A direct composite fixed partial denture fabricated using a wax mock-up technique: A clinical report

Toru Nikaido, DDS, PhD,[a] Masaomi Ikeda, BSc, RDT,[a] Richard M. Foxton, BDS, PhD,[b] and Junji Tagami, DDS, PhD[a,c]

[a]Cariology and Operative Dentistry, Department of Restorative Sciences, Graduate School, Tokyo Medical and Dental University, Tokyo, Japan, [b]Division of Conservative Dentistry, Guy's, King's and St. Thomas' Dental Institute, Kings College of London, London, UK, and [c]Member of the Center of Excellence Program for Frontier Research on Molecular Destruction and Reconstruction of Tooth and Bone, Tokyo Medical and Dental University, Tokyo, Japan

An 80-year-old woman was provided with a direct composite fixed-partial denture to replace a missing maxillary first premolar using a wax mock-up technique. A wax mock-up was made in the laboratory and then a silicone impression was taken of the basal aspect of the pontic to make silicone matrix. The surface of the adjacent maxillary canine was not prepared and the bonding surface was expanded to any undercut areas and the disto-labial/disto-buccal corners, while the adjacent maxillary second premolar had a MOD cavity as a retainer, because of the removal of the secondary caries associated with a failed metal inlay. A composite fixed partial denture was then directly fabricated at the chairside using the silicone matrix to shape the base of the pontic. This is fairly minimally invasive prosthodontic treatment option for constructing a transitional fixed partial denture. **(Int Chin J Dent 2005; 5: 65-70.)**

Key Words: adhesion, direct composite, fixed partial denture, pontic.

Introduction

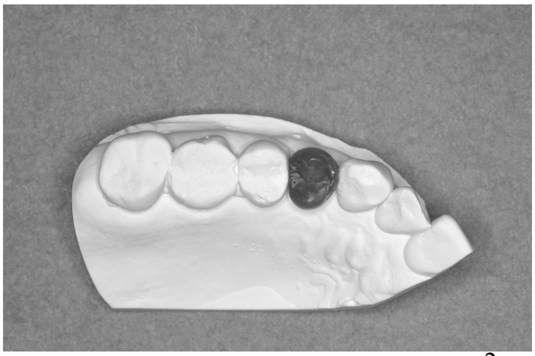
The development of good adhesive materials has enabled a minimally invasive approach to caries treatment to be undertaken using a direct resin composite.[1,2] This has also lead to the development of resin-bonded fixed partial dentures (RBFPD) with metal frameworks as an alternative to full-preparation FPDs.[3,4] Recently, resin pre-impregnated fiber-reinforced composites (FRCs) have been developed, which offer high fracture strength and tooth-colored metal-free frameworks.[5,6] Fiber-reinforced composite FPDs can be fabricated either directly at chairside[7-9] or indirectly in the laboratory.[6,9] Adding fibers creates a layer, which could act as an impediment to crack formation and debonding.[10] However, in some pre-impregnated FRC materials, air bubbles trapped between the fibers in the matrix may weaken the matrix and localize stresses that could lead to crack formation, contributing to failures within the FRC matrix.[10]

It is generally thought that fiber-reinforced fixed partial dentures are not always necessary when replacing only one missing tooth, if good adhesive materials and proper procedures are adhered to.[11] The direct composite fixed partial denture without fiber reinforcement is an option for fabricating three-unit FPDs. Previously, composite denture teeth have been used as pontics in RBFPDs.[12] However, it is difficult to form the basal shape of a pontic intraorally. The following case report describes how a direct composite fixed partial denture can be made using a wax mock-up technique with minimal intervention.

Clinical Report

An 80-year-old patient attended the Operative Dentistry Clinic of the Dental Hospital of Tokyo Medical and Dental University requesting treatment for a missing maxillary right first premolar. The adjacent canine was intact and the second premolar had a gold MOD inlay with secondary caries (Fig. 1).

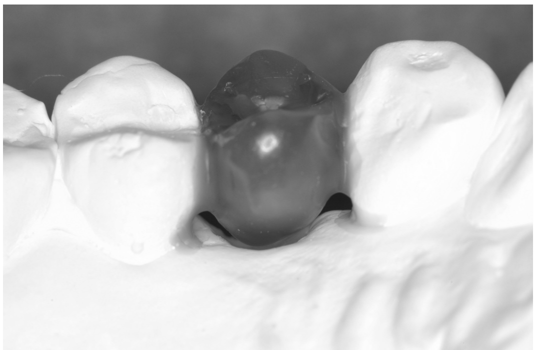
1



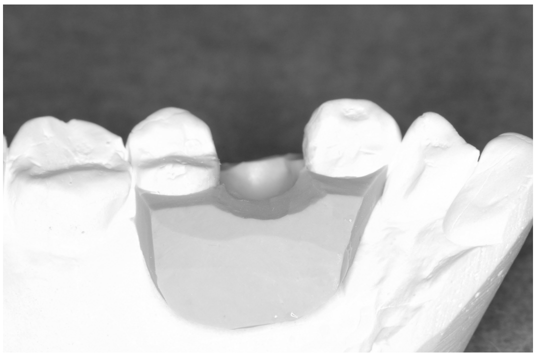
2

Fig. 1. A missing maxillary right first premolar. The adjacent canine was intact and the second premolar had a gold inlay with secondary caries.

Fig. 2. A wax mock-up of the missing first premolar was fabricated onto the working cast.



3



4

Fig. 3. A wide contact area between the pontic and abutment teeth was provided to ensure maximum surface area for bonding. A 0.5-mm space was provided between the base of the pontic and the alveolar ridge.

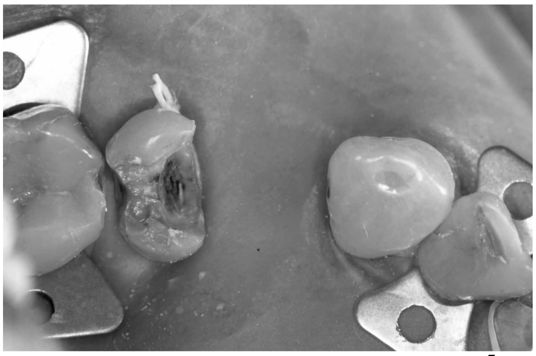
Fig. 4. An impression of the basal surface of the pontic and the surrounding area was taken using a heavy body type silicone rubber impression material. Following this, the occlusal half was removed with a razor blade.

An irreversible hydrocolloid impression (Aroma Fine DFIII, GC, Tokyo, Japan) was taken to make a working cast (New Fuji Rock, GC). A wax mock-up of the missing first premolar was fabricated (Parafin Wax, GC) (Fig. 2).

After forming the pontic, both the mesial and distal proximal surfaces of the wax pattern were heated to fix the pontic between the canine and the premolar. A 0.5-mm space was provided between the base of the pontic and the alveolar ridge. A wide contact area between the pontic and abutment teeth was provided to ensure maximum surface area for bonding (Fig. 3).

Following this, an impression of the basal surface of the pontic and the surrounding area was taken using a heavy body type silicone rubber impression material (Exafine Putty Type, GC). When the silicone had set, the occlusal half was removed with a razor blade (Fig. 4).

At the second visit, the gold inlay was removed with a tungsten carbide bur (#1931, GC) in an air-turbine handpiece with water spray. After the cement remnants were ultrasonically removed, the caries-infected dentin was carefully removed with a steel round bur (ISO#010, GC) in a low-speed micromotor handpiece leaving the caries-affected dentin and intact dentin. Following this, the teeth were isolated with a rubber dam for the subsequent bonding procedures (Fig. 5).


5

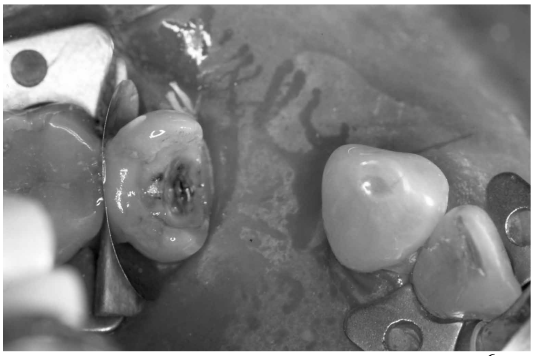

6

Fig. 5. After removal of the caries infected dentin, the teeth were isolated with a rubber dam for the subsequent bonding procedures.
Fig. 6. The distal aspect of the second premolar was restored using a direct resin composite.


7


8

Fig. 7. After applying the bonding system and a flowable resin composite, the silicone matrix was then seated on the alveolar ridge between the abutment teeth.
Fig. 8. Composite placement began at the base of the pontic. A resin composite was incrementally built-up and light-cured to connect the abutment teeth.

A steel sectional matrix (KerrHawe, Bioggio, Switzerland) was inserted in the interproximal space and wedged. A two-step self-etching adhesive (Clearfil SE Bond, Kuraray Medical, Tokyo, Japan) was applied to the whole cavity according to the manufacturer's instructions, and then a flowable composite was applied to the cured adhesive and light-cured for 30 s using a halogen light curing unit (New Light VL-II, GC). Following this, the distal aspect of the second premolar was restored using a direct resin composite, Estelite Σ (Tokuyama Dental, Tsukuba, Japan) (Fig. 6).

The distal surface of the canine was prepared for bonding by grinding the enamel surface with a plastic strip (#1000, Inoue Attachment, Tokyo, Japan). Phosphoric acid (37%, K-etchant, Kuraray Medical) was then applied to the enamel surface for 30 s, rinsed and dried. Following this, SE Primer in Clearfil SE Bond was applied to the surface for 5 s and gently air-blown. SE Bond in Clearfil SE Bond was applied to the canine surface and light-cured for 10 s. In addition, a flowable resin composite, Unifil Flow (GC), was applied to the adhesive surface and light-cured for 30 s. The sectional matrix at the distal site of the premolar was removed and the silicone matrix was seated on the alveolar ridge between the abutment teeth (Fig. 7).

Composite placement began at the base of the pontic. A resin composite was incrementally built-up and light-cured for 30 s at each step to connect the abutment teeth (Fig. 8).

After the build-up procedure, the silicone matrix was removed and the composite was light-cured from the occlusal, buccal and lingual sides for 30 s each. After checking for and removing any premature occulsal contacts, the restoration was finished and polished (Fig. 9).

The patient was recalled one week later to check for any problems at the pontic and interproximal areas. At this point, there were no clinical symptoms such as occlusal problems or postoperative sensitivity.

Fig. 9.
Post-operative view of the direct composite fixed partial denture fabricated using a wax mock-up technique.

Discussion

Self-etching adhesive systems use weak acidic monomers to condition both the enamel/dentin substrates.[13,14] Self-etching adhesive systems are effective in bonding resin composite to dentin.[15] However, the application of self-etching systems on enamel has been a controversial issue. It was reported that the adhesion of self-etching adhesives to ground enamel was inferior when compared with systems utilizing phosphoric acid as a separate conditioner.[16,17] On the other hand, other studies have shown that self-etching systems might be a satisfactory alternative to phosphoric acid conditioning of ground enamel.[18,19] The acidity of the etchant may not have a relationship with bond strength to enamel.[19] In this report, 37% phosphoric acid was applied to the canine enamel, which was un-ground enamel, while only a self-etching primer was applied to the enamel of the second premolar, which was ground enamel.

Flowable composites have lower elastic moduli, lower filler contents and in general, inferior mechanical properties than traditional hybrid composites.[20] However, the additional application of a flowable composite on the cured adhesive significantly improves the sealing of the dentinal margins.[21] Theoretically, a gradual change in material properties at the interface could reduce stresses during loading of the restoration.[22,23] At the hybrid resin composite/tooth interface, application of a flowable composite between the hybrid composite and adhesive resin is expected to result in a gradual change of properties from the outermost surface toward the tooth.[24,25] It has therefore been recommended to include a flowable composite in the chairside fabrication protocol of RBFPDs.[8]

The pontic must meet certain structural requirements to ensure the mechanical stability of the restoration.[26] In addition, the pontic must fulfill the complex roles of replacing the function of the lost tooth, achieving an esthetic appearance, enabling adequate oral hygiene, and preventing tissue irritation.[27] At the chair-side, it is difficult to fabricate a pontic with a correct relationship to the alveolar ridge and/or to the abutment teeth. Therefore, before beginning treatment in the mouth, a working cast was fabricated onto which a pontic was waxed. In order to maintain healthy soft tissues, a pontic with a smooth and convex shape was fabricated, 0.5 mm from the alveolar ridge. The bonding surfaces of the mesial/distal abutment teeth were extended as much as possible to obtain a large adhesive interface. An impression of the basal surface was taken using a silicone putty impression material.

A hybrid composite was used to build the pontic up incrementally. Composite placement began at the base of the pontic. During polymerization, shrinkage stresses compete with the adhesive-tooth bond, potentially causing failure of the bond and eventually, the restoration itself.[28] To reduce curing stresses, an incremental technique has been advocated when placing composite resin.[29,30]

Wear resistance is one of the most important factors affecting the longevity of direct composite FPDs. Recent composite materials seem to have attained a balance of good wear resistance and low abrasiveness towards antagonistic enamel.[31] However, attritional wear may be a problem when composites are placed in heavy contact.[32] Occlusion has an important effect on the wear process. The distribution of forces can be altered through selective occlusal adjustment. Multiple contact areas maintain occlusal stability by lowering stress concentrations.[33]

Teeth have some degree of mobility under function, which causes repeated tensile and compressive stresses at the adhesive joint, which would cause fatigue failures. The survival rate of resin-bonded FPDs is dependent upon location, type and length of the FPD.[3,4] The debonding rate of resin-bonded FPDs with a span greater than one pontic is higher as a result of increased tensile stresses at the bonded interface from occlusal loads.[34] In the case of three-unit FPDs, a direct composite FPD without fiber reinforcement requires less invasive treatment than conventional FPDs, which may be a new treatment option. Long-term clinical evaluation of this new technique will be carried out in the near future.

Acknowledgment
This study was supported by the grant for the Center of Excellence Program for Frontier Research on Molecular Destruction and Reconstruction of Tooth and Bone at Tokyo Medical and Dental University.

References

1. Mount GJ, Ngo H. Minimal intervention: a new concept for operative dentistry. Quintessence Int 2000; 31: 527-33.
2. Peters MC, McLean ME. Minimally invasive operative care. I. Minimal intervention and concepts for minimally invasive cavity preparations. J Adhes Dent 2001; 3: 7-16.
3. Creugers NH, DeKanter RJ, Verzijden CW, Van't Hof MA. Risk factors and multiple failures in posterior resin-bonded bridges in a 5-year multi-practice clinical trial. J Dent 1998; 26: 397-402.
4. Pröbster B, Henrich GM. 11-year follow-up study of resin-bonded fixed partial dentures. Int J Prosthodont 1997; 10: 259-68.
5. Galan D, Lynch E, Heath MR. Bond strength of fiber reinforced composite restorations. J Esthet Dent 1992; 4: 24-9.
6. Vallittu PK, Sevelius C. Resin-bonded, glass fiber reinforced composite fixed partial dentures; a clinical study. J Prosthet Dent 2000; 84: 413-8.
7. Culy G, Tyas MJ. Direct resin bonded fiber reinforced anterior bridges; A clinical report. Aust Dent J 1998; 43: 1-4.
8. Meiers JC, Duncan JP, Freilich MA, Goldberg AJ. Preimpregnated, fiber-reinforced prosthesis. Part II. Direct applications; splints and fixed partial dentures. Quintessence Int 1998; 29: 761-8.
9. Ahlstrand WM, Finger WJ. Direct and indirect fiber-reinforced fixed partial dentures: Case reports. Quintessence Int 2002; 33: 359-65.
10. Tezvergil A, Lassila LV, Vallittu PK. Strength of adhesive-bonded fiber-reinforced composites to enamel and dentin substrates. J Adhes Dent 2003; 5: 301-11.
11. Furukawa K, Inai N, Tagami J. The effects of luting resin bond to dentin on the strength of dentin supported by indirect resin composite. Dent Mater 2001; 18: 136-42.
12. Minesaki Y, Suzuki S, Kajihara H, Tanaka T. Effect of reinforcement methods on the retention of resin-bonded fixed partial dentures using a composite denture tooth as a pontic: in vitro evaluation. J Adhes Dent 2003; 5: 225-34.
13. Van Meerbeek B, Lonn LJ, Duke ES. Correlative transmission electron microscopy examination of non-demineralized and demineralized resin dentin interfaces formed by two dentin adhesive systems. J Dent Res 1996; 75: 879-88.
14. Harada N, Nakajima M, Pereira PNR, Yamaguchi S, Ogata M, Tagami J. Tensile bond strength of a newly developed one-bottle self-etching resin bonding system to various dental substrates. Dent in Japan 2000; 36: 47-53.
15. Nikaido T, Kunzelmann K-H, Chen H, Ogata M, Harada N, Yamaguchi S, Cox CF, Hickel R, Tagami J. Evaluation of thermal cycling and mechanical loading on bond strength of a self-etching primer system to dentin. Dent Mater 2002; 18: 269-75.
16. Hara AT, Amaral CM, Pimenta LA, Shinhoreti MA. Shear bond strength of hydrophilic adhesive systems to enamel. Am J Dent 1999; 12: 181-4.
17. Jayasooriya PR, Wettasinghe KA, Ogata M, Nikaido T, Tagami J. Micro-tensile bond strength of a self-etching primer bonding system to fluorosed enamel. Int Chin J Dent 2002; 2: 107-15.
18. Kanemura N, Sano H, Tagami J. Tensile bond strength to and SEM evaluation of ground and intact enamel surfaces. J Dent 1999; 27: 523-30.
19. Weerasingthe DS, Nikaido T, Wettashinghe KA, Abayakoon JB, Tagami J. Micro-shear bond strength and morphological analysis of a self-etching primer adhesive system to fluorosed enamel. J Dent 2005; 33: 419-26.
20. Bayne SC, Thompson JY, Swift EJ, Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. J Am Dent Assoc 1998; 129: 567-77.

21. Belli S, Inokoshi S, Ozer F, Pereira PNR, Ogata M, Tagami J. The effect of additional enamel etching and a flowable composite to the interfacial integrity of class II adhesive composite restorations. Oper Dent 2001; 26: 70-5.
22. Tam LE, Pilliar RM. The effect of interface stiffness on dentine-composite interfacial fracture resistance. J Dent 2000; 28: 487-93.
23. Ausiello P, Apicella A, Davidson C. Effect of adhesive layer properties on the stress distribution in composite restorations; a 3D finite element analysis. Dent Mater 2002; 18: 295-303.
24. Labella R, Lambrechts P, Van Meerbeek B, Vanherle G. Polymerization shrinkage and elasticity of flowable composites and filled adhesives. Dent Mater 1999; 15: 128-37.
25. Unterbrink G, Liebenberg WH, Flowable resin composites as filled adhesives; Literature review and clinical recommendations. Quintessence Int 1999; 30: 249-57.
26. Smyd ES. Mechanics of dental structures: Guide to teaching dental engineering at undergraduate level. J Prosthet Dent 1952; 2: 668-92.
27. Edelhoff D, Spiekermann H, Yildirim M. A review of esthetic pontic design options. Quintessence Int 2002; 33: 736-46.
28. Ciucchi B, Bouillaguet S, Delaloye M, Holz J. Volume of the internal gap formed under composite restorations in vitro. J Dent 1997; 25: 305-12.
29. Neiva IF, De Andrada MA, Baratieri LN, Monteiro Jr S, Ritter AV. An in vitro study of the effect of restorative technique on marginal leakage in posterior composites. Oper Dent 1998; 23: 282-9.
30. Miguez PA, Pereira PNR, Foxton RM, Walter R, Nunes MF, Swift EJ Jr. Effects of flowable resin on bond strength and gap formation in class I restorations. Dent Mater 2004; 20: 839-45.
31. Suzuki S. Does the wear resistance of packable composite equal that of dental amalgam? J Esthet Restor Dent 2004; 16: 355-67.
32. Willems G, Lambrechts P, Braem M, Vanherle G. Three-year follow-up of five posterior composites: in vivo wear. J Dent Res 1993; 21: 74-8.
33. Abboud M, Stark H, Koeck B. Integration of all-ceramic restorations in reconstructive prosthetic dentistry: A case report. Quintessence Int 2004; 35: 103-7.
34. Phillips RW. Skinner's science of dental materials. 9th ed. Philadelphia; WB Saunders; 1991. p373-5.

Reprint request to:

Dr. Toru Nikaido
Cariology and Operative Dentistry, Department of Restorative Sciences
Graduate School, Tokyo Medical and Dental University
1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8549, Japan
Fax: +81-3-5803-0195 E-mail: nikaido.ope@tmd.ac.jp

Received July 7, 2005. Revised August 5, 2005. Accepted August 10, 2005.