



## Clinical Success of Fiber-reinforced Composite Resin as a Space Maintainer

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### ABSTRACT

**Introduction:** The early loss of deciduous molars is a frequently encountered problem in dentistry. Various space maintainer designs were developed to prevent the loss of the space. The aim of this study was to evaluate long-term clinical performance and survival rates of fiber-reinforced composite resin (FRCR) as a space maintainer clinically.

**Materials and methods:** This study was designed on 44 children who had early missed deciduous molars. Space maintainers were prepared on plaster models of patients and fixed directly to the adjacent teeth. Survival rate and whether it causes any damage to adjacent teeth were examined clinically and radiographically for 24 months or until failure. Kaplan–Meier survival analysis was used for the statistical analyses.

**Results:** Overall, 16.2% of space maintainers were dislodged and accepted to be failed at the end of 12 months. At the 24-month control, 52.2% success was stated with the FRCR space maintainer and because of permanent tooth eruption, 31.8% of space maintainer were taken out. The mean duration of space maintainers was measured to be  $14.8 \pm 3.48$  months. There was no statistical significance between survival time and gender, tooth number, localization, and measured space ( $p > 0.05$ ).

**Conclusion:** After all 24 months follow-up, as well as esthetic properties of FRCR space maintainer, their applicability in a single seance and strength against the forces are determined as the advantages of the technique.

**Clinical significance:** The FRCR space maintainers can be thought of as alternatives to metal space maintainers.

**Keywords:** Esthetic, Fiber-reinforced composite, Prospective clinical trial, Space loss, Space maintainer.

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### INTRODUCTION

The early loss of primary first molars is a frequently encountered problem in pediatric dentistry. The shift/tip of neighboring teeth to the site due to the early extraction of primary teeth or due to various other reasons and formation of a loss of space, crowding of permanent teeth, ectopic eruption, cross-bite, and the shift of the midline to the affected region are among various problems that may appear clinically. In addition to these problems, esthetic loss and weakened chewing functions may also occur.<sup>1-3</sup>

The use of space maintainers to prevent esthetic and functional losses due to possible malocclusion in addition to decreasing the necessity of costly and long-term orthodontic treatments is an effective method.

Today, metal band/crown-loop space maintainers, fixed band composite resin space maintainers, Nance appliance, distal shoe space maintainers, mandibular lingual arc, and transpalatal bar and removable space maintainers of different types are among space maintainers that can be applied in place of lost teeth.<sup>1,4,5</sup>

The biggest disadvantage of these fixed space maintainers is that they require laboratory processing along with their esthetic insufficiencies. Hence, materials that do not require laboratory processing and which can be easily prepared by the dentist in a clinical environment thereby preventing loss of time are currently being studied. Fiber-reinforced composite resin (FRCR) provides new opportunities to us in this regard.<sup>4,6</sup>

In addition to their mechanical properties, FRCR materials are now being used in many areas of dentistry

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due to their advantages, such as the possibility to be prepared by the dentist near the patient, the decrease of the number of visits, adherence to teeth structures by way of adhesive applications along with improved esthetic properties.<sup>7</sup>

Pedodontists have developed various space maintainer designs using fiber material.<sup>8-10</sup> However, many of these studies are technical and case presentations, and the number of studies which evaluate clinical success and long-term results is very small.

The aim of this study is to determine the long-term clinical performance of applied FRCR space maintainers and their survival rates.

## MATERIALS AND METHODS

This study was conducted on 44 children (33 girls and 11 boys); children who had applied to the Pedodontics Department with primary first or second molar tooth loss and who prefer the esthetic fiber space maintainers have been included in our study. Inclusion criteria of the patients are given in Table 1.

The Ethics Council approval required for our study was acquired from Clinical Studies Ethics Council (13.03.2013/78) and approved consent was taken from the parents of the participants.

**Table 1:** Inclusion criteria of the patients

|              |  |
|--------------|--|
| Clinic       | <ul style="list-style-type: none"> <li>• The absence of systemic or allergic problems</li> <li>• Cooperation level is four according to Frankl Scale</li> <li>• The absence of parafunctional habits, such as bruxism</li> <li>• The absence of malocclusion</li> <li>• Presence of adjacent teeth mesial and distal to the lost teeth</li> <li>• The absence of pathologies, such as dental caries, fluorosis, enamel hypoplasia, and stainless steel crown or extensive restoration on the adjacent teeth</li> <li>• All restorative procedures have been completed</li> <li>• Absence of gingival infection or any pathological conditions around abutment teeth</li> </ul> |
| Radiographic | <ul style="list-style-type: none"> <li>• The absence of any pathology on the teeth</li> <li>• Presence of permanent tooth germ under the lost tooth</li> <li>• Presence of bone crypts on the underlying permanent tooth germ</li> <li>• No pathology seen on the eruption way of the underlying permanent teeth</li> <li>• Permanent tooth root development not more than one-third</li> <li>• Abutment teeth root resorption not more than one-third</li> <li>• Abutment teeth do not have any endodontic treatments</li> </ul>  |

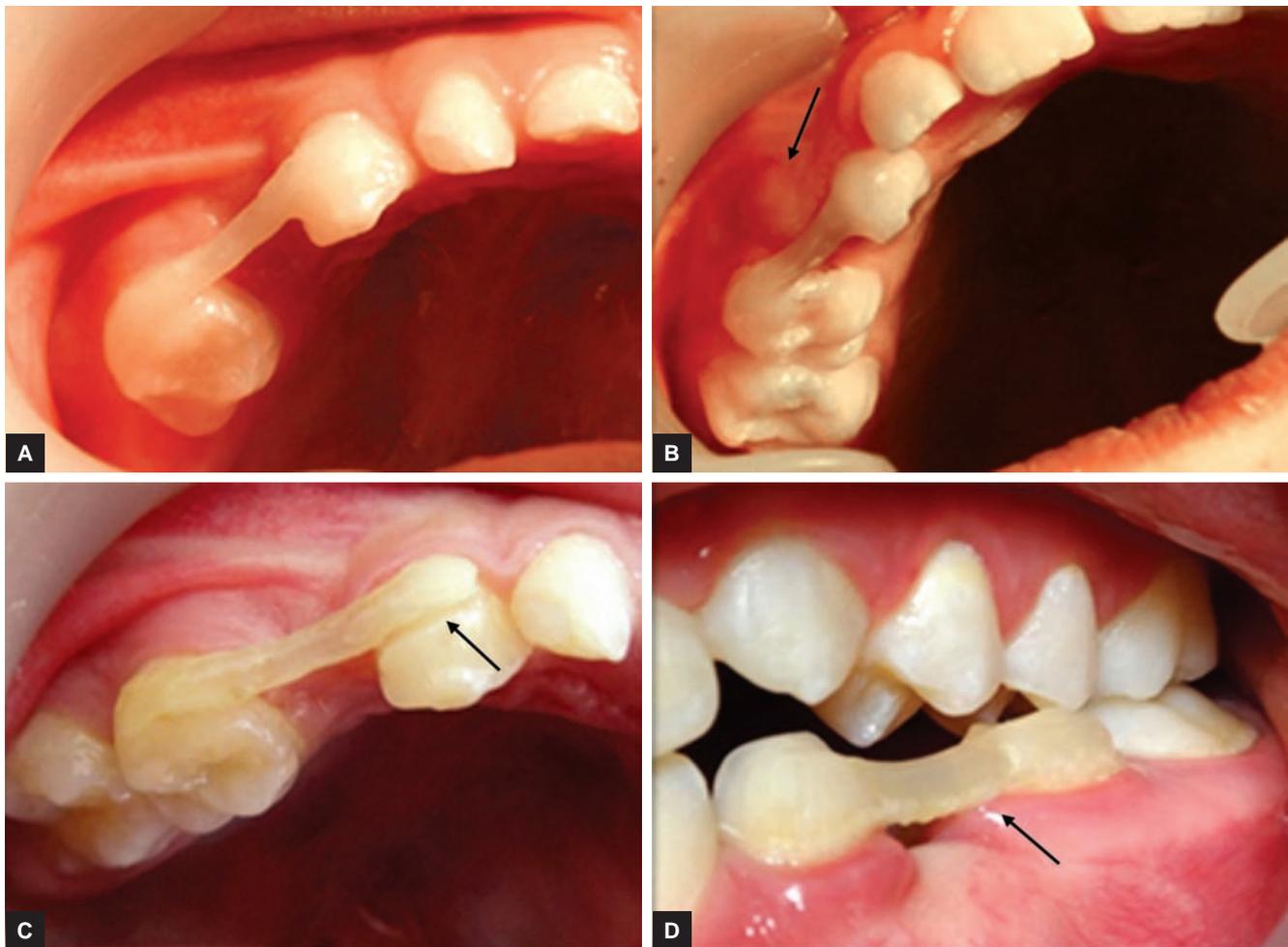
Maxillary and mandibular impressions were obtained with alginate (Cavex Color Change; Cavex Holland BV, Haarlem, The Netherlands), and models have been obtained. The same dentist measured space spans on these models and recorded. A space maintainer resting on the buccal surfaces of the neighboring teeth has been planned using FRCR material. To this end, glass fiber (everStick® C and B; Stick Tech Ltd., Turku, Finland) material has been cut in required size and has been shaped on the model of each patient in accordance with the directions of the manufacturing company.

Afterward, the following procedures were carried out on abutment teeth:

- They were cleaned with nonfluoride polishing paste.
- Isolation precautions are taken.
- Etching was made with 37% phosphoric acid for 30 seconds (15 seconds for permanent teeth).
- Bonding agent (Prime & Bond NT; Dentsply International Inc., Milford, DE, USA) was applied and scrubbed for 20 seconds and 10 seconds light was applied for polymerization.
- Flowable composite (Flow Line; Heraeus Kulzer, Dormagen, Germany) was applied to enamel surfaces.
- Space maintainers that were previously prepared were placed and were then polymerized by applying light for 20 seconds. A halogen light device (Blue Swan; Dentanet, Ankara/Turkey) with light power of 800 mW/cm<sup>2</sup> was used during the polymerization of both the bonding agent and the composite resin material.
- Polishing and final occlusion controls were made (Fig. 1A).
- Children and their parents were informed and motivated about oral hygiene practices.
- Patients were recalled and inspected at every 3 months for 2 years. Furthermore, children and parents were warned that they will be able to observe and come to control visit if the space maintainers are removed or disappeared.

Furthermore, feedback about the esthetic satisfaction of the patients and their parents about the space maintainers were taken via a mini-survey (very satisfied, satisfied, and not satisfied).

The survival of space maintainers, status of abutment teeth, and oral hygiene were evaluated during control sessions clinically and if necessary radiographically. Measurements of the spaces were repeated and recorded at the end of this period. The position of the permanent teeth was evaluated during visits via radiography, and space maintainer was removed if the permanent tooth eruption is seen (Fig. 1B). Space maintainers that fell before time or those in which there was a failure were recorded as unsuccessful (Fig. 1C).



**Figs 1A to D:** (A) The intraoral appearance of the FRCR space maintainer after luting; (B) the permanent tooth swelling is seen (arrow); (C) the reason the majority of space maintainers failed was debonding of the enamel composite interface. Dislodged space maintainer is seen (arrow); and (D) there is a plaque accumulation at gingival part of the abutment teeth and the space maintainer

The data were then processed and analyzed using Statistical Package for the Social Sciences statistical software version 17.0 (Inc., Chicago, Illinois, USA). Kaplan-Meier survival analysis was used to check qualitative data and define statistical significance.

**RESULTS**

Totally, 44 space maintainers were applied in our study to 44 children whose ages varied between 6 and 10 ( $7.9 \pm 1.26$ ) to prevent the loss of space because of the early missed deciduous first molars.

The distribution of space maintainer depending on gender and jaws is shown in Table 2. Table 3 summarizes the number of successful and unsuccessful space maintainers in patients controlled in intervals of 3 months. At the end of the first year, 6 of 44 space maintainers were dislodged and recorded as failures.

**Table 2:** The distribution of the space maintainers according to gender and jaws

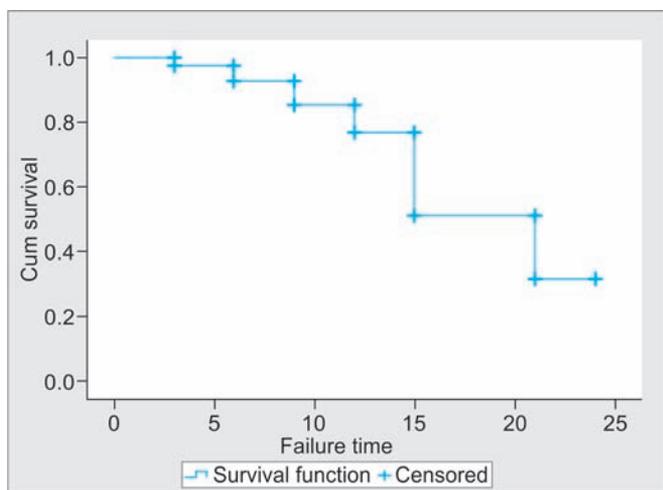
| Gender | Tooth      | Localization on the jaws |       |       |      | Total |
|--------|------------|--------------------------|-------|-------|------|-------|
|        |            | Lower                    | Upper | Right | Left |       |
| Girl   | Primary IV | 5                        | 22    | 13    | 14   | 27    |
|        | Primary V  | 2                        | 4     | 4     | 2    | 6     |
| Boy    | Primary IV | 3                        | 7     | 5     | 5    | 10    |
|        | Primary V  | 1                        | –     | 1     | –    | 1     |
| Total  |            | 11                       | 33    | 23    | 21   | 44    |

After 24 months, a total of 9 space maintainers were retained and defined as successful, and 14 space maintainers were removed to allow permanent tooth eruption. The mean survival time of the space maintainers was  $14.8 \pm 3.48$  months (maximum 24 months; minimum 4 months) (Graph 1).

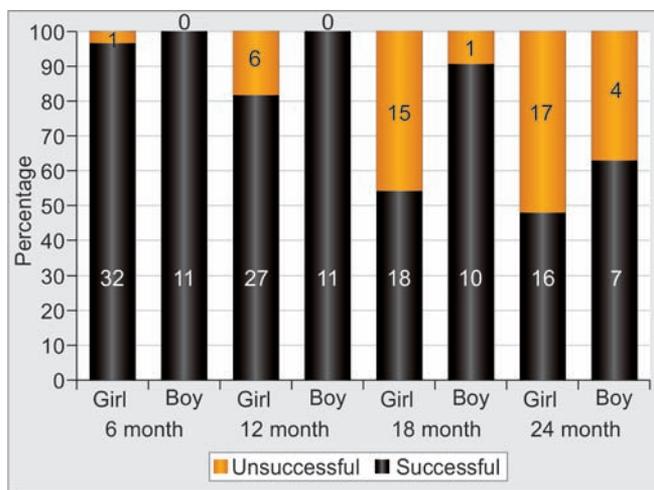
When the relationship between the survival time of space maintainers and gender, type of the teeth, location

**Table 3:** The numbers of successful and unsuccessful space maintainers

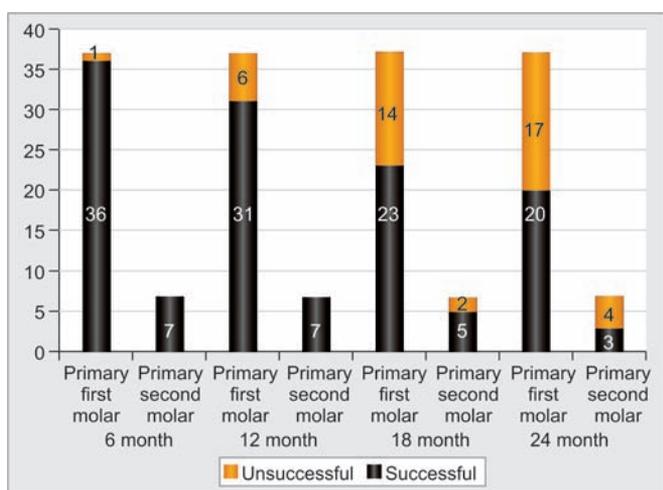
| Status of space maintainer | 3 months | 6 months | 9 months | 12 months | 15 months | 18 months | 21 months | 24 months |
|----------------------------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|
| Successful                 | 44       | 43       | 41       | 38        | 35        | 28        | 28        | 23        |
| Unsuccessful               | –        | 1        | 3        | 6         | 9         | 16        | 16        | 21        |



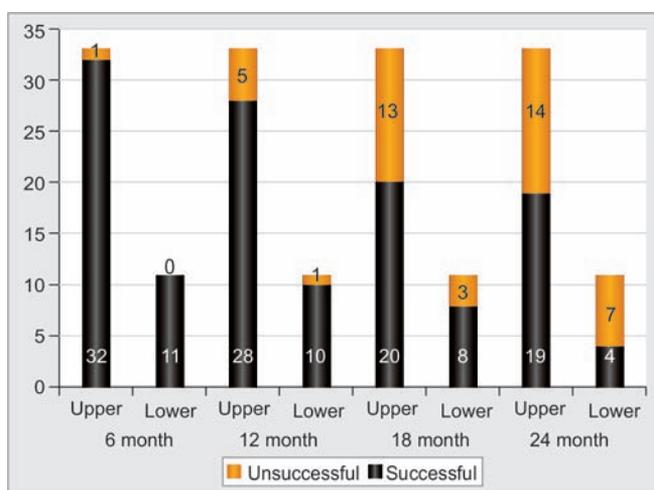
Graph 1: Survival curves for space maintainers



Graph 2: The survival rates of the space maintainers according to gender



Graph 3: The survival numbers of the space maintainers according to the missing teeth

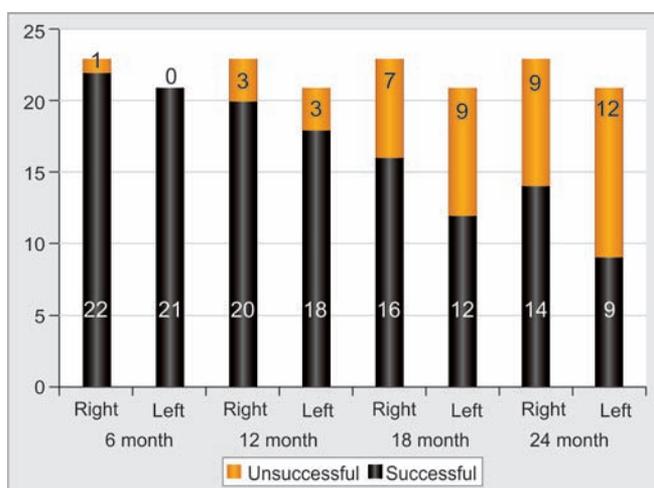


Graph 4: The survival numbers of the space maintainers according to localization on the jaw

of the teeth was examined, no statistically significant difference was observed ( $p > 0.05$ ; Graphs 2 to 5). There was no statistically significant difference between the survival time of space maintainers placed on primary teeth–primary teeth and primary teeth–permanent teeth ( $p = 0.967$ ).

The average distance between the teeth where space maintainers were placed was determined as  $5.89 \pm 1.27$  mm. The relationship between this measurement and survival time of the space maintainers was not statistically significant ( $p = 0.281$ ). The first distance was statistically compared with the distance after the removal of the space maintainers or after the last control – a comparison which resulted in the fact that there was no statistically significant difference between them ( $p > 0.05$ ).

It was determined that patients and parents are very satisfied with the applied space maintainers and no caries formation was observed around the abutment teeth even though there was an inclined plaque accumulation (Fig. 1D).



Graph 5: The survival numbers of the space maintainers according to side of the jaw

## DISCUSSION

In our study, totally 44 FRCR space maintainers have been observed. We saw that after 24 months, patients showed

minimal participation on control seances, and therefore, study finalized and 24-months data are presented.

At the beginning of the study, we aimed only to evaluate the survival rates of the esthetic and flexible FRCR space maintainers which are more preferred by patients and it was not intended to compare with another type of space maintainer. Therefore, there was no control group created.

Space maintainers made from FRCR material which are adhered to the surfaces of teeth have various advantages, such as biocompatibility, esthetics, ease of application, and fast preparation by the dentist or assistant in one appointment.<sup>3,10</sup>

In our study, composite resin space maintainers reinforced with glass fiber material were fixed to the neighboring teeth via composite material. The facts that glass fibers woven with glass filaments have perfect esthetic properties and that they increase the impact resistance of composites are significant advantages. On the contrary, it is a disadvantage that they cannot adhere to the resin matrices easily.<sup>11</sup>

The stabilization of abutment teeth via space maintainers in developing jaws is seen as one of the disadvantages of the method; however, the flexible nature of the fiber material decreases this effect.<sup>7,8</sup> In this study, no additional process was carried out to increase the retention of abutment teeth on which FRCR is applied to children.

A simple design has been used in this study because of the difficulties of shaping the material in our previous studies. Kirzioğlu and Ertürk<sup>3</sup> have carried out another study stating that problems were observed in saliva isolation during the application of space maintainers fixed to the lingual surfaces of adjacent teeth to minimize the occlusal stresses. Hence, the space maintainers prepared in our study were fixed to the buccal surfaces of the adjacent teeth to decrease saliva contamination.

The FRCR space maintainers were fixed on primary teeth–primary teeth or primary teeth–permanent teeth. When such space maintainers are fixed on primary teeth, the prismless enamel surface structure of primary teeth may have negative effects on the retention of resin material. It has been stated in previous studies that space maintainers prepared similarly using fiber material are more stable when fixed on permanent teeth.<sup>3</sup> Swaine and Wright<sup>12</sup> have carried out a study during which they determined the failure rate as 18% in cases when primary teeth are used as abutment and as 60% in cases when application is made between primary and permanent teeth. Researchers think this is due to isolation problems in addition to the fact that polymerization light cannot reach the back region sufficiently. Researchers

have suggested etching at the area to where space maintainers will be applied to decrease the external prismless layer of the enamel. In our study, there was no statistically significant difference between the failure rate of space maintainers placed on primary teeth–primary teeth and primary teeth–permanent teeth.

The failure rate of wire-composite space maintainers during the first 6 months varies between 4 and 30%,<sup>12,13</sup> whereas the failure rate at the end of the first 6 months in our study is 2.3%, which is quite low.

Studies during which the retention of FRCR space maintainers was compared for 12 months with those of band-loop space maintainers have indicated the success ratios as 53 and 33% respectively.<sup>5</sup> In our study, a success rate of 55.8% was observed at the end of the 12 months, which is similar to the findings of the other researchers, whereas the success ratio at the end of 24 months was observed to be 52.27%. This is a considerable success when compared with other space maintainers.

Baroni et al<sup>14</sup> emphasize that occlusal stresses are more important for the long-term use of space maintainers instead of their design. Furthermore, in another study made by Kara et al<sup>15</sup> to compare the biomechanics of space maintainers, it is found that load distributions of band-loop, direct bonded, and fiber-reinforced space maintainers seem comparable. It has also been put forth that children mostly use the right side of the jaw when chewing and hence, space maintainers fixed to the right side of the jaw experience more occlusal stress and are thereby lost earlier.<sup>16</sup> Kirzioğlu and Ertürk<sup>3</sup> have stated that the FRC space maintainers they made and placed to the right side of the arc are less successful in comparison with those placed to the left side. It has been determined during the study carried out by Subramaniam et al<sup>5</sup> that 46% of the space maintainers applied to the right side of the jaws are unsuccessful. On the contrary, Santos et al<sup>17</sup> have stated that they have determined a high failure rate in the left maxilla region, whereas Kirzioğlu and Yilmaz,<sup>13</sup> Baroni et al<sup>14</sup> have determined no statistically significant difference during their studies in which they compared wire-composite space maintainers placed to the right and left sides of the jaw. Similarly, even though the failure rate of space maintainers applied to the right side was higher in our study, no statistically significant difference was observed.

Studies in the literature carried out in this topic are generally in the form of either a case report or the evaluation of a method. The number of studies examining the long-term success of such space maintainers is rare. Yeluri and Munshi<sup>9</sup> have defined the design of a fiber space maintainer. Kulkarni et al<sup>7</sup> have compared different types of fiber space maintainers in the same design with band

loop space maintainers. However, the space maintainers have not been applied on the patient and they cannot simulate *in vivo* studies, especially in children. Hence, our study is important in this aspect.

The initial oral hygiene of the participated patients was determined after the oral hygiene trainings were performed. It was observed during this period that plaque accumulation increased on the gingival region of the space maintainers on abutment teeth. The reason for the increase in this plaque accumulation is thought to be the fact that children tend to shy away from brushing the region of the abutment teeth to avoid the fall of the space maintainers. However, decalcified regions were not observed on any teeth. It has also been reported that enamel decalcifications or cavity formations are common in fixed band and loop space maintainers as well as on the abutment teeth.<sup>18</sup> This supports the findings of Erbe et al<sup>19</sup> who indicate that the metal material increases plaque accumulation. Therefore, we think that space maintainers made from fiber materials are more successful than metal space maintainers in this aspect. In addition to the esthetic properties of FRCR space maintainers, it is also observed that they can be prepared in just one session and that they are more resistant to forces from outside. This shows that they can be thought of as alternatives to metal space maintainers.

## CONCLUSION

As a conclusion of our study, the advantages of FRCR space maintainers are:

- It is more esthetic than metal space maintainers.
- It can be prepared in one session.
- Its durability is acceptable.

Two-year follow-up of our study shows that FRCR space maintainers can be used successfully as an alternative to the metal space maintainers. However, different application types and the long-term use of this material as a space maintainer in children must be evaluated further.

## CLINICAL SIGNIFICANCE

Space maintainers are very important subject in preventive dentistry. Today, different types of space maintainers can be applied for space maintenance. This study indicated that FRCR space maintainers can be accepted as a successful appliance.

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