The presence of a space between the two maxillary central incisors—a maxillary midline diastema (MMD)—is considered a normal developmental phenomenon in children and requires no treatment. Lindsey¹ conducted a study, the results of which showed that about two-thirds of children in whom only central incisors had erupted exhibited an MMD. An MMD of greater than 2 millimeters in the mixed dentition is unlikely to close spontaneously² and may persist in the permanent dentition. An MMD can be inherited and is more prevalent in certain ethnic groups.² Gass and colleagues³ reviewed the literature and reported a prevalence of MMD that ranged from 1.6 to 25.4 percent of adults from various populations and age groups. They also reported that MMDs are more common among African Americans than they are among whites, Asians or Hispanics.³

Keene⁴ defined an MMD as a space greater than 0.5 mm between the proximal surfaces of the two central incisors because such a gap is noticeable. McKnight and colleagues⁵ reported that patients consider MMDs to be less esthetic than mild fluorosis or isolated opacity. An MMD also can adversely affect body image and self-esteem, and it can be one of the most negative factors in self-perceived dental appearance.⁶ Kerosuo and colleagues⁷ con-
ducted a study in which they showed Finnish students photographs of faces modified according to one of four dental arrangements. The authors reported that the participants ranked faces exhibiting a median diastema as less intelligent, beautiful and sexually attractive than faces with an ideal occlusion; they also judged them as belonging to a lower social class. In addition to poor esthetics, patients who request closure of an MMD also may complain of impaired speech, lip biting and adverse psychological effects.7

Before formulating a definitive treatment plan for a patient with an MMD, the clinician needs to understand the etiology of the condition. It can be an anomaly in the number of teeth (such as mesiodens or hypodontia) or the size of teeth (such as microdontia), an enlarged labial frenum, abnormal oral habits (such as tongue thrusting or finger biting) or advanced periodontitis. Clinicians must obtain a comprehensive medical history, including the duration of the diastema, any changes in size and any previous orthodontic treatment, as well as a comprehensive family history.

The clinical examination should include inspection of the dentition and occlusion, labial frenum and lips and an assessment of periodontal condition. Full-mouth periapical radiography is necessary to assess periodontal support. The clinician also should make study models, and he or she can use a diagnostic wax-up to illustrate the possible results of treatment. In general, the dentist can use the “golden proportion” (8:5)—the ratio of the mesiodistal crown width of the central incisor to that of the lateral incisor—as a guideline for esthetic evaluation. Last, but not least, the patient’s preferences, which are affected by psychological, physical, financial and time factors, are key to performing successful dental treatment.

We present five cases to illustrate the management of MMDs in general dental practices.

**REPORT OF CASES**

**Case 1. Description.** A 20-year-old woman visited her dentist (C.H.C.) because she was unhappy with her smile and the spacing in her maxillary teeth, particularly between the two central incisors (Figure 1). The clinical examination revealed generalized spacing in the maxillary and mandibular teeth due to a discrepancy in the size of her teeth and dental arches. The dentist took impressions to prepare a study cast and diagnostic wax-up. After discussing treatment options with the patient, the dentist placed resin-based composite buildups on her four maxillary incisors to close the spacing. He cleaned the incisors with pumice but did not prepare the teeth. The clinician added resin-based composite (A2 shade, Vita Classical Shade Guide, Vident, Brea, Calif.) to the proximal surfaces of the incisors to close the space between the central and lateral incisors. The clinician followed the emergence profile of the incisors in the cervical regions during buildup of the resin-based composite to ensure a smooth lingual-to-buccal finish (Figure 2). He thinned the restoration and merged its margin with the enamel surface. The patient was satisfied with this simple noninvasive treatment (Figure 3) even though the spacing between her mandibular teeth persisted (Figure 4).

**Discussion.** Making a diagnostic wax-up and study cast requires an extra appointment, but they serve as a record, aid in communication and allow ample time for the patient to evaluate the intended treatment outcome outside the dental office. Moreover, the clinician can fabricate a silicon index from the study cast to aid in buildup of the resin-based composite. Dalvit and colleagues8 advocated a simple chairside try-in

method with the use of orthodontic wax, but this method may require considerable chairside time to evaluate the intended outcome. In addition, once the wax is removed, the patient cannot reevaluate the proposed outcome.

Building up the incisors with resin-based composite is a simple, direct and relatively low-cost restorative treatment. It also is reversible and does not preclude orthodontic treatment in the future. Willhite\textsuperscript{9} proposed three criteria for successful diastema closure: an increased emergence profile with natural contours at the interface between the gingiva and tooth; a completely closed gingival embrasure (that is, no black triangle); and a smooth subgingival margin that does not catch on or shred dental floss.

The clinician can round the mesial surface of the natural teeth into the facial surface to provide a natural bevel for the restoration. The resin-based composite should be nonsticky and nonslumping, and it should contain a high (>65 percent) filler content by volume and a particle size smaller than 5 micrometers. Because the color of resin-based composite changes across time, and leakage may occur around the margin, touch-ups usually are required every seven to 10 years.\textsuperscript{10} In addition, a proper bonding technique and good moisture control are essential to prevent fracture or debonding of the restorative material. Limiting exposure to direct force on the incisal edge minimizes the risk of fracture substantially.\textsuperscript{11} Before performing the procedure, the dentist should discuss possible deterioration (that is, shade and texture) and dislodgment of the restorations with the patient.

**Case 2. Description.** A 28-year-old man visited one of us (C.H.C.) with a complaint of an MMD visible when he smiled. His teeth also had been discolored by tetracycline staining (Figure 5). To close up the MMD and mask the discoloration, the dentist placed porcelain veneers on the incisors, canines and premolars.

To accommodate the thickness of the porcelain veneer, the clinician removed an enamel layer of about 0.5 mm in thickness with diamond burs. The clinician prepared the incisal edge and extended it minimally onto the palatal surface as a heavy chamfer; however, it extended into the gingival proximal area for esthetic reasons. He was careful not to create undercut areas and expose the dentin unnecessarily. Proximal contact areas were not part of the preparation.

The clinician prepared the teeth by using a three-step bonding agent (Scotch Bond MP, 3M ESPE, St. Paul, Minn.) before taking an impression. Because the patient wanted to save money and was satisfied with his appearance during treatment, the dentist did not place temporary restorations. The veneers were made of pressed porcelain ingots (IPS Empress, Ivoclar Vivadent, Schaan, Liechtenstein).

At the patient’s next appointment, the clinician cleaned the teeth with pumice and selected the correct shade by using water-soluble try-in paste (Variolink II, Ivoclar Vivadent). He used a light pink opaquer to produce a Vita shade of A3.5 (Vita Classical Shade Guide). The clinician cemented a total of 10 veneers, beginning with the two central incisors and then the lateral incisors, ensuring correct positioning during bonding. After about two seconds of light curing, the clinician removed the excess cement before performing a final thorough curing of at least 40 seconds. He examined the patient one week later (Figure 6), and the patient was satisfied with the veneers (Figure 7). The clinician prescribed a nightguard for the patient after explaining to him that the veneers can fracture as a result of excessive chewing and grinding.

**Discussion.** Because the color of the enamel layer comes from the dentin, preparing tetracycline-stained teeth makes the enamel darker owing to an increased chroma and a reduced value. Thus, fabricating a porcelain veneer with good esthetics is challenging, and the clinician must assess the patient’s esthetic expectations before treatment. Porcelain is far superior to resin-based composite with regard to mechanical properties and esthetics. It also lasts longer and exhibits little staining.
appropriate tooth preparation is not carried out, the teeth could appear overcontoured and bulky, which might induce gingival inflammation. In addition, it is desirable that at least one-half of the prepared surface area remain in enamel because porcelain veneer bonded to dentin is prone to fracture.12

To minimize food trapping and irritation to the tongue, the dentist performed proximal preparation of the central incisors to create appropriate mesiopalatal contours. To minimize postoperative dentin hypersensitivity, Magne and colleagues13 advocated immediate dentin sealing before taking the working impression. To achieve successful veneer treatment, practitioners need to consider the following elements in esthetic design: facial midline, incisal embrasures, axial inclinations, shade progression, tooth reveal, vestibular space and the smile line.14

**Case 3. Description.** A 19-year-old man visited one of us (C.H.C.) because he wanted closure of the space between his two maxillary central incisors (Figure 8). Cephalometric analysis revealed normal anatomical landmarks such as sella, nasion, A point (SNA); sella, nasion, B point (SNB); and mandibular plane angles. However, the patient also had an increased angle between the upper incisors and maxillary plane. The mandibular teeth were well aligned.

The treatment plan was to close the MMD by using a removable upper appliance containing a Roberts retractor. The clinician trimmed the acrylic baseplate to allow retraction of the central incisors. He checked the extension and position of the Roberts retractor to make sure it rested on the buccal sulcus with no distortion, and he adjusted the loop of the retractor to prevent it from contacting the attached or free gingivae.

The dentist instructed the patient to wear the removable orthodontic appliance 24 hours a day and examined the patient the following day to check for any discomfort. At the next follow-up appointment four weeks later, the patient had complied fully with the 24-hour regimen; the space was closed after three months (Figure 9).

The patient wore a Hawley-type removable retainer 24 hours a day for six months and then about 12 hours every night for another six months. At the 12-month examination, the patient was satisfied with the results (Figure 10), and the dentist encouraged him to continue wearing the heat-cured retainer at night to prevent relapse.

**Discussion.** Although most patients who receive a removable orthodontic appliance can be treated with a fixed appliance, a removable appliance can be a good option for those who want a less expensive option. In addition, oral hygiene is simpler for patients wearing removable appliances. In this case, the clinician closed the MMD by tipping the incisors palatally and reducing the width of the upper arch. Root repositioning was not required. Generally, MMDs should be no more than 3 mm wide for this type of treatment to be effective.2 Ample room must exist between the upper and lower anterior incisors for palatal retraction of the upper incisors to occur. In addition, the patient’s periodontal condition must be good and stable. A slightly increased overjet, reduced overbite and proclined upper incisors are desirable because these will be lessened with retraction of the incisors. Case selection is vital for a successful outcome, as is the patient’s adherence to the treatment regimen. Apart from the patient’s wearing the retainer, good periodontal support of posterior teeth is needed to maintain the treatment outcome.

A removable appliance has three main components. The first is the retention device, which in this case was achieved with an Adams clasp placed on the maxillary first molars. The second is the active component, in this case a Roberts retractor designed to tip the incisors palatally for space closure. The removable appliance tips teeth with little bodily movement. The optimal force used is 25 to 40 grams; a smaller or larger force will affect tooth movement. The final component is the acrylic baseplate, which joins the components together. The Roberts retractor is made of 0.5-mm stainless steel wire reinforced...
by tubes on both sides for rigidity. A loop is included for greater resilience and ease of adjustment. To ensure a comfortable fit, the acrylic baseplate, which is not a denture, should not extend as far as the soft palate. A routine oral hygiene maintenance program (including regular scaling and polishing and oral hygiene reinforcement) should be scheduled to ensure good plaque control. Because the patient was instructed to wear the retainer for an extended period, his dentist (C.H.C.) made a heat-cured retainer to increase polymerization and reduce porosity.

**Case 4. Description.** A 19-year-old woman visited her dentist (C.H.C.) for closure of her MMD, but she could not afford the time required for, or the expense of, a comprehensive fixed appliance. Her oral hygiene was unsatisfactory. The clinical examination revealed localized marked gingivitis, a rotated upper canine and an MMD. She had no other problems regarding tooth alignment, function or esthetics. The practitioner explained treatment options to the patient, as well as the importance of oral hygiene. After the gingival inflammation had resolved, he closed the MMD with a sectional fixed appliance.

The clinician bonded four orthodontic brackets onto the upper incisors and inserted a 16-mil (0.41 mm) round stainless steel wire that was stabilized with elastic ligatures. The dentist used loop-forming pliers to create loops at both ends of the wire to prevent lateral sliding and dislodgment of the wire. After four weeks, he replaced the 16-mil wire with an 18-mil (0.46 mm) round stainless steel wire and used an elastomeric chain to close the MMD. The power chain spanned from the mesial wing of one lateral incisor bracket to the mesial wing of the other lateral incisor bracket (Figure 11).

The dentist replaced the power chain with a new chain at the one-month follow-up visit. MMD closure had occurred after three months of active treatment, with the spacing redistributed to the proximal areas of the lateral incisor and canine. The clinician then applied a metal ligature to the four incisors to stabilize the teeth for three months. Figure 12 shows the results after removal of the brackets. The patient’s MMD was closed and her oral hygiene had improved. Finally, the clinician fitted a removable retainer and gave the patient instructions on how to wear it. She was happy with the results of this simple and inexpensive orthodontic treatment.

**Discussion.** When MMD is the patient’s only concern and alignment of the teeth is acceptable, a sectional archwire can be used to close the MMD. It can be a suitable option when time and cost prohibit comprehensive treatment with a fixed appliance. In this case, the incisors were moved mesially to close the MMD. Initial use of a 16-mil round wire allowed for better alignment of the four incisors before active movement. The 18-mil wire provided enough strength to ensure that the incisors were pulled mesially by the elastics to achieve the desired movement. The dentist must be careful not to overstretch the power chain, as this can cause unwanted mesial rotation of the lateral incisors. The practitioner also can use a rectangular (16 × 22 mil [0.56 mm]) archwire for three-dimensional control. He or she should proceed with care when using the simple sectional fixed appliance because incisors may act against each other and produce unwanted tooth movement. An alternative approach is to use a 2 × 4 appliance (bands on the first two molars and brackets on the four maxillary incisors), together with a utility arch, to better control tooth movement. This latter method also prevents minor incisor flaring.

**Case 5. Description.** A 26-year-old woman visited her dentist (C.H.C.) with a complaint of an MMD. Her molar and canine had a normal Class I relationship. The two central incisors also were tilted distally, but there was adequate spacing in the maxillary arch. Because the patient’s mandibular teeth were in reasonable alignment and she had no other complaints, treatment consisted of closing the MMD by realigning the two maxillary central incisors with a full-arch fixed appliance.

Orthodontic treatment consisted of banding the maxillary first molars and bonding brackets from the left second premolars to the right second premolars. The dentist fitted a 16-mil nickel-titanium (NiTi) wire with elastic ligatures to align the teeth horizontally and fitted a ligature wire to the canine and first molar.
(tieback) to prevent mesial movement of the canine tooth (Figure 13). Two months later, he replaced the 16-mil NiTi wire with an 18-mil NiTi wire. When initial alignment was established, he replaced the NiTi wire with an 18-mil stainless steel wire to promote mesial bodily movement. The clinician fitted a power chain to close the space between the central incisors. The treatment took seven months, and the patient was highly satisfied with the outcome (Figure 14).

Finally, the clinician fitted a removable retainer and instructed the patient in how to wear it. After treatment, he studied the patient’s occlusion clinically and in the mounted study cast. The clinician made no adjustment because the upper and lower teeth had achieved satisfactory occlusion.

Discussion. In this case of MMD involving tilted maxillary central incisors, treatment consisted of controlled tooth movement. Our use of a fixed appliance was simple and fast. Alignment of the mandibular teeth was acceptable, and the maxillary space allowed for alignment of the upper teeth. In cases such as this, a diagnostic setup is necessary. The clinician can assess the space by examining the study cast. If there is mild crowding in the maxillary arch, midline expansion can be achieved with a screw, quad-helix or Porter arch. In general, a 1-mm midline expansion would provide 2 to 3 mm of space in the arch. The first molars are banded to serve as anchors, and a small-diameter archwire is fitted initially and supported with brackets. After horizontal alignment of the teeth is achieved, the clinician needs to place a rectangular archwire if the root positions need correcting. Clinicians should provide patients with detailed explanations, including the importance of follow-up and maintenance care.

DISCUSSION

MMD is not an uncommon complaint of adult patients. The dentist
should perform a thorough oral examination to determine if there are any relevant etiologic factors. In addition, the dentist should talk with the patient about his or her expectations for dental care and treatment preferences, because these often are key to achieving the patient’s satisfaction and successful treatment outcomes. If the patient’s condition is complicated and requires the opinion and care of an expert, the clinician should refer him or her to the appropriate dental specialist. In this report, we presented five cases of adults with MMDs and no obvious pathology who were treated by a general dentist. Figure 15 is a flowchart that summarizes these cases and the procedures performed. General dentists can perform a range of restorative and orthodontic treatments in appropriate clinical situations to address patients’ esthetic concerns.

CONCLUSIONS
MMDs create a dark spot within the smile, which prompts many patients to seek treatment. General dentists play an important role in reaching correct diagnoses and should consider a multidisciplinary approach to achieve an optimal outcome. Clinicians should perform a detailed assessment, which often includes radiographic assessment, spacing analysis and occlusal analysis on study casts and the diagnostic wax-up. It also is essential to study the position and size of the tongue in relation to the dental arch.

Treatment by specialists may be required depending on the etiologic factors. However, it is not uncommon for clinicians to find no underlying pathology. When comprehensive orthodontic care is not the patient’s choice of treatment and if function and alignment of the teeth are acceptable, clinicians can perform restorative or simple orthodontic treatment successfully. We have presented five cases to illustrate treatments that general dentists can perform to manage MMDs in their patients.

Disclosure. None of the authors reported any disclosures.

The authors thank Dr. Trevor Lane for editing the manuscript of this article.