethylene fibers or glass fibers can result in materials with enhanced mechanical properties, i.e. stiffness, strength, toughness and fatigueless.[1,2] Fibers produce a load-enhancing effect on brittle composite materials by acting as the stress-bearing component and by crack-stopping or crack-deflecting mechanisms.[2,3] The introduction of fiber-reinforced composites (FRCs) in dentistry enabled the development of tooth substance saving, esthetic and cost-effective treatment approaches.[4]

doi: 10.5336/dentalcase.2014-42756

Several different types of fiber reinforcement materials were introduced in the early 1990s. Kevlar, carbon, glass, ultra-high-molecular-weight polyethylene (UHMWPE), and silane-treated glass have been used to provide fiber reinforcement.[5-9] Currently, the most popular fiber types are UHMWPE and glass. When used in dental fiber-reinforcing materials, UHMWPE is typically woven into a fabric ribbon (Ribbond® Reinforcing Ribbon, Ribbond, Seattle, WA; and Connect™, Kerr, Orange, CA).[10] Glass fibers are used in different forms to strengthen dental composites, including woven short and loose fibers, woven long and loose fibers, and fiber bundles.[11] Glass fiber-reinforcing materials are available as resin-impregnated (pre-preg), fiber-reinforcing materials (Splint-It®, Pentron, Wallingford, CT; everStick®, Stick Tech, Turku, Finland) or non-resin impregnated (GlasSpan®, GlasSpan, Inc, Exton, PA)[10] The clinical successes with these materials have been varied.[8,9,12]

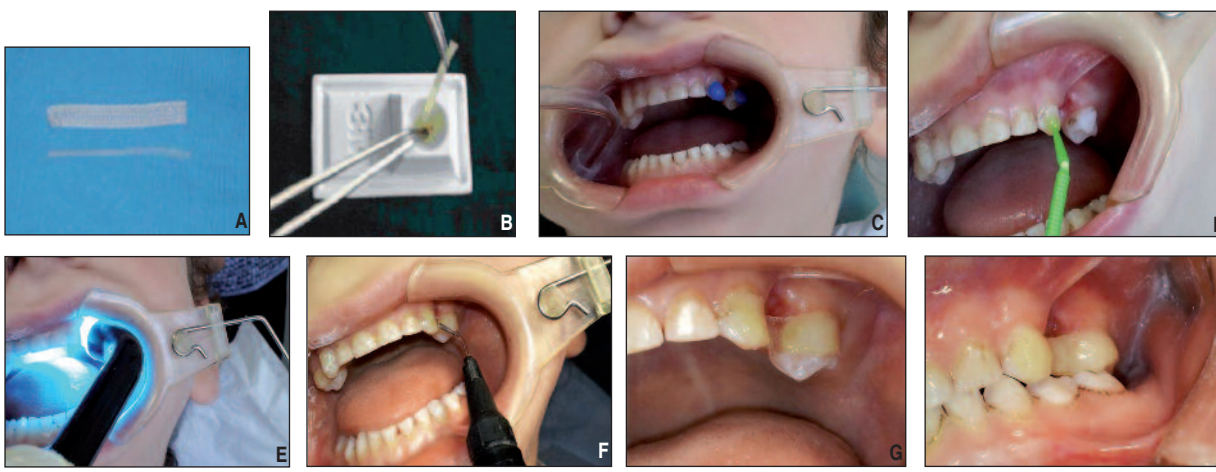
Premature primary tooth loss may result in deleterious changes in dental arch integrity like space loss, crowding and midline shift, compromising the eruption of succedaneous teeth and altering the development of normal occlusion. The most confident way to cope with these problems is through the use of space maintainers.[13] Fiber reinforced space maintainers developed as an alternative to traditional band-loop type space maintainers. FRCs are biocompatible, esthetical, easily acceptable by patients, have low caries risk development and soft tissue impingement. They can be applied to the patient at single session and not require the laboratory stage.[13-16]

The purpose of this article is to present clinical applications of two different fiber reinforced composites as space maintainers and discuss the advantages/disadvantages over the traditional band and loop space maintainers.

CASE REPORTS

CASE 1: FIXED SPACE MAINTAINER WITH NON-RESIN IMPREGNATED FRC.

A 5-year-old girl was referred to Istanbul University Faculty of Dentistry, Pediatric Dentistry Clinic with an extracted primary maxillary left first molar. According to the patient's parents, the molar had been extracted two months earlier. Following clinical and radiographic examinations, the decision was made to create a fixed-space maintainer using Ribbond (Ribbond Inc., Seattle, WA, USA). The length of the dental arch between the neighboring teeth (63-65) was measured with dental floss, and the required length of 2-mm-wide Ribbond was cut with the special scissors supplied by the manufacturer to prevent unraveling (Figure 1A). The Ribbond was wetted with Single Bond (3M/ESPE, St. Paul, MN, USA) and



FIGURES 1A-H: Fixed space maintainer with non-resin impregnated FRC.

protected from exposure to light until ready for use (Figure 1B). The abutment teeth were cleaned with a non-fluoridated pumice paste, etched with 37% phosphoric acid, rinsed and dried (Figure 1C). Single Bond and a flowable composite resin (Unifilflow, Gc, Tokyo, Japan) were applied to the enamel surfaces, the Ribbond was placed, and slight pressure was applied using a rounded instrument to create close contact during the curing process (Figure 1D-F). The Ribbond was coated with flowable composite, the excess composite was removed, and light cured for 40 seconds (Figure 1G). The occlusion was checked, corrections were made and the composite was polished using a polishing disc.

CASE 2: FIXED SPACE MAINTAINER WITH RESIN-IMPREGNATED (PRE-PREG) FRC.

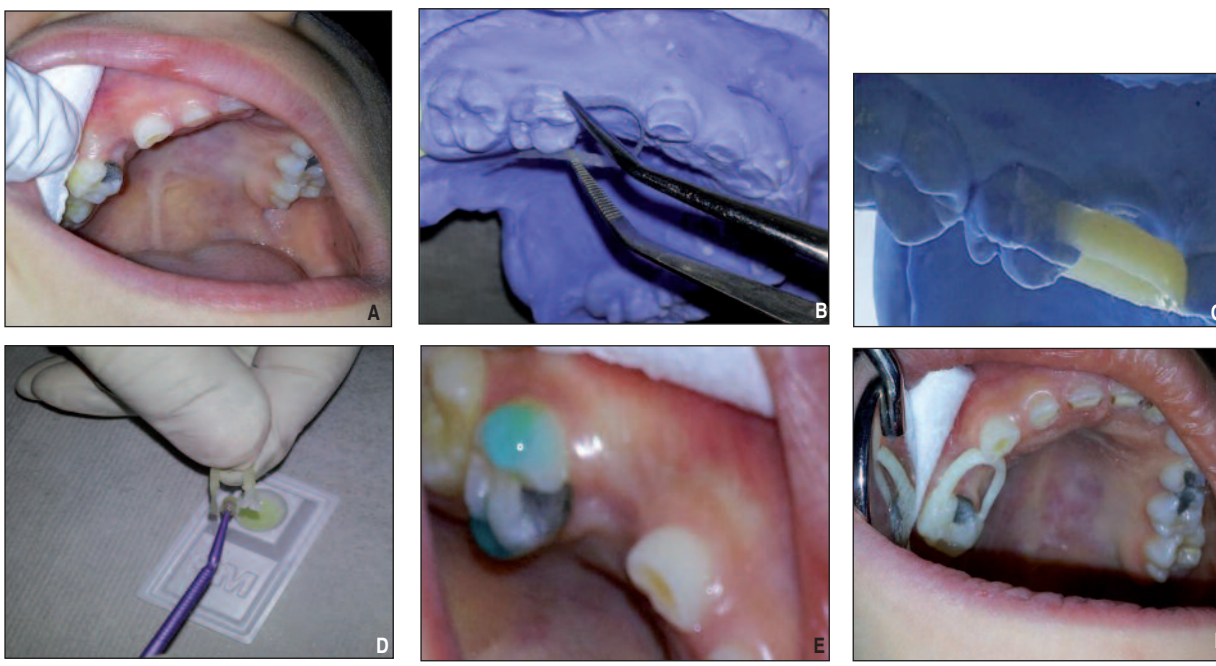
A fixed space maintainer with resin-impregnated FRC was constructed in a 7-year-old boy with extracted primary maxillary left first molar. The tooth had been extracted two months earlier (Figure 2A). A fixed-space maintainer using a resin-impregnated FRC (everStick® C&B, Stick Tech Ltd Oy, Turku, Finland) was constructed. The length of the dental arch between the neighboring teeth (63-65) was measured with dental floss, and the required length of 2-mm-wide FRC was cut with the scissors and protected from light to avoid premature curing (Figure 2B). The abutment teeth were cleaned with a non-fluoridated pumice paste, etched with 37% phosphoric acid, rinsed and dried (Figure 2C). Single Bond and a flowable composite resin (Unifilflow, Gc, Tokyo, Japan) were applied to the enamel surfaces (Figure 2D), the FRC was positioned and light cured for 5–10 sec. per tooth (Figure 2E, F). The FRC was coated with flowable composite, the excess composite was removed, and light cured for 40 sec. per tooth (Figure 2G). The occlusion was checked, corrections were made and the composite was polished using a polishing disc (Figure 2H, I).

FIGURES 2A-I: Fixed space maintainer with resin-impregnated (pre-preg) FRC.

CASE 3: SEMI-FIXED SPACE MAINTAINER WITH NON-RESIN IMPREGNATED FRC

A semi-fixed space maintainer with FRC was constructed in a 6-year-old boy with extracted primary maxillary right first molar. The tooth had been extracted one month earlier (Figure 3A). The space maintainer was prepared by indirect method. The impression for dental cast was obtained from child. The Ribbond was wetted with Single Bond to formulate the loop, leaving 5 mm of fiber on each end for attachment to the abutment tooth (Figure 3B). A thin layer of restorative composite resin (Filtek Z 250, 3M-ESPE, St. Paul, MN, USA) was added to the outer portion of the fiber, leaving the 5 mm of fiber on each end to provide initial rigidity, handling and adaptability to the middle third of the buccal and lingual surface of the the abutment tooth (Figure 3C). The fiber was then light cured for 40 seconds. The loop was then detached from the tooth; restorative composite resin was added to the inner portion of the loop except the 5 mm of the fiber on each end and light cured for 40 seconds. The loop was finished and polished with finishing burs and soflex discs. Single Bond was applied to the free ends of the fiber and protected from the light (Figure 3D). The abutment tooth was cleaned with a non-fluoridated pumice paste, the buccal and lingual surfaces of the tooth were etched with 37% phosphoric acid, rinsed and dried (Figure 3E). Single Bond was applied and cured for 40 seconds. The loop was finally attached to the tooth using restorative composite resin followed by finishing and polishing.

Informed consents were obtained from all patients prior to treatments. Oral hygiene instruction and motivation were given to the patients. All patients were periodically recalled. Results at the end of 6th month showed acceptable clinical performance with failures due to debonding at the enamel-composite interface. There were no fiber fractures, caries or gingival inflammation with the space maintainers. Semi-fixed space maintainer showed retention loss after 4 months. The problems were solved by rebonding and repairing. After 6 months, due to the failure of the FRC space maintainers irreversibly, according to the patients' ages traditional band and loop space maintainers were applied.



FIGURES 3A-F: Semi-fixed space maintainer with non-resin impregnated FRC.

DISCUSSION

Premature loss of the primary teeth is a common occurrence in children. Maintaining arch length during the development of dentition with a space maintainer is essential for the development of occlusion. Among the various space maintainers used in pediatric dentistry, band and loop is the most commonly used fixed space maintainer. Several types of fixed space maintainers were introduced in pediatric dentistry with advantages and disadvantages.[15]

Fiber-reinforced composites have been used in many situations in dental practice with great success. The techniques and clinical success of FRCs as space maintainers were reported limitedly in pediatric dental literature. Design and construction of space maintainers with FRCs were presented by various researchers, but the reports about clinical success are unsufficient.[13-17]

Gajanan et al. reported that ribbond space maintainer as well as repaired ribbond space maintainer are comparable to the conventional band and loop in terms of physical strength.[18]

Yeluri and Munshi presented the semi-fixed type FRC space maintainer and concluded that they have advantages over the traditional band and loop space maintainers.[15]

Semi-fixed type FRC space maintainers may overcome the disadvantages of band and loop space maintainers such as adversely influence the growth and development, exfoliation of primary teeth and the eruption of succedaneous teeth.[15]

We constructed the fixed type of FRC space maintainers in order to enhance their retention by additional length of fiber to the buccal region of the abutment teeth. It has been recommended to use cavities or filled surfaces when presented in abutment teeth to improve the retantion.

The debonding at the enamel-composite interface was reported the main reason for failure of FRC space maintainers. The observation time of the problem was reported as early as 3 months and the possible reasons were described as mechanical stresses, prismless enamel surface of primary teeth and inadequate isolation.[16,17]

The clinical success rates were presented as 27% (6 months), 43% and 53% (1 year) in similar studies.[14,16,17] Kirzioglu and Erturk and Saravanakumar et al. recommended to use splint-it space maintainers only for short periods, Kargul et al. stated that the FRC space maintainers functioned well over 5 months, but Subramaniam et al., recommended glass fiber-reinforced composite resins as a suitable alternative to the conventional fixed space maintainer.[14,16,17,19] Saravanakumar et al. evaluated the clinical success of FRC space maintainers over a period of 18 months and reported the mean survival time as 12 months.[19]

We observed failures due to debonding at the enamel-composite interface within 6 months in both type of maintainers, but the problems were solved by rebonding and repairing. After 6 months, severe damage was detected and according to the patients' ages traditional band and loop space maintainers were applied. The handling properties of resin-impregnated (pre-preg) FRC were found to be superior than non-resin impregnated FRC.

Fracture of the fiber frame at 3 months was reported as other reasons for failure of FRC space maintainers, in contrast to previous reports[14,16,17] The possible reasons for fiber frame fractures were described as chewing patterns, supraeruption and impingement of opposite tooth on the fiber frame.

Chewing pattern and chewing sites were reported as other possible reasons. Space maintainers placed on the right side of the mount had a high percentage (46%, 94%) in early loss in comparison with the left side.[16,17] The survival time of FRC space maintainers for maxilla was reported longer than in the mandible.[14]

Fiber reinforced composite space maintainers can be accepted as an alternative to traditional band-loop type space maintainers with their various advantages. Their function can be maintained with composite resin repair and resurfacing in short term usage. Correct patient selection and proper treatment planning will increase success of FRC space maintainers.

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