Treatment of Maxillary Lateral Incisor Agenesis with Zirconia-Based All-Ceramic Resin-Bonded Fixed Partial Dentures: A Case Report

Margrit P. Maggio, DMD
Assistant Professor of Restorative Dentistry, Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.

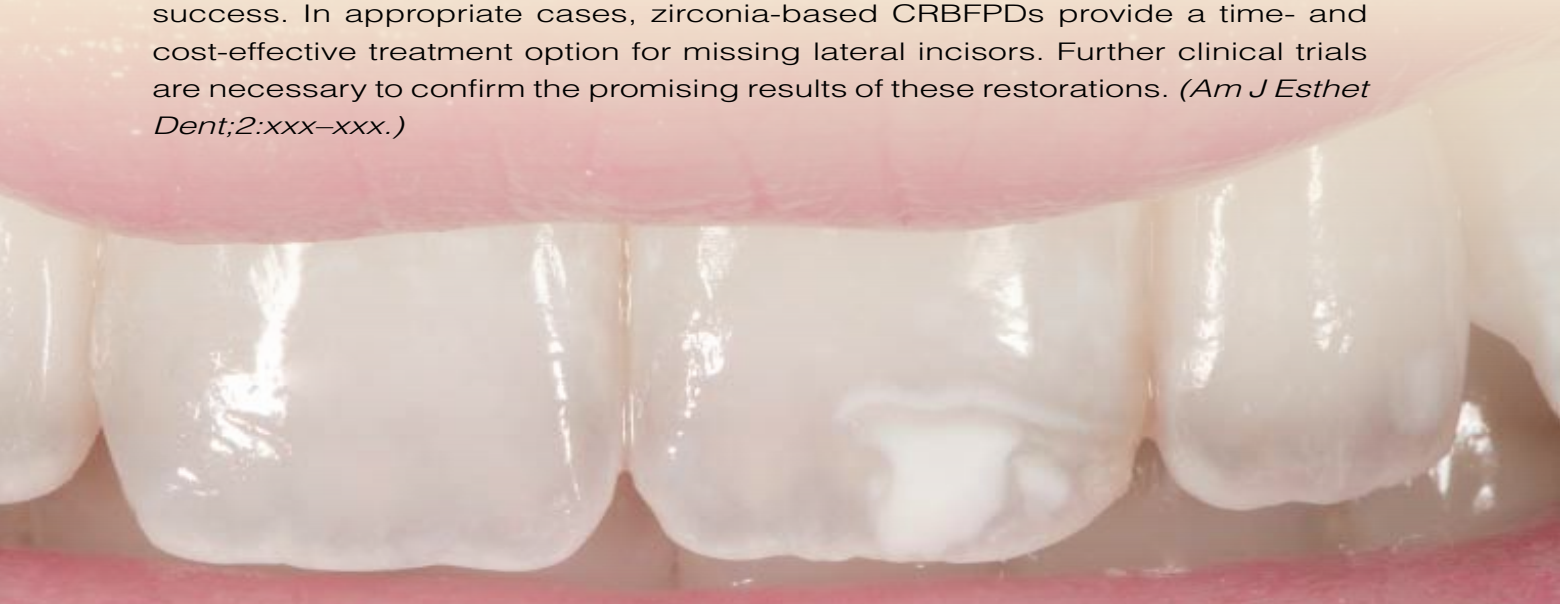
Michael Bergler, MDT
Director of Laboratory Services, Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.

Daniel Kerrigan
Dental Student, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.

Markus B. Blatz, DMD, PhD
Professor and Chair, Department of Preventive and Restorative Sciences, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.

Correspondence to: Dr Margrit Maggio
University of Pennsylvania School of Dental Medicine, Robert Schattner Center, 240 South 40th Street, Philadelphia, PA 19104. Email: mmaggio@dental.upenn.edu

This case report describes the treatment of a 14-year-old female patient with maxillary bilateral lateral incisor agenesis. All-ceramic resin-bonded fixed partial dentures (CRBFPDs) were selected as the most conservative and esthetic treatment option. Single-retainer cantilever zirconia-based CRBFPDs were fabricated and adhesively bonded to the abutment teeth, closely following the protocols suggested by the most recent scientific evidence. Proper case selection, preparation technique, and bonding protocols are fundamental for long-term clinical success. In appropriate cases, zirconia-based CRBFPDs provide a time- and cost-effective treatment option for missing lateral incisors. Further clinical trials are necessary to confirm the promising results of these restorations. *(Am J Esthet Dent;2:xxx–xxx.)*



Studies have shown that congenitally missing maxillary lateral incisors present a therapeutic challenge to the dental practitioner.[1] Treatment options include orthodontic canine substitution, single-tooth implant crowns, and tooth-supported restorations.[2–6] While endosseous implants have become the most popular treatment for the replacement of single missing teeth,[7,8] this option is not indicated for or desired by all patients. In younger patients, implant placement should be postponed until the end of dentoalveolar development and skeletal growth,[9–11] which is typically reached between 20 and 22 years of age for males and 16 and 17 years of age for females.[10,11] Many patients with congenitally missing teeth undergo orthodontic treatment as children or adolescents; however, such treatment is often completed before the end of skeletal growth. In these cases, interim tooth replacement becomes necessary to provide esthetic and functional space maintenance and to prevent the roots of the adjacent teeth from converging, which could make future implant placement difficult or even impossible.[12] Treatment options for tooth replacement and arch stabilization include removable retainers with prosthetic teeth and tooth-supported restorations.

Tooth-supported restorations, either provisional or definitive, include resin-bonded, cantilever, and conventional fixed partial dentures (FPDs).[4,10] The least invasive option that meets the esthetic and functional objectives should be preferred,[3–5] especially for provisional restorations. In many cases, resin-bonded FPDs (RBFPDs) most adequately fulfill these requirements. Further, RBFPDs have been successfully used to replace congenitally missing teeth for many years.[10] They are a cost-effective solution that requires few office visits.

Clinical failure of RBFPDs is mainly associated with debonding of the framework from the abutment teeth. Studies indicate that improvements in adhesive technology along with adapted preparation designs have the ability to limit bonding failures and significantly increase the clinical longevity of RBFPDs.[13,14] Traditional RBFPDs made with a metal-alloy framework have one esthetic disadvantage: a grayish discoloration of the abutment teeth caused by a shadow effect of the framework showing through the tooth enamel. All-ceramic RBFPDs (CRBFPDs) with a white or tooth-colored framework can minimize this disadvantage.

The physical properties of high-strength ceramic framework materials, especially fracture strength and modulus of elasticity, have placed traditional RBFPD designs with two retainer wings into question. Kern and Sasse[15] reported a 5-year survival rate of 92% for cantilever, single-retainer CRBFPDs, which was significantly higher than the 74% survival rate found for the traditional two-retainer design. Numerous authors have supported these findings, recommending a cantilever, single-retainer design for RBFPDs with ceramic frameworks.[15–24]

The ideal patient for a zirconia CRBFPD is a nonbruxer who has abutment teeth that are immobile and upright and a shallow overbite that will allow maximum enamel surface area for adhesion.[10] Contraindications include a deep overbite or proclined teeth, mobile teeth, or a history of bruxism.[18] RBFPDs rely on optimal adhesive bonds, and debonding is the most common reason for failure.[13,14] Bonding methods such as hydrofluoric acid etching and application of a silane coupling agent can be successful for silica-based ceramics but not for high-strength ceramics that contain little to no silica.[24–31] For zirconia-based restorations, long-term resin bond strength can be achieved through the use of either silica-silane coating (eg, Cojet, 3M ESPE) or air-particle abrasion with aluminum oxide and a ceramic bonding system containing special adhesive phosphate monomers (eg, Clearfil Ceramic Primer, Kuraray, which contains 10-methacryloyloxydecyl dihydrogen phosphate).[25–31]

Ultimately, proper case selection, communication with other treating specialists and the laboratory, abutment tooth selection, framework design, minimal tooth preparation, and bonding technique are critical for the clinical success of CRBFPDs. This article presents the clinical application of CRBFPDs with cantilever zirconia frameworks to replace congenitally missing maxillary lateral incisors.

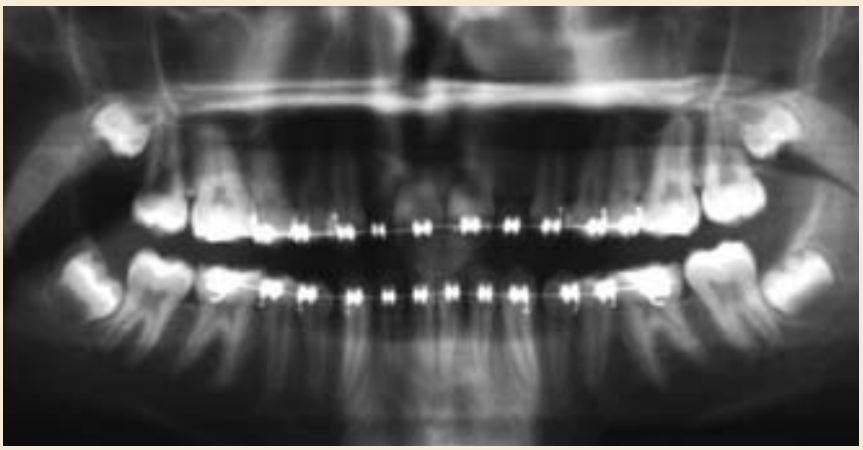


Fig 1 Preoperative, postorthodontic panoramic radiograph.

CASE REPORT

A 14-year-old female patient presented to the University of Pennsylvania Faculty Practice with congenitally missing maxillary lateral incisors. She was nearing completion of a 5-year orthodontic treatment phase that included palatal expansion and she was seeking consultation for subsequent prosthetic treatment of the edentulous lateral incisor areas. Her medical history was unremarkable, and her dental history included orthodontic treatment, routine recall visits, minor operative dentistry, and sealants on permanent molars. A comprehensive examination was conducted, including radiographic (Fig 1) and dental examinations, periodontal probing, and temporomandibular evaluation. Preliminary study casts were mounted in an articulator.

Diagnosis and treatment planning

Extraoral findings were normal, and intraoral and radiographic findings revealed no caries lesions. All soft tissues were normal and healthy. The anterior teeth had a shade of A3 (VITA Shade Guide, Vident). Mild-to-moderate enamel hypoplasia was noted throughout the dentition. The maxillary canines had markedly pointed cusps, and mamelons were present on the mandibular lateral incisors. The patient was unhappy with both the shade of her teeth and the mandibular mamelons but did not want any changes to the characteristic hypoplastic markings, other tooth morphology, or position and angulations of her natural teeth. The edentulous alveolar ridges were mildly deficient in the orofacial dimension. Denture teeth were fixed to the orthodontic archwire to occupy the missing lateral incisor spaces. The patient had a Class I skeletal relationship with bilateral Class I molar relationships and canine guidance.

All other findings were normal. The dentofacial diagnosis was good. Anterior spacing was adequate for restorative replacement. The periodontal diagnosis was type I according to American

Fig 2 Preoperative extraoral view with the retainer after bleaching.

Fig 3 Preoperative intraoral view with the retainer after bleaching.

Academy of Periodontology criteria. The biomechanical diagnosis showed no compromised areas. The functional diagnosis was normal, consistent with the current degree of tooth eruption.

The prognosis for this dentition and for patient compliance was good. All treatment options were discussed with the patient and her parents. Dental implants were not recommended at that time due to the patient's incomplete growth. The treatment goals were as follows: *(1)* provide minimally invasive, prosthetic replacement of the missing lateral incisors; *(2)* meet the patient's and parents' esthetic expectations; and *(3)* achieve stable occlusion. The definitive treatment plan included tooth bleaching and zirconia-based CRBFPDs, which would allow for implant placement at a later time.

Clinical treatment

The patient returned 3 months later following the completion of orthodontic treatment. A Hawley-type retainer[32] with denture teeth for the edentulous spaces had already been fabricated. New diagnostic casts were made and mounted in an articulator for occlusal analysis, preparation planning, and framework design. Bleaching trays were fabricated on a second set of diagnostic casts. The patient followed an at-home bleaching protocol (Opalescence PF 10%, Ultradent) and was advised to bleach one arch at a time, nightly, for 1 week per arch. Shade B1 was selected at the postbleaching follow-up appointment. Figures 2 and 3 show the preoperative situation with the retainer in place. Due to the occlusal scheme and canine guidance, the central incisors were selected as abutment teeth for the single retainers. Figures 4 and 5 show the preoperative intraoral situation without the retainer in place. During the preparation appointment, a 0.6-mm reduction of the lingual surfaces of the maxillary central incisors was carried out using a tapered chamfer diamond bur (no. 856-016, Brasseler). A slight interproximal elbow preparation was completed to counter dislodging forces and increase frame-

Fig 4 Preoperative intraoral view without the retainer showing the edentulous areas.

Fig 5 Preoperative occlusal view without the retainer. The maxillary central incisors were selected as abutment teeth for single-retainer cantilever CRBFPDs.

Fig 6 Definitive preparation of the central incisors.

work connector strength. Finally, a small indentation was placed in the center of the lingual fossa preparation to facilitate exact three-dimensional seating of the framework (Fig 6). Final impressions were made using a vinyl polysiloxane (VPS) putty in a full-arch stock impression tray and a light-body wash material syringed onto the prepared teeth (Aquasil Easy Mix putty, Aquasil Ultra LV). An opposing cast impression was also made with VPS putty, and interocclusal records were taken using Regisil 2X (Dentsply).

Master casts and opposing casts were fabricated in the dental laboratory, mounted, and scanned. The frameworks were designed on the computer (Figs 7 and 8) and milled from zirconia ceramic. A small, extra wing was fabricated on each framework to facilitate correct placement during try-in (Fig 9). These wings would later be removed. The frameworks were designed to provide optimal support for the veneering porcelain (Fig 10).

A try-in visit was scheduled to verify the path of draw, fit, and margins of the frameworks. Three-dimensional seating of the wings was confirmed, assisted by the small indentations prepared in the lingual fossa areas. The final shade was selected. In the laboratory, master casts were slightly trimmed in

Fig 7 The zirconia frameworks were designed on the computer based on the individual characteristics of the patient and the material requirements in regard to connector dimensions and support for veneering porcelain.

Fig 8 Occlusal view of the framework design on the computer.

the edentulous ridge areas to accommodate ovate pontics and optimize the soft tissue architecture and esthetics. External layers of feldspathic veneering porcelain were fired onto the frameworks, matching the characteristics of the adjacent natural teeth (eg, enamel hypoplasia and stains) (Fig 11). The definitive restorations can be seen in Fig 12.

The definitive CRBFPDs were tried in to verify the fit, pontic relief, and esthetics. A small lateral incision (approximately 3 mm wide and 1.5 mm deep) was placed in the alveolar crest area of the maxillary lateral incisors with an electrosurgical unit to decrease tension of the soft tissue and allow for intimate seating of the ovate pontic. The intaglio surfaces of the frameworks were then cleaned in an ultrasonic bath with alcohol. The bonding surfaces of the retainer wings were airborne-particle abraded with 30-µm aluminum oxide particles at a pressure of 1.5 bar for 5 seconds at a distance of 1 cm. Care was taken to protect the feldspathic veneering porcelain during this procedure. Next, Clearfil Ceramic Primer (Kuraray) was applied in a thin layer (Fig 13) and left to air dry. The adherent surfaces of the maxillary central incisors were cleaned with pumice and rinsed. The area was isolated and prepared for final cementation with Panavia 21 TC (Kuraray). For better control, the two FPDs were bonded independently, one after the other. The enamel bonding surfaces were acid etched with 40% phosphoric acid (K-Etchant Gel, Kuraray) for 30 seconds. After thorough rinsing and drying, self-etching ED Primer (Kuraray) was applied and lightly dried. Each restoration was placed in position, and excess cement was removed from the margins with microbrushes. Oxyguard II (Kuraray) was applied onto the marginal areas and sprayed off after complete polymerization of the composite resin luting agent.

Fig 9 Zirconia frameworks on the master cast. Note the extra wings on the canines to facilitate correct seating of framework.

Fig 10 Anterior view of the zirconia frameworks on the master cast. The framework was designed for optimal support of the veneering porcelain.

Fig 11 Definitive restorations on the master cast.

Fig 12 Definitive single-retainer cantilever CRBFPDs.

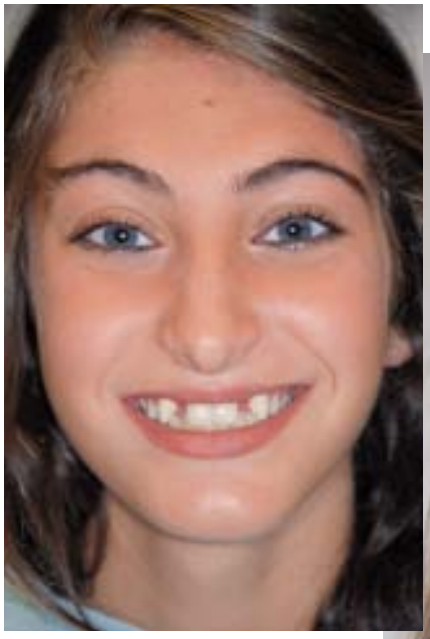
Fig 13 Application of a special zirconia ceramic primer to the pretreated bonding surface was carried out to provide a durable bond.

Any excess cement still remaining was removed with an explorer and a sharp scaler. Occlusion was confirmed in maximum intercuspation, protrusion, and lateral excursions. Proper management of the occlusion of the pontic is crucial for the long-term success of cantilever prostheses. If eccentric contact remains on the pontic, the potential risks include loosening of the restoration, migration of the abutment, and fracture.[33,34] Therefore, all

Figs 14a to 14f Final result (at 8 weeks).

contacts in protrusive and excursive movements were removed from the cantilever. Any adjusted ceramic surfaces were polished (Dialite Polishing Kit, Brasseler). Mamelons on the mandibular lateral incisors were smoothed flat using polishing disks (Super Snap, Shofu). Alginate impressions were made from each arch, and an occlusal guard was fabricated for the patient

to wear at night. All esthetic and functional parameters were verified during the subsequent follow-up visits, which were initially scheduled at 1 week, 4 weeks, 8 weeks, and 6 months and then at 6-month intervals thereafter. Figures 14a to 14f show the final result at the 8-week follow-up visit. Figs 15a and 15b show the preoperative and 1-year posttreatment facial photos.



Figs 15a and 15b Pre-operative and 1-year post-treatment facial photos.

CONCLUSIONS

Zirconia-based cantilever resin-bonded fixed partial dentures provide a viable treatment option for missing lateral incisors in select cases. These restorations are cost effective and require few treatment steps. Specific design and clinical handling protocols must be followed to achieve long-term clinical success. Further clinical trials are necessary to confirm the already promising results of these restorations.

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