Clinical Evaluation of Simple Fixed Space Maintainers Bonded With Flow Composite Resin

Sera Simsek, PhD, DDS Yucel Yilmaz, PhD, DDS Taskin Gurbuz, PhD, DDS

ABSTRACT

The aim of this study was to evaluate the clinical performance of simple fixed space maintainers bonded by using a flow composite resin (Tetric Flow) to prevent space resulting from early extracted primary teeth. For that reason, 64 fixed space maintainers (34 in the lower jaw and 30 in the upper jaw) were applied to 45 patients. The patients followed up for 12 to 18 months. Survival rate, prevention ability of that space, and whether damage to the abutment teeth occurred were evaluated. Five percent of space maintainers were determined to be unsuccessful at the end of the control period. During this period, loss of space among the abutment teeth was found to be statistically insignificant ($P>.05$). Finally, it was observed that the use of simple fixed space maintainers was successful due to operator experience and the choosing of favorable patient groups. (*J Dent Child.* 2004;71:163-168)

KEYWORDS: SIMPLE FIXED SPACE MAINTAINERS, FLOW COMPOSITE

The premature loss of the primary molars and the failure to protect this site during normal growth and developmental events may endanger the occurrence of the neutral occlusion in the permanent dentition.

The goal of dentists, especially those who examine and treat children's teeth, must be to completely protect the dental occlusion of patients. Protection of dental arch relations in the premature loss of teeth can only be ensured with placement of space maintainers. In addition to such fixed space maintainers as Sannerud space maintainers, band-loop space maintainers, crown-loop space maintainers, lower-lingual holding arch space maintainers, maxillary arch wire space maintainers, and Nance appliances, removable partial dentures of different kinds have also been used.[1-5]

Among their disadvantages, these fixed space maintainers:

1. tend to lead to tipping and rotating in the supporting teeth;
2. are likely to cause demineralized sites and cavities in the supporting bonded teeth;
3. require some preparation in some of the abutment teeth;
4. involve long periods of consultation with the patient;
5. require long laboratory stages;
6. involve the process of soldering during the preparation;
7. can lead to ruptures in the soldered sites over time;
8. can require solders that have cytotoxicity.[3-10]

Some changes have appeared in the preparation of the fixed space maintainers ever since Buonocore[11] reported that the process of acid etching could increase the rate at which resin holds on to the surface of the enamel. The space maintainers designed with the orthodontic wire were bonded with resin to the soldered enamel for the space control to test their efficiency and their duration of staying within the mouth.[12-14] Their duration of success did not last longer than 6 months. In the early days, the materials used to bond the fixed space maintainers were the bonding agents and composite resins cured with chemicals or UV rays.[14,15] In 1976, Swaine and Wright[14] achieved a 70% success rate with fixed space maintainers bonded by using composite resin polymerized by the UV rays. In 1999, however, Kirzioglu and Yilmaz[15] reported an 86% success rate in their study in which they used for the bonding of the fixed molars the fourth-generation bonding agents and hybrid composite resins polymerized by the visible light.

In recent years, by reducing the filling rate of the composite resins but without changing their resin matrixes, "flow composite" resins, a new class of these materials, have begun to be used in dentistry.[16] Until they are activated by the ray, these materials continue to flow into cavities difficult to reach due to their thixotropic qualities. Opdam et al[17] applied flow

Drs. Simsek, Yilmaz, and Gurbuz are assistant professors, Department of Pedodontics, Faculty of Dentistry, Atatürk University, Erzurum, Turkey.
Correspond with Dr. Yilmaz at yyilmaz25@atauni.edu.tr

Figure 1. The inner-mouth appearance of a patient prior to the application.

Figure 2. The appearance of the prepared space maintainer on the study model.

composite in the restoration of Class I cavities and reported that less porosity occurred at the end of the application. They also reported that these materials would better adapt to the cavities.

The objective of this study was first to investigate the clinical effectiveness on the bonding of the simple fixed space maintainers of the fifth-generation dentin-bonding agent (Single Bond) and a flow composite resin (Tetric Flow) with no described indication in the bonding of the space maintainers, and then to reveal the protective quality of these space maintainers after 18 months of observation.

METHODS

This study was conducted on 51 children (19 girls and 32 boys; average age=7.3), who received permission from their parents and who had lost their primary first and second molars early due to various reasons. They had all come to the Clinic of Child Dentistry at the Faculty of Dentistry, Atatürk University, Erzurum, Turkey.

Among the authors' criteria for inclusion in the study, each child had to have:

1. lost primary molar;
2. tooth in the mesial and distal areas of the extraction space;
3. no restorative application on the buccal surfaces of the abutment teeth (Figure 1).

Radiographically, the authors looked for:

1. root resorption degree of the abutment teeth;
2. presence of lower permanent tooth;
3. amount of bone crypt on the tooth germ;
4. root development degree of the permanent tooth;
5. absence any pathological evidence on the eruption track of the permanent tooth;
6. completed apex formation on any tooth that was to be used as the abutment tooth.

The authors took some measurements with alginate from the jaws of children meeting these criteria and obtained the study models. The authors prepared space maintainers that would be 1 mm away from the orthodontic wire, gingival edge, and gingiva (Figure 2). Prior to the clinical application of the space maintainers prepared, abutment teeth were cleaned by means of a nonfluoride polish paste. After that, the abutment tooth was subjected to etching by phosphoric acid (Art. No. 1063, Voco, Cuxhaven, Germany), first in the mesial and then in the distal in accordance with manufacturers instructions. Being a dentin-bonding agent, Single Bond (3M Dental Products St. Paul, Minn) was then applied to the etched abutment teeth. After a 25-second wait, they were exposed to rays for 10 seconds/hour following the process of spreading with air spray. The fixed space maintainer placed on the abutment teeth was bonded with Tetric Flow (Reorder No. 556546, Vivadent-Ets, FL–9494 Schaan/Lichtenstein), a flow composite resin, by using the layer method and exposing each layer to the ray for 40 seconds/hour. The authors controlled whether there were any early contact points on the space maintainers placed, and the process was completed by means of Sof-Lex discs (Order No. 2380, 3M ESPE Dental Products D–82229 Seefeld-Germany; Figure 3).

The patients were given oral hygiene instructions and were called back for controls every 3 months. During the control portion of the study, the authors clinically examined whether the space maintainer was still in its place and whether there was any problem in the supporting tooth. If there were broken wire ends on the abutment teeth, the space maintainer

Figure 3. The inner-mouth appearance of the prepared space maintainer after the application.

was regarded as unsuccessful. If the loss was one third in the composite resin without losing the space maintainer or if there was no loss observed in the patients, they were regarded as successful.

In the evaluation process, the position of the permanent tooth was examined with radiographs taken. If the tooth was about to erupt, the composite resins on the space maintainer abutment teeth were taken away and removed, and then the abutment teeth to remain in the mouth were polished and protected with fluoride varnish.

The ability of the space maintainer to maintain the space during the study was determined by evaluating the linear and spatial relationships between the 2 abutment teeth. These measurements were fulfilled on the initial study models and on the final control models of the jaws concerned. The spatial measurements that demonstrated whether there was any rotating movement of teeth and any loss between the initial and final models were obtained by modifying the methods of Swaine and Wright[14] and calculated by entering these data into Microsoft Excel software.

The measurements and calculations were made in the following way:

1. In the absence of primary first molar (Figure 4), the line that connects the mesiobuccal and mesiolingual cusp tips of the primary second molar constituted the base side (A1) of the triangle.
2. The line that connects the cusp tip of the mesiolingual and the cusp tip of the canine of the primary second molar constituted the second side (C1) of the triangle.
3. The line that connects the cusp tip of the mesiobuccal and the tip of the canine of the primary second molar constituted the third side (B1) of the triangle.

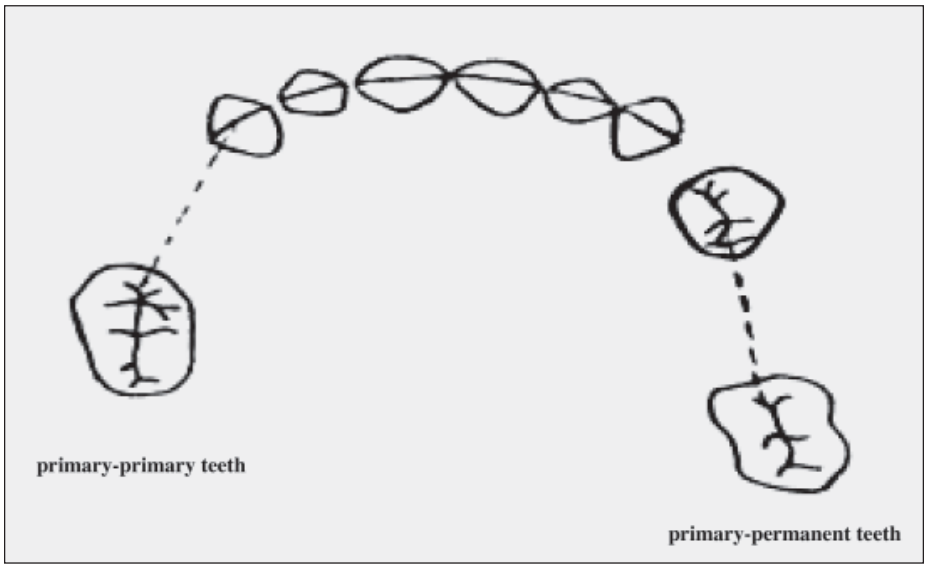

Figure 4. Measurement of the linear change between primary–primary tooth and primary–permanent tooth.

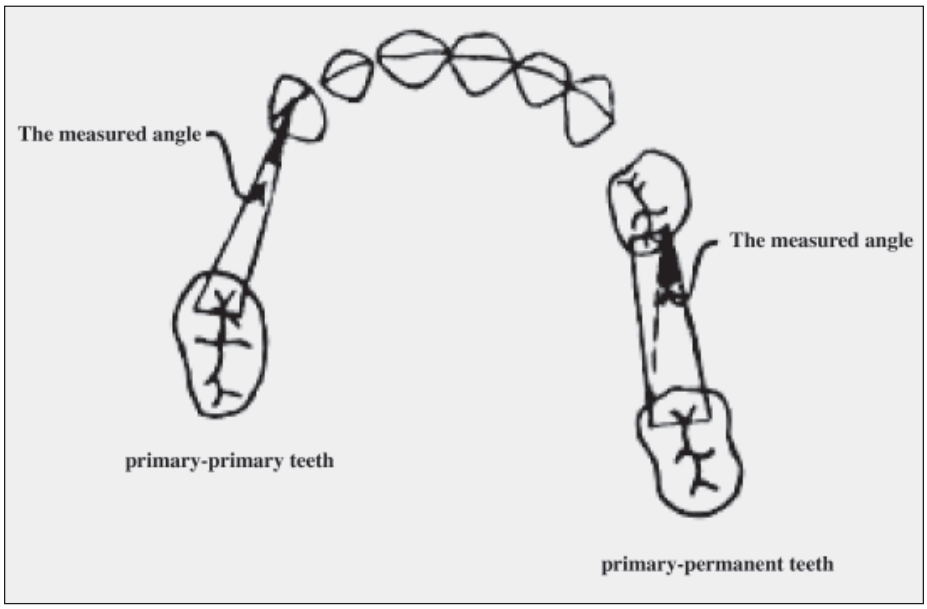

Figure 5. Measurement of the angular change between primary–primary tooth and primary–permanent tooth.

The measurements recorded under these criteria were applied in square root formula ([B1*B1+C1*C1-A1*A1/2]/2). Thus, the median of the triangle was obtained. To find out whether there any rotating movement occurred in the abutment teeth, the top angle of the triangle was taken into consideration (Figure 4). This angle was calculated with the degree formula ([ACOS (B1*B1+C1*C1-A1*A1)]/[2*B1*C1]).

In the absence of the primary second molar, the length of the line (A1) that connects the mesiolingual and mesiobuccal cusp tips of the first permanent molar and the length of the line (D1) that connects the distolingual and distobuccal cusp tips of the primary first molar were measured. Then, the length of the line (C1) that connects the mesiolingual cusp tip of the first permanent molar and the distolingual cusp tip of the primary first molar and the length of the line (B1) that connects the mesiobuccal cusp tip of the first permanent molar and the distobuccal cusp tip of the primary first molar were measured. This process led to a rectangle (Figure 5).

Afterwards, the length of the line that connects the midpoints of the lines connecting the cusp tip of each tooth was calculated via the square root formula ([B1*B1+C1*C1-(A1-D1)*(A1-D1)/2]/2). To determine if any angular change occurred in the space maintainers bonded to

these teeth, the authors used the degree formula ([ACOS (B1*B1+E1*E1-A1*A1)]/[2*B1*E1]) to calculate the top angle of the triangle facing the vestibule obtained through the connection of the line (E1) extending from the mesiolingual cusp tip of the first permanent tooth to the distovestibule cusp tip of the primary first molar.

Whether there was any statistically significant difference between the initial and the final linear and angular values obtained was tested by using the equalized *t* test.

RESULTS

The placement of 74 space maintainers applied to 51 children, with the aim of protecting the loss of space that resulted from the premature loss of the primary teeth. Forty-five children come to the authors at recall visits. While 64 fixed space maintainers were evaluated, six patients who did not come for the control were excluded from the study. The distribution of the fixed space maintainers applied in this study is listed in Table 1, according to gender.

The distribution of space maintainers placed is listed in Table 2, according to the jaws and sides of the jaws. As seen in Table 2, 34 space maintainers were placed in the mandible while 30 of them were placed in the maxilla.

The distribution of the space maintainers is given in Table 3 according to the abutment teeth to which they were bonded.

The first distance between the teeth where space maintainers were placed was statistically compared with the distances after the removal of the space maintainers or after the last control—a comparison which resulted in the fact that there was not a statistically significant difference between them ($P>.05$). Also, the comparison of the angular changes that occurred in abutment teeth with time gave the result that the angular changes that occurred between the first and final measurements were not statistically significant ($P>.05$).

The duration of the presence of the space maintainers within the mouth was determined to be 12 to 18 months (average=15.6 months; Figures 6-8). During this follow-up period, 3 space maintainers in the mandible (5%) failed—2 of them failing in the first 2 months while the third failed in the 17th month.

Table 1. Distribution of Space Maintainers According to Gender

Gender	Number of space maintainers
Girls	29
Boys	35

Note: Data represent about 90% of US children.

Table 2. Distribution of Space Maintainers According to the Jaws

	Direction of jaw	
Distribution	Right	Left
Lower	21	13
Upper	19	11

Table 3. Distribution of Space Maintainers According to Abutment Teeth

Abutment teeth	Mandible	Maxilla
Permanent-primary	12	8
Primary-primary	22	22

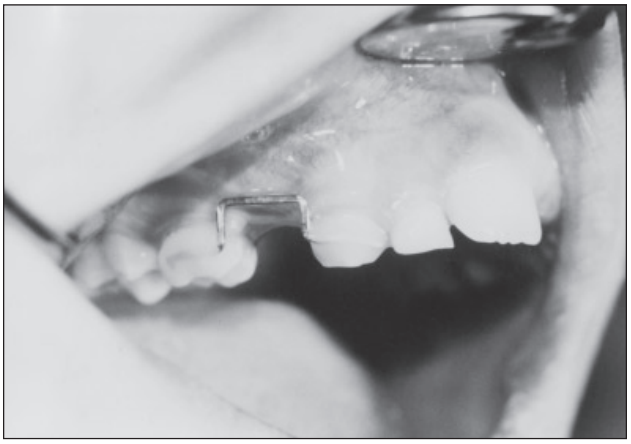

Figure 6. The intra-oral appearance of a patient at 12 months.

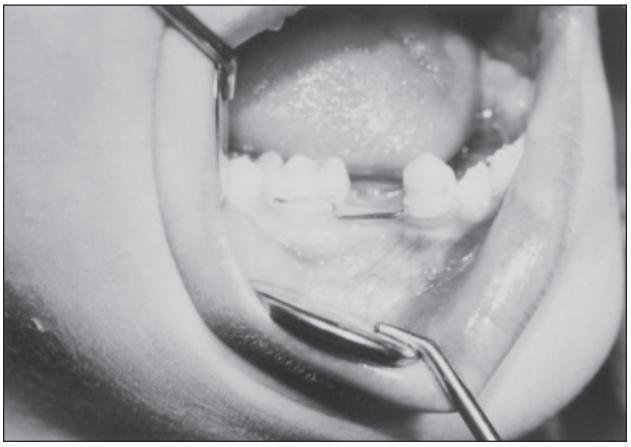

Figure 7. The intra-oral appearance of a patient at 14 months.

Figure 8. The intra-oral appearance of a patient at 18 months.

DISCUSSION

The placement of the proper space maintainer in children requires the knowledge of the growth process of the dental arch. In their study, in which they examined the impact of the removable space maintainers on the distance between the canines during the process from the primary canine dentition to permanent canine dentition, Dincer et al[18] reported that such space maintainers could hinder the development of the width and length of this site. However, no study was found reporting that the fixed space maintainers could create such an impact. Baroni et al[9] emphasized that the fixed space maintainers could be used without changing for 7 to 8 years.

As a result of the premature loss of 1 or more primary teeth, the following can occur:

1. a midline discrepancy in permanent dentition;
2. crowding in the dental arches;
3. some changes in the arch line;
4. loss of space.

Hoffding and Kisling[19] reported that the:

1. premature loss of the primary first molars in the maxilla could lead to crowding in the back segment and to loss of place in the mandible;
2. premature loss of the primary second molars could lead to changes in the horizontal direction molar relations.

Even though a variety of indications have been suggested for the use and design of space maintainers in child dentistry, there is very little data on their efficiency.[6,9,20] The space maintainers most commonly used in the premature loss of the back teeth were reported as being band-loop or crown-loop space maintainers prepared in laboratory conditions. Baroni et al,[9] reported that the failure with such space maintainers occurred between 12.5 and 14 months on the average and their failure rate was 10% and 11%, respectively. In this study, however, the authors made a clinical evaluation of simple fixed space maintainers—a kind of space maintainer which, the authors believed, the dentist could easily prepare near the patient without needing any laboratory stage. Furthermore, the authors determined that the rate of failure after a 15.6-month follow-up was 5%.

On the other hand, other researchers reported that the rate of failure with fixed space maintainers, prepared in the same way as the authors, was 15% and 30%, results which are quite high. The authors are of the opinion that the differences between the rates of failure in these studies have resulted from the bonding systems and resin materials used in the studies. Unlike the other researchers, this study's authors used Single Bond, a fifth-generation dentin-bonding system, and Tetric Flow, a flow composite resin. It was stated that the flow composites, because of their thixotropic qualities, could better adapt to the difficult places to access and that lower air bubbles could emerge during the application.[17] The high clinical rates of success obtained accounts for these explanations.

All failures in space maintainers applied by the authors that occurred during the follow-up period were, not unlike previous studies, observed in the mandible.[14,15] Whereas the other researchers attributed the high rates of failure in the mandible to the deficiency of saliva isolation in the area and to the excess of the chewing forces, Yilmaz et al[21] have recently shown that enamel surface qualities of the primary teeth in the mandible could also be influential on this result. All of the failed space maintainers in this study were the ones placed between primary-primary teeth, a result which is supportive of the findings by Yilmaz et al.[24]

Although the patients were given oral hygiene training during the follow-up evaluation periods of the space maintainers placed, it was observed that there was an accumulation of plaque in the abutment teeth, but there was no decalcified area or cavity. Artun and Marstrander[12] and Kirzioglu and Yilmaz[15] also reported similar cases. If band-loop space maintainers had been used in this study, these cases might have produced different results. Prush[8] expressed that decalcification of the enamel and occurrence of caries are common problems in the abutment tooth where the orthodontic band of the band-loop space maintainers is present.

CONCLUSIONS

It was revealed in this study that the loss of space—which might appear in the linear measurements between the abutment teeth where space maintainers were placed—was of no statistically significant difference ($P>.05$). This is in accordance with the results found by the other researchers.[14,15] As for the evaluation of the angular changes in the abutment teeth, no statistically significant difference ($P>.05$) was found, as in the study by Swaine and Wright.[14] Accordingly, the use of such space maintainers eliminates the problem of rotating in the abutment teeth, which is normally a matter of concern with the other space maintainers.

In light of these evaluations, it was observed that flow composites used together with the fifth-generation bonding system were quite successful in bonding such space maintainers. Thus, the authors believe that another significant indication exists for flow composite resins in pediatric dentistry.

REFERENCES

1. Croll TP. Light-hardened luting cement for orthodontic bands and appliances. *Pediatr Dent*. 1999;21:121-123.
2. Hill CJ, Sorenson HW, Mink JR. Space maintenance in a child dental program. *J Am Dent Assoc*. 1975;90:811-815.
3. Kisling E, Hoffding J. Premature loss of primary teeth: Part IV, a clinical control of Sannerud's space maintainer, type I. *J Dent Child*. 1979;46:17-21.
4. Qudeimat MA, Fayle SA. The longevity of space maintainers: A retrospective study. *Pediatr Dent*. 1998;20:267-272.
5. Wright GZ, Kennedy DB. Space control in the primary and mixed dentitions. *Dent Clin North Am*. 1978;22: 579-601.
6. Bayardo RE. Anterior space maintainer and regainer. *J Dent Child*. 1986;53:452-455.
7. Croll TP. Prevention of gingival submergence of fixed unilateral space maintainers. *J Dent Child*. 1982;49: 48-51.
8. Prush RJ. The use of stainless steel crowns in the contruction of space maintainers. *J Dent Child*. 1978;45:37-39.

9. Baroni C, Franchini A, Rimondini L. Survival of different types of space maintainers. *Pediatr Dent*. 1994;16: 360-361.
10. Mockers O, Deroze D, Camps J. Cytotoxicity of orthodontic bands, brackets, and archwires in vitro. *Dent Mater*. 2002;18:311-317.
11. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res*. 1955;34:849-853.
12. Artun J, Marstrander PB. Clinical efficiency of two different types of direct bonded space maintainers. *J Dent Child*. 1983;50:187-204.
13. Santos VLC, Almeida MA, Mello HAS, Keith O. Direct bonded space maintainers. *J Clin Pediatr Dent*. 1993;17:221-225.
14. Swaine TJ, Wright GZ. Direct bonding applied to space maintenance. *J Dent Child*. 1976;43:401-405.
15. Kirzioglu Z, Yilmaz Y. Kompozit reçine ile yapistirilan basit yer tutucularin uzun süreli gözlemlenmesi. *Atatürk Üni Dis Hek Fak Derg*. 1999;9:47-53.
16. Bayne SC, Thompson JY, Swift EJ, Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. *J Am Dent Assoc*. 1998;129: 567-577.
17. Opdam NJ, Roeters JJ, Peters TC, Burgersdijk RC, Teunis M. Cavity wall adaptation and voids in adhesive Class I resin composite restorations. *Dent Mater*. 1996;12: 230-235.
18. Dincer M, Haydar S, Unsal B, Turk T. Space maintainer effects on intercanine arch width and length. *J Clin Pediatr Dent.* 1996;21:47–50.
19. Hoffding J, Kisling E. Premature loss of primary teeth: Part II, the specific effect on occlusion and space in the permanent dentition. *J Dent Child*. 1978; 284-287.
20. Qudeimat MA, Fayle SA. The use of space maintainers at a UK pediatric dentistry department. *J Dent Child*. 1999; :383-386.
21. Yilmaz Y, Simsek S, Yüksel Kocogullari ME. An in vitro evaluation of adhesive strength of the simple space maintainers on different deciduous teeth surfaces. 9th International Dental Congress of TDA. June, 2002.