

# Fiber Splint in Space Maintainer

## Fiber Space Maintainer

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### ABSTRACT

**Background:** Early loss of primary teeth may result in drifting of teeth and and harm the normal occlusal development. Effective use of space maintainer can prevent or minimize malocclusion by preserving the space.

**Aims:** Compare between the effectiveness of using of fiber splint incorporated with composite resin in space maintainer and the conventional band and loop space maintainer.

**Material and Methods:** Forty six healthy cooperative children aged 6-9 years. The children were randomly divided into two groups: for first group conventional band and loop space maintainer was performed, for the second group, performed using fiber splint and conventional composite resin.

**Results:** Distortion and cement loss of conventional space maintainer were occurring in few cases these need correction. Debonding at the enamel–composite interface of fiber splint space maintainer occurs in few cases, re-attachment was need.

**Conclusions:** The simple technique in performing space maintainer showed many advantages over conventional space maintainer.

**Key Words:** fiber, splint, space, maintainer.

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### INTRODUCTION

In pediatric dentistry, prematurely loss of primary teeth may result in drifting of adjacent primary and permanent teeth and loss of space that can compromise the eruption of the succedaneous teeth and lead to malocclusion development. So, effective use of space maintainer can prevent or minimize the incidence of malocclusion by preserving the space<sup>[1]</sup>

When a primary molar is missing prematurely a conventional fixed band and loop space maintainer is often used to preserve the space. Even these appliances are effective, but they also have many disadvantages such as multiple visits required, time consuming laboratory procedures, food and dental plaque accumulation need additional dental care, caries formation, breakage of solder joints and require cytotoxic solders<sup>[2,3]</sup>.

The use of fibers to improve the mechanical properties has been used in aerospace technology, automobiles and ships. According to clinical and lab studies, fiber is strong and showed greater flexural strength than stainless steel, titanium or zirconia. With the popularization of dental composites, it is natural for fiber reinforcements to become a useful material in dentistry<sup>[4]</sup>. Different types of fibers are used in dentistry such as carbon fiber (unesthetic), glass fibers, polypropylene and polyethylene fibers<sup>[5]</sup>.

Fiber-reinforced composites are resin based materials containing fibers aimed at enhancing their physical properties. These were first introduced in the 1960s by Smith when glass fibers were used to reinforce polymethylmethacrylates<sup>[6]</sup>.

Ribbon® fibers, introduced to the market in 1992, are bondable reinforced fibers consisting of ultrahigh-strength polyethylene fibers. These fibers far exceed the breaking point of fiberglass and are so tough that specially made scissors are required to cut them<sup>[7]</sup>.

The aim of this study was to compare between the effectiveness of using of fiber splint incorporated with conventional composite restoration material and the conventional band and loop in maintain the available space result from prematurely loss of primary mandibular molars. Clinical follow ups carried out after 1, 6, 12 and 18 months.

### **MATERIAL AND METHODS**

Forty six healthy cooperative children aged 6-9 years old of both gender, with either unrestorable painful mandibular primary molar indicated for extraction or prematurely extracted primary mandibular molar and space loss not yet occur, were involved in this study. The study was extended from July 2015 to July 2017 in Pediatric Dentistry Private Dental Clinic, Baghdad, Iraq. The children were randomly divided into two groups (twenty three children in each): for first group conventional band and loop space maintainer was performed, meanwhile for the second group, space maintainer performed using fiber splint and composite resin material. After full clinical and radiographical examinations, full detailed treatment plans were explained to the children's parents and written consents were obtained for including the children in this study. Teeth adjacent to the space were evaluated, any caries were restored and any defective restorations were changed then teeth cleaned with pumice. After one week from accused tooth extracting, the space maintainer was started to perform.

#### **Constructions of band and loop space maintainer<sup>[8]</sup>:**

Preoperative occlusal analysis was performed. Orthodontic bands (0.005inches\*0.180inches) (3M ESPSE, United States) were adapted on the abutment tooth followed by quadrant elastomeric impression (ORMAMAX, Italy) was used to take the impression to the space and adjacent teeth, then a model is poured in stone to make the working cast. Once the stone has achieved its full set, the working model was separated from the impression and loop fabrication was carried out using a 0.036 inch stainless steel wire that is contoured to fit the band and edentulous space. A properly contoured loop should be:

- Parallel the edentulous tissue space,
- lie approximately 1 mm above the gingival tissues,
- reach the distal surface of the tooth anterior to the edentulous apase just below its contact point,
- have sufficient width buccolingually to permit unobstructed eruption of the permanent tooth,
- and should not impinge on either the tongue or buccal mucosa.

Then the loop initially held in place using stone, can then be permanently soldered to the band. After trimming, finishing and polishing, the appliance is cemented with luting glass ionomer cement (RIVA, SDI, England) and occlusion checked for any premature contact (Figure 1).



**Fig. 1: Constructions of band and loop space maintainer**

### Constructions of fiber splint with conventional composite material space maintainer:

Preoperative occlusal analysis was performed. The teeth mesial and distal to the space isolated using cotton rolls and high – volume suction. In order to determine the length of fiber splint required, stainless steel band performed in loop shape and checked intraorally in the space and leaving 5 mm in each proximal edge to be bounded to the buccal and lingual surfaces of distal abutment tooth. Then the exact length of fiber splint (4 mm U.P. Fiber Splint, INNO Dental CO., LTD, Korea) was cut.

Both buccal and lingual surfaces of distal abutment tooth were etched with 35% orthophosphoric acid for 15 s. The teeth were rinsed, air-dried, and wetted with an adhesive (Adper Single Bond-2® 3M) that was light-cured for 40 s. A thin layer of high strength and low wear flowable composite (Filtek, 3M-ESPE, USA) was applied to the buccal surface of distal abutment tooth without light-curing it, then one end of the fiber were adapted to flowable composite with a plastic filling instrument. Preliminary curing was done at the end of the fiber splint for 40s. An additional layer of restorative composite resin (Filtek Z500, 3M-ESPE, USA) was applied over the area where the fiber abutted the tooth surface and this was light-cured for 40s. A similar procedure was repeated on the lingual aspect of the abutment teeth. Then flowable composite was applied along, covered all surfaces and saturated the fiber splint. The distal surface of the mesial abutment tooth (where the fiber splint attached) was etched, rinsed, air-dried, and wetted with an adhesive and light-cured in the same manner mention above (Figure 2). The space maintainer was checked for gingival clearance and occlusal interference. Finishing was done using composite finishing burs.



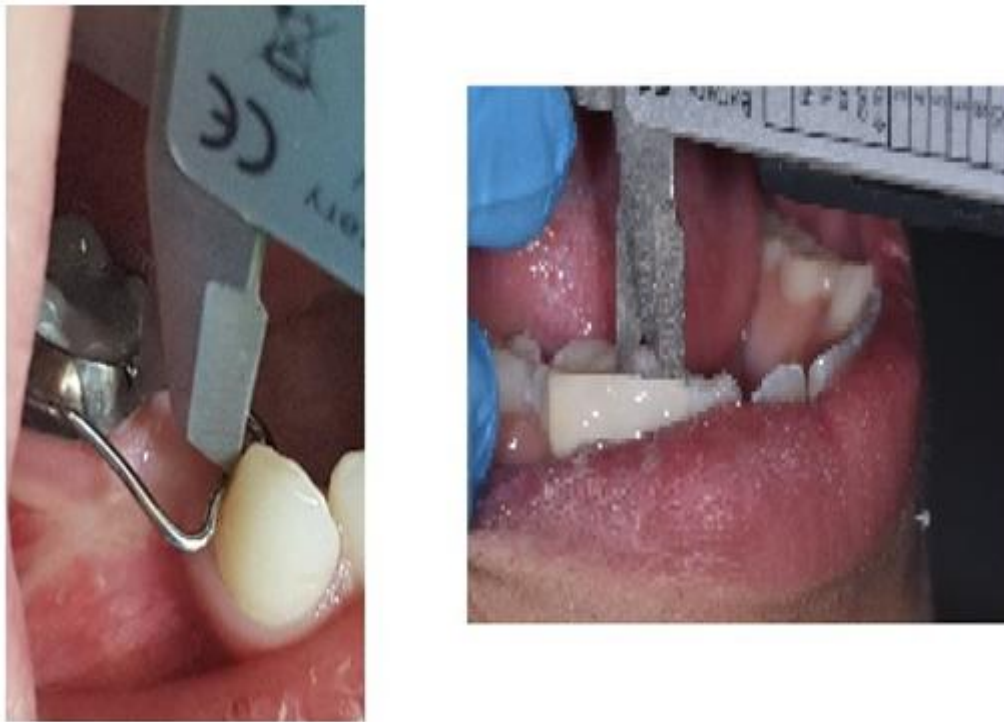
**Fig. 2: Constructions of fiber splint with conventional composite material space maintainer**

The parents were advised to control their children to avoid chewing of hard food and to maintain proper oral hygiene. They were instructed to return promptly if an appliance was loosened, dislodged, or broken. All patients were recalled at 1, 6, 12, and 18 months for evaluation of both types of space maintainers using the criteria given by Qudeimat and Fayle<sup>[9]</sup> and Kirzioglu and Erturk<sup>[10]</sup> (Table 1).

**Table 1: Evaluation criteria for space maintainers**

Evaluation criteria for band and loop space maintainer <sup>(9)</sup>	Evaluation criteria for fiber splint with composite resin space maintainer <sup>(10)</sup>
<ul style="list-style-type: none"> <li>• Distortion</li> <li>• Cement loss</li> <li>• Fracture of the loop</li> <li>• Caries or gingival inflammation</li> </ul>	<ul style="list-style-type: none"> <li>• Debonding at the enamel–composite interface</li> <li>• Debonding at the fiber–composite interface</li> <li>• Fracture of the fiber frame</li> <li>• Caries or gingival inflammation</li> </ul>

Measuring the effectiveness of each type of space maintainer in maintaining the space available was determined through measuring the mesio-distal length of space available using digital vernier caliper (Guangdong, China) (the distance was measured from distal surface of mesial abutment tooth to the mesial surface of distal abutment tooth) at baseline visit and after 1, 6, 12 and 18 months recall visits (Figure 3).



**Fig. 3: Space available was determined through measuring using digital caliper**

The data were summarized and described using relative frequencies and percentages for categorical variables. When the outcome variables were categorical, chi – square and t- test were used to compare between frequencies means for statistical significance. Data were analyzed using SPSS software, version 16.0 (SPSS Inc., Chicago, IL, USA) for Windows. Statistical significance was set at  $p \leq 0.05$ .

## RESULTS

Table (2) illustrated the clinical criteria of conventional band and loop space maintainer after 1, 6, 12 and 18 months recall visits. Distortion occurs in 1 and 2 of 23 cases at 6 and 18 months visit respectively, for those re-contouring the appliance then re-cemented.

**Table 2: Band-and-loop space maintainer**

Evaluation criteria	1 month No.(%)	6 months No.(%)	12 months No.(%)	18 months No.(%)	( p value)
Distortion	0 (0%)	1 (4.3%)	0 (0%)	2 (8.6)	0.9
Cement loss	1 (4.3%)	2 (8.6)	0 (0%)	1 (4.3%)	0.9
Fracture of the loop	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.0
Caries or gingival inflammation	0 (0%)	0 (0%)	3 (13%)	1 (4.3%)	0.8

Concerning cement loss, 1 and 2 cases of 23 at 1, 6 and 18 months, respectively, recorded little degree of rocking these needs re-cementation.

No any case recorded fracture of loop or caries development. Only mild gingival inflammation was recorded in 3 and 1 cases of 23 at 12 and 18 months visits.

Table (3) illustrated the clinical criteria of fiber splint with composite resin material space maintainer after 1, 6, 12 and 18 months recall visits. Debonding at the enamel–composite interface occurs in 1, 2 and 1 of 23 cases at 6, 12 and 18 months visit respectively, for those re-attachment of the appliance was need.



**Table 3: Fiber splint with composite resin space maintainer**

Evaluation criteria	1 month	6 months	12 months	18 months	( p value)
Debonding at the enamel–composite interface	0 (0%)	1 (4.3%)	2 (8.6)	1 (4.3%)	0.9
Debonding at the fiber–composite interface	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.0
Fracture of the fiber frame	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.0
Caries or gingival inflammation	2 (8.6)	1 (4.3%)	2 (8.6)	3 (13%)	0.7

Concerning debonding at the fiber–composite interface and fracture of fiber frame, no any case was recorded. No caries was developed and only mild gingival inflammation was recorded in 2,1,2 and 3 cases of 23 at 1, 6, 12 and 18 months visits, respectively.

Table (4) demonstrated the space available measurements for each space maintainer type at 1, 6, 12 and 18 recall visits. Both types showed no significant differences in the dimension of space available with progression of time.

**Table (4) Space available measurements for each space maintainer type at 1, 6, 12 and 18 recall visits.**

Space Maintainer types	Space available (Mean mm $\pm$ SD)					t - test ( p value)
	1 <sup>st</sup> visit	1 month	6 months	12 months	18 months	
Fiber splint with composite resin	6.22 $\pm$ 0.34	6.21 $\pm$ 0.31	6.21 $\pm$ 0.31	6.20 $\pm$ 0.31	6.20 $\pm$ 0.31	0.0 (1.0)
Band and loop	7.67 $\pm$ 0.12	7.66 $\pm$ 0.12	7.66 $\pm$ 0.12	7.66 $\pm$ 0.12	7.66 $\pm$ 0.12	0.0 (1.0)

## DISCUSSION

Various types of space maintainers can be used to avoid malocclusion as a result of premature loss of primary teeth. The continuous development of dental field to overcome disadvantages of conventional band and loop space maintainer reveal the need for designing new types of space maintainer. The technological advances that have occurred in the past few decades in dental materials for use in children necessitate constant re-evaluation of our treatment philosophies and techniques<sup>[2,3]</sup>.

The development of the fiber-reinforced composite technology has brought a new material into the realm of metal-free adhesive esthetic dentistry<sup>[11]</sup>. Fiber-reinforced composites that incorporates long fibers such as glass or carbon are a new generation of materials with similar features to metals<sup>[12]</sup>.

Most of published researches were involved the using of Ribbond® fibers (Fiber-reinforced composites) in chair-side fabrication of space maintainer<sup>[13,14]</sup>, meanwhile, other<sup>[15]</sup> used EverStick, which is a semi-manufactured product made of glass fibers, thermoplastic polymer, and light-curing resin matrix for reinforcing the dental polymer for performed chair – side space maintainer.

This is the first known clinical study reporting the clinical longevity of using fiber splint incorporated with conventional composite resin material for simple chair – side fabricated space maintainer and compared the outcomes with the conventional band and loop in maintain the available space. Clinical follow up extend to 18 months.

In few cases not reach significant level, band and loop appliance showed distortion and cement loss due to chewing hard and sticky food. These cases could be corrected before any space loss may occur.

McDonald and Avery<sup>[16]</sup> suggested that the band and loop space maintainer should be removed once a year to inspect, clean and apply fluoride to the tooth. Fiber splint loop space maintainer seems to eliminate these annual maintenance steps.

As moisture contamination has been reported to be one of the main reasons for failure of the glass fiber reinforced composite resin space maintainer<sup>[17]</sup>. Subramaniam et al. <sup>[18]</sup>, in their study space maintainers were applied under rubber dam isolation and use of high – volume suction. In another study<sup>[19]</sup> which did not use rubber dam isolation, a relatively high percentage (32%) of glass fiber reinforced composite showed depending at the enamel – composite interface.

In this study, debonding at the enamel–composite interface was occur in few cases not reach significant level because the teeth were isolated using cotton rolls and high – volume suction and reattachment was considered for these cases before any space loss was occur. Debonding at enamel – composite interface was occur may be due to chewing hard

and sticky food and in all cases of debonding, the primary teeth was the abutment, these direct to though the presence of prismless enamel could have negatively influenced the retention of resin<sup>[20]</sup>.

No incidence of caries was observed in all the experimental groups till the end of the study. Even conventional band and loop space maintainer showed better gingival health, but fiber splint space maintainer recorded non significant mild gingival inflammation that can be controlled through repeated instruction about good oral hygiene to the child and parent.

Initially, both types of space maintainers showed no failure and could maintain the space available without significant space loss. This may have been because patients were more careful in the post – appliance – placement period. It is also possible that the parents were more vigilant and more strictly compliant with post – treatment instructions during this period.

Fiber splint and composite restoration space maintainer demonstrated many advantages over conventional band and loop space maintainer. It has an esthetic appearance, is easily manipulated, can be quickly inserted in a single-visit procedure that requires no laboratory services, poses no risk of damage to abutment teeth or gingiva and is easy to clean.

### **CONCLUSION**

Fiber splint incorporation with conventional composite material space maintainers could be considered as a viable alternative to conventional fixed band and loop space maintainers used in pediatric dentistry. Since their survival rate was high as conventional. Long – term clinical trials till the eruption of successor teeth are needed to evaluate their results in the maintenance of such space and eliminate or reduce the need for prolonged orthodontic treatment. But the use of such space maintainers can be successful with careful patient selection.

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