

Integrating Esthetic Dentistry and Space Closure in Patients with Missing Maxillary Lateral Incisors

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Treatment plans for patients with missing maxillary lateral incisors have traditionally included either space closure or space reopening.¹⁻⁹ The most common objections to orthodontic space closure are that the treatment outcome may not look “natural”, that retention is difficult, and that the functional occlusion may be compromised. Many clinicians have therefore preferred to create space for missing lateral incisors with single-tooth implants or resin-bonded bridges.^{8,9} In the past, however, neither approach produced results that were entirely satisfactory from an esthetic and functional standpoint.

Now, with the possibility of esthetic tooth restorations using bonded ceramics and resin composites, together with various procedures for at-home or in-office tooth whitening, the profession is changing its way of thinking.¹⁰ The purpose of this article is to show the considerable improvement that can be achieved today with the space-closure alternative by combining techniques from esthetic dentistry and carefully detailed orthodontic treatment. Such treatment

may include:

- Esthetic recontouring of a mesially relocated cuspid to a more ideal lateral incisor shape and size by using a combination of grinding and composite resin build-ups or porcelain laminate veneers.
- Intentional whitening by vital bleaching of a yellowish cuspid that has been moved mesially into the lateral incisor position.
- Careful correction of the crown torque of a mesially relocated cuspid to mirror the optimal lateral incisor crown torque, along with the provision of optimal torque for the mesially moved maxillary first and second bicuspid.
- Individualized extrusion and intrusion during the mesial movement of the cuspids and first bicuspid, respectively, to obtain an optimum level for the marginal gingival contours of the anterior teeth.
- Increasing the width and length of mesially moved and intruded first bicuspid with composite resin build-ups and/or porcelain laminate veneers.
- Simple minor surgical procedures for localized clinical crown lengthening.

These techniques, when used in combination, can provide the needed improvements to approach the looks of a natural intact dentition, and can thus make orthodontic space closure a more attractive treatment alternative than ever before for patients with missing lateral incisors.

Rationale

The most evident advantage of esthetic space closure is the permanence and biological compatibility of the finished result.^{3,4,11} At the end of orthodontic treatment, the overall treatment is completed. The gingival papillae will properly surround all the teeth. Even when



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Integrating Esthetic Dentistry and Space Closure

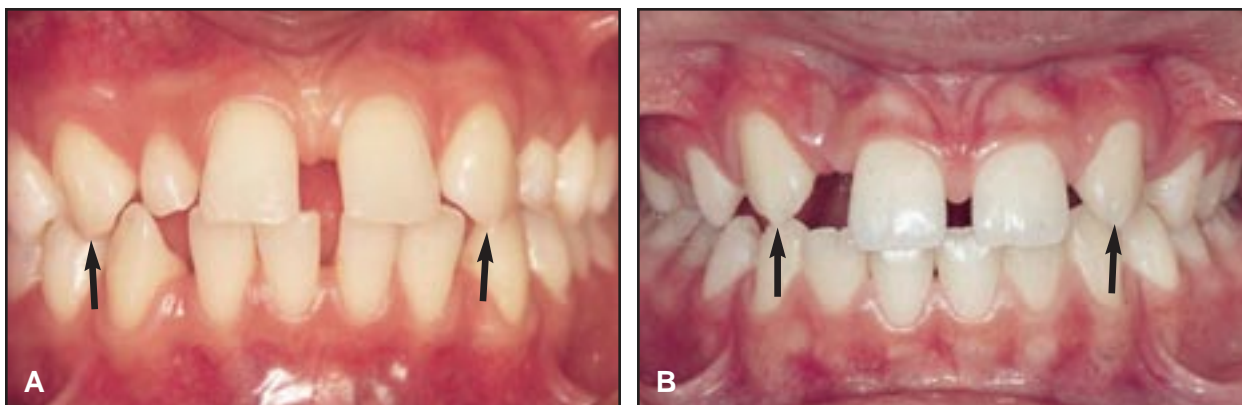


Fig. 1 Two young patients with bilateral agenesis of maxillary lateral incisors. Both show remarkably different crown torque between right and left maxillary cuspids (arrows). These torque differences must be compensated for by individual archwire bends during orthodontic space closure.

porcelain laminate veneers are needed in young patients, such restorations can be made immediately after appliance removal. Because only a minimal amount of enamel is removed during the preparation, there is no risk of pulp damage, in contrast to the conventional jacket crowns or crowns made of porcelain fused to gold.

Recent studies have indicated that tooth eruption may continue into the patient's 30s, and sometimes even longer.¹²⁻¹⁵ With properly placed fixed lingual retainers,¹⁶ stability of the treatment result is assured. In the years to come, all the teeth will erupt in synchrony with any remaining growth of the face. It should also be emphasized that any recession of the labial gingival margins that may occur later, due to normal aging or for other reasons (mechanical, including overzealous toothbrushing, or periodontal), will take on a natural look and reflect the incoming light normally, even with porcelain veneers. If considered desirable, a functional occlusion with cuspid protection can be obtained with the resin build-ups or porcelain veneers on the first bicuspids. The bonded retainer wire can cover four or six teeth, and since it is placed supragingivally, it can easily be repaired if it becomes loose or broken.¹⁶

In contrast, orthodontic space reopening and replacement with a single-tooth implant and prosthetic crown inherently commit the patient to a lifelong artificial restoration in the most visible area of the mouth. In this region, tooth shade and transparency, along with gingival color, contour, and margin levels, are critical and difficult to control, particularly in the long term.^{3,9,14,15} Techniques for obtaining complete and stable interdental gingival papillae and normal gingival topography around single-tooth implants are

presently subject to considerable clinical research.^{14,15,17-24} The labial and interdental gingival recession that is commonly found in adults may result in unesthetic "blueing" of the marginal gingivae or even disclosure of the implant margins after several years.^{18,19} In young patients and adolescents, the implant and final restoration cannot usually be placed until all skeletal growth is completed and tooth eruption has ceased.¹²⁻¹⁶ Furthermore, recent studies have demonstrated that even after dental and skeletal development is complete, infraocclusion and progressive malalignment of single-implant crowns may occur in the anterior maxilla.^{14,15}

Indications and Contraindications for Space Closure

From a treatment-planning point of view, orthodontic space closure may be indicated or contraindicated, depending upon the original malocclusion.²⁵ Important considerations are the degree of crowding or spacing, the size and shape of the teeth, and the state of the occlusion. Factors favoring space consolidation include:

- A tendency toward maxillary crowding in a patient with a well-balanced profile and normally inclined anterior teeth⁹
- Cuspids and bicuspids of similar size
- Dentoalveolar protrusion
- Class II malocclusion
- Marked mandibular crowding or protrusion⁹

Space reopening is usually preferable in a patient with:

- No malocclusion and normal intercuspation of the posterior teeth
- Pronounced spacing of the maxillary dentition

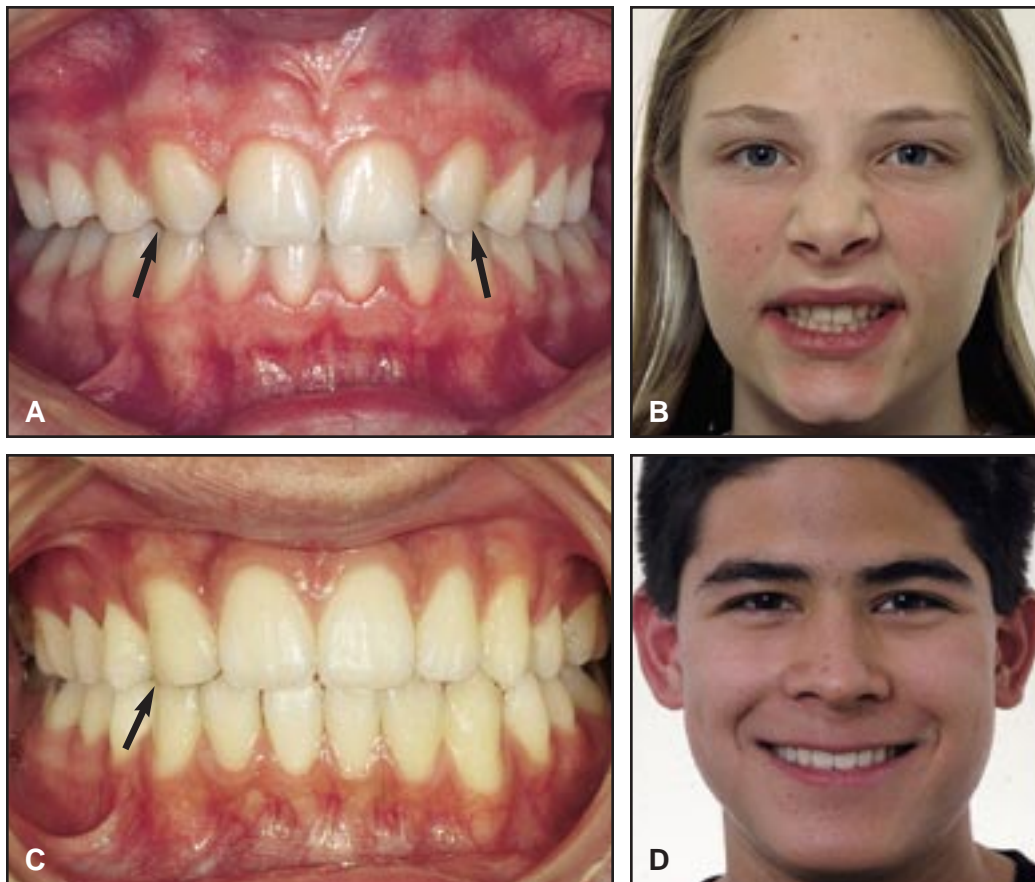


Fig. 2 Excessive lingual tilting of maxillary cuspid crowns produces undesirable esthetic results (arrows) in orthodontic space closure with either bilateral (A,B) or unilateral (C,D) agenesis. Natural maxillary lateral incisor has labial crown torque (patient's left side in C).

- Class III malocclusion and retrognathic profile
- A large size difference between cuspids and first bicuspid

Clinical Problems Associated with Space Closure

The clinical significance of the potential problems associated with orthodontic space closure increases the more the patient reveals of the dentition in normal conversation and smiling.²⁶ Successful treatment of patients with missing lateral incisors requires a cooperative patient and careful attention to the following details:

The *size difference* between cuspids and first bicuspid. Variations in crown length and width can create a poor esthetic balance between the hard and soft tissues. In general, the cuspids have longer clinical crowns than the lateral incisors, and the first bicuspid is shorter than the cuspids. An undesirable periodontal profile may

result if the “lateral incisors” are too long and too large mesiodistally, and the “cuspids” are too short and too small. If the first problem is solved with extrusion of the cuspids and reshaping by interproximal grinding, the first bicuspid that will occupy the position of the cuspids will invariably be undersized in both the mesiodistal and vertical dimensions.

The *color difference* between cuspids and incisors. The cuspids are usually darker and/or more *yellowish* than the incisors, accentuating the contrast between the maxillary central incisors and the “new” lateral incisors.

The *crown torque difference* between cuspids and lateral incisors, and the marked individual variation in cuspid torque (Fig. 1). In a follow-up study 10 years after treatment of cases with absent lateral incisors by orthodontic space closure,²⁷ the most common mistake was found to be inadequate crown torque of the mesially relocated cuspids (Fig. 2). The differences in crown

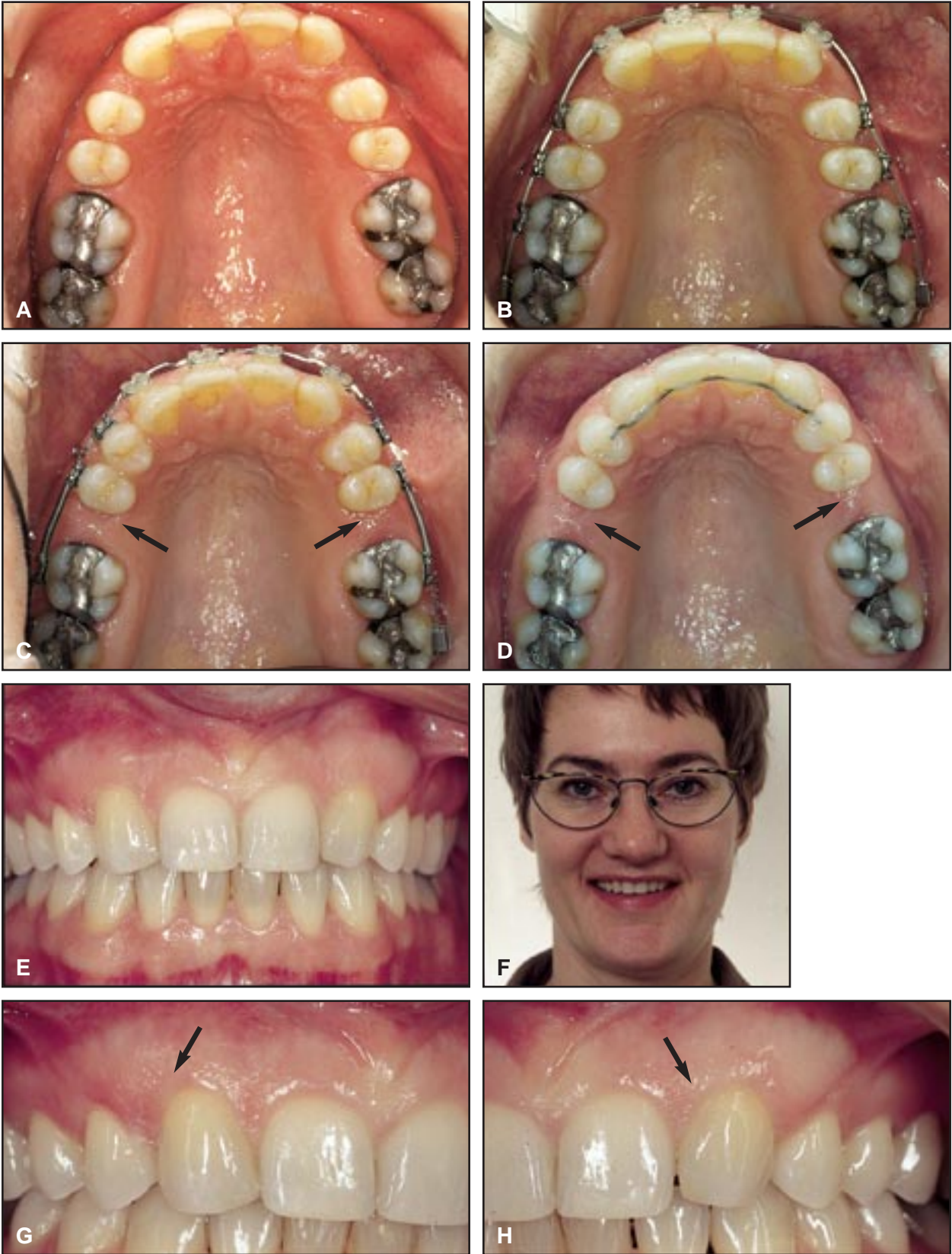


Fig. 3 Alternative treatment option when maxillary lateral incisors are absent is to open space posteriorly rather than anteriorly. Spaces can be closed by single-tooth implants or cantilever bridges from first molars. A-D. Young adult female patient treated by opening space distal to second bicuspid (arrows). E-H. Note excellent gingival condition four years after treatment.

torque and crown-root angle among cuspids in different persons is considerable. Asymmetry of crown torque can often be seen even between the right and left cuspids in the same patient (Fig. 1). If the crown of a cuspid in lateral incisor position has not been given the correct lateral incisor torque, the result may appear unnatural (Fig. 2C,D). In addition, the cuspid is wider buccolingually than a lateral incisor, creating the possibility that the cuspid *eminence* may be moved to an area where an eminence does not normally occur,^{6,28} while a normal cuspid eminence may be difficult to achieve with the first bicuspid.

The type of *functional occlusion* at the end of treatment. A cuspid-protected functional occlusion is generally not feasible with orthodontic space closure alone.^{4,11} Usually, a lateral group guidance is achieved on the maxillary bicuspids and relocated cuspids. In such instances, abrasion may be noted on the mandibular lateral incisor if the contact with the maxillary cuspid is excessive. If possible, the functional forces should be on the mesially relocated first bicuspid.⁸ It may sometimes be desirable to grind the palatal cusp to avoid balancing contacts, but if the bicuspid is properly rotated mesially, most of the contact with the mandibular cuspid will be on the mesial ridge of the buccal cusp. Some clinicians fear a loss of periodontal attachment because of the stress placed on the thinner and smaller roots of the premolars. Long-term studies have shown, however, that space closure is as sound as space reopening occlusally and is preferable periodontally.¹¹

Relapse after retention, including long-term space reopening. There is usually a marked tendency for spaces to reopen in the maxillary anterior region after closure and conventional retention with plates or splints. For this reason, the retention of space-closure cases must not be taken lightly. We recommend long-term (10 years or more) or even permanent retention with lingually bonded multistranded wire retainers over six teeth (Fig. 3D), combined with a removable plate to be used continuously for the first six months and then at night. No apparent side effects were noticed with this regimen in the 10-

year follow-up study cited above.²⁷ The bonded retainer wire should include the first bicuspid, but after several years, it can usually be cut distal to the cuspids, so that only the cuspids and central incisors are included. Should spaces still open up distal to the cuspids, these can be filled with composite resin build-ups.

An interesting alternative to reopening space for missing lateral incisors is to open up space in the posterior region (Fig. 3C,D). This technique has the same biological advantages in the anterior portion of the maxilla as normal space closure (Fig. 3G,H), and it may promote better long-term stability, particularly if there is a jaw-size or tooth-size discrepancy. The spaces opened up behind the second bicuspids (Fig. 3D) can be filled with single-tooth implants or by cantilever bridges from the first molars. Restorations on single-tooth implants behind the second bicuspids do not need to meet the same strict esthetic requirements as in the anterior region, and such implants will also receive a more favorable axial loading.

Size differences in agenesis cases. When there is a peg-shape lateral incisor on one side and agenesis of the lateral incisor on the other (Fig. 4A-C), it may be difficult to obtain esthetically pleasing results. The best solution in such cases is to combine the space closure with a good porcelain laminate veneer on the peg tooth (Fig. 4D-F).

Keys to Clinical Treatment

Setups: A diagnostic setup on plaster models can clearly identify the tooth-size problems and the amount of crown reshaping that will be needed. It may also be advisable to make a pictorial setup with the patient smiling (and/or speaking). This will allow the clinician to focus on the crucial aspects of the tooth display—the relationship between teeth, gingivae, and lips—which is different in every patient. The “visual setup” procedure is helpful in planning any intrusion or extrusion needed to obtain normal relationships for the marginal gingival contours, with the cuspids at the same level as the central incisors and the

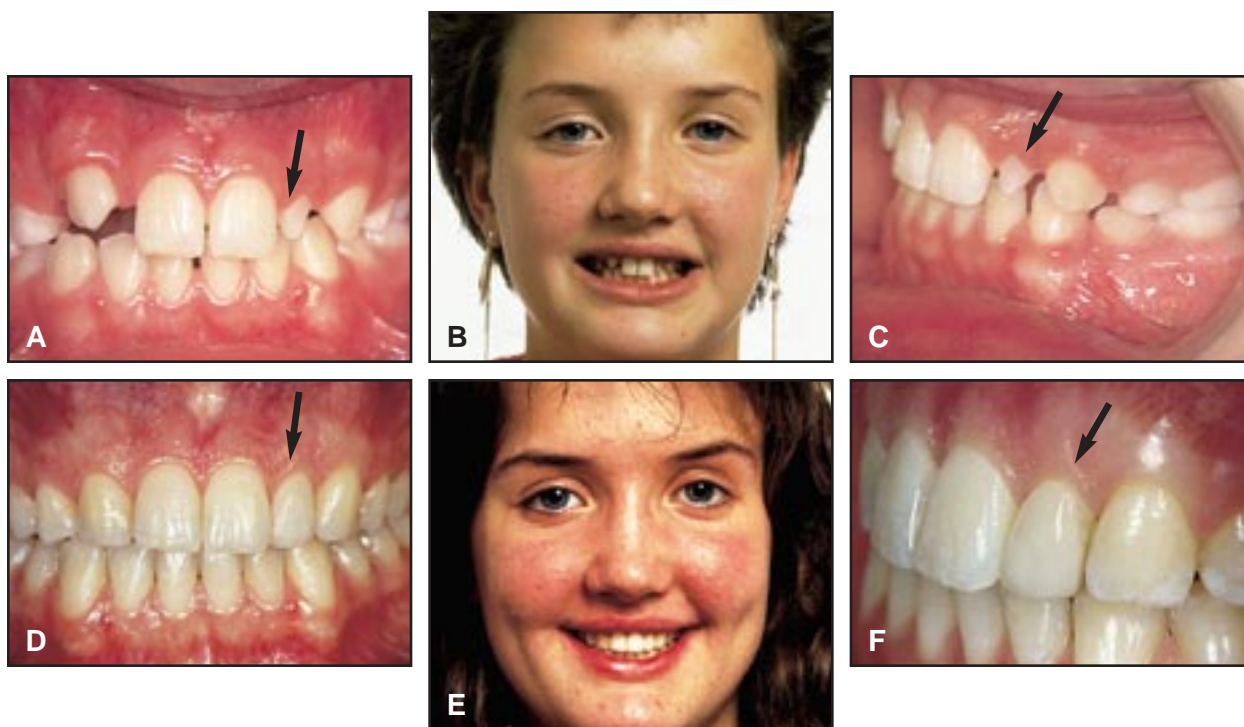


Fig. 4 Difficult unilateral maxillary lateral incisor agenesis case in young girl with peg-shape contralateral lateral incisor (A-C). Right cuspid was extruded and then recontoured by grinding only (A,D); porcelain laminate veneer crown was made for peg tooth. Note excellent reflection of incoming light with no darkening of exposed root surface some years later, when labial gingiva has retracted from veneer margin (arrow in F).

lateral incisors at a lower level²⁹ (Figs. 5-8) and a natural exposure of the gingivae in smiling (Figs. 5F,8H). It can be done by hand on acetate tracing paper, or by means of sophisticated software on the computer. The goal is to make an accurate prediction of the size, morphology, axial inclination, and crown torque of the “new” lateral incisors and cuspids. The visual setup can also help decide the amount of gingival prominence in the lateral incisor and cuspid areas, and the ideal relationship between the anterior teeth and lips when speaking and smiling, as appropriate for the patient’s age and facial type.²⁹

Orthodontic finishing: Since the cuspid is thicker labiolingually than a lateral incisor, a mesial archwire outset will be necessary to obtain a proper contact point between the cuspid and the central incisor (Fig. 9C). Similarly, the correct mesial rotation of the first bicuspid (to improve the “cuspid” look from the front) can be obtained with a distal outset and/or a more distal bracket

position (Fig. 9C). The proper crown torque for the cuspid that is to occupy the lateral incisor position must be individually determined by viewing each patient directly from the front, keeping in mind the extreme variation in cuspid torque among untreated patients (Fig. 1). Generally speaking, most cuspids need marked lingual root torque to look like lateral incisors (Figs. 4D; 5B,D-F; 8D,G; 9D; 10D-F) and to reduce the root eminence. The torque problem may be handled partly by bracket selection, but archwire torquing and careful monitoring of its effect is almost always necessary throughout the treatment period. Both for esthetic and functional reasons, the crown torque for first bicuspid in cuspid positions should be relatively straight (Figs. 3E; 5B,E,F; 8G). When the first bicuspid are intruded with labial fixed appliances, the crowns tend to tip buccally, and the “cuspid” eminence is reduced. Therefore, intrusion of the first bicuspid should be combined with buccal

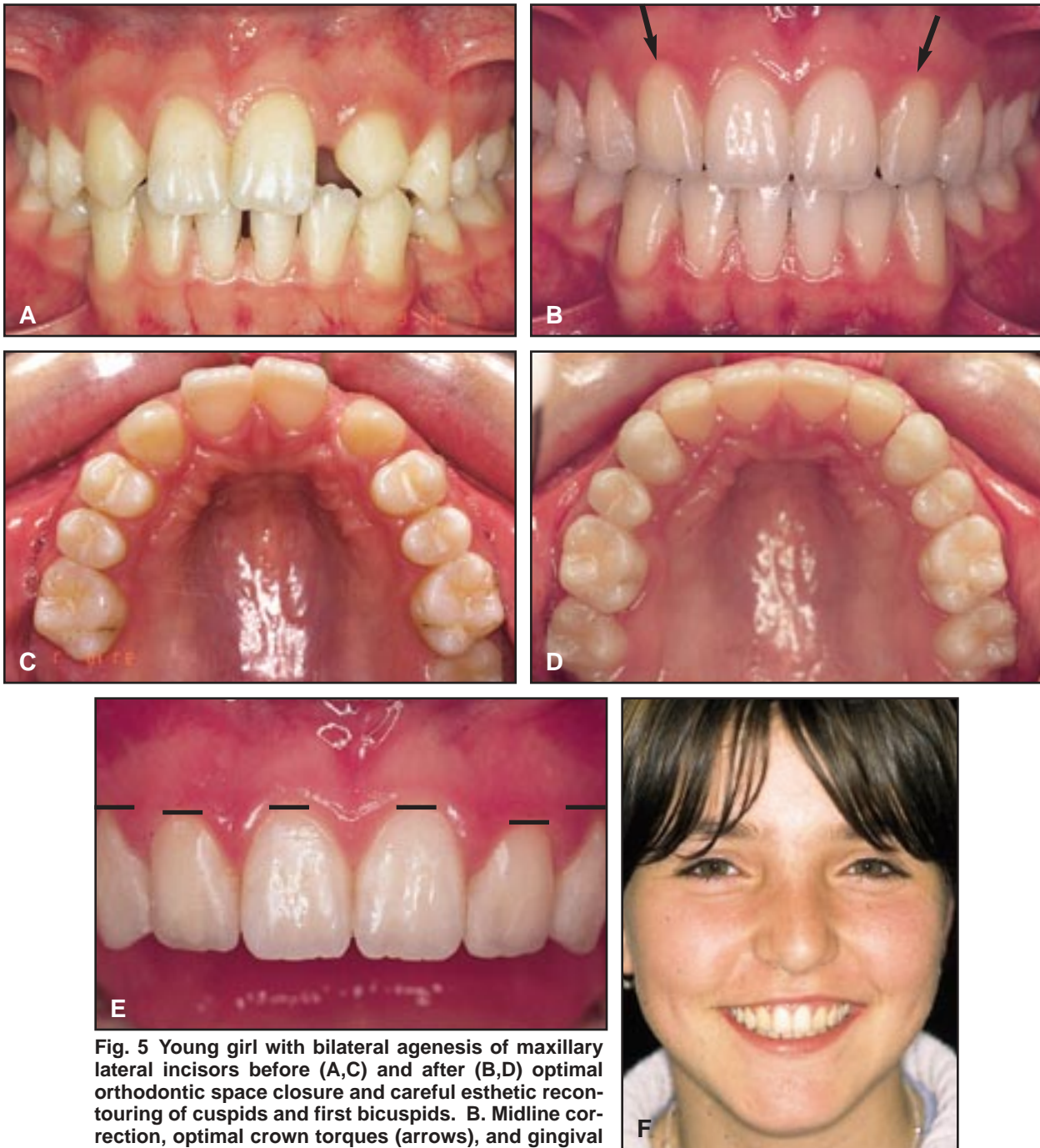


Fig. 5 Young girl with bilateral agenesis of maxillary lateral incisors before (A,C) and after (B,D) optimal orthodontic space closure and careful esthetic recontouring of cuspids and first bicuspids. B. Midline correction, optimal crown torques (arrows), and gingival leveling. D. Hybrid composite resin build-ups. E. Marginal gingival levels after treatment. F. Post-treatment smile almost indistinguishable from that of patient with intact natural dentition.

root torque (Fig. 6A,B).

A natural-looking marginal gingival contour will be at the same labial level for the central incisor and the first bicuspid in cuspid position, with the relocated cuspid at a lower level

(Fig. 5E,F). This usually means that the cuspids have to be extruded and the first bicuspids intruded (Figs. 6A-D, 8E,F). Because the cuspids are thicker than lateral incisors, their extrusion may create excessive occlusal contact with the

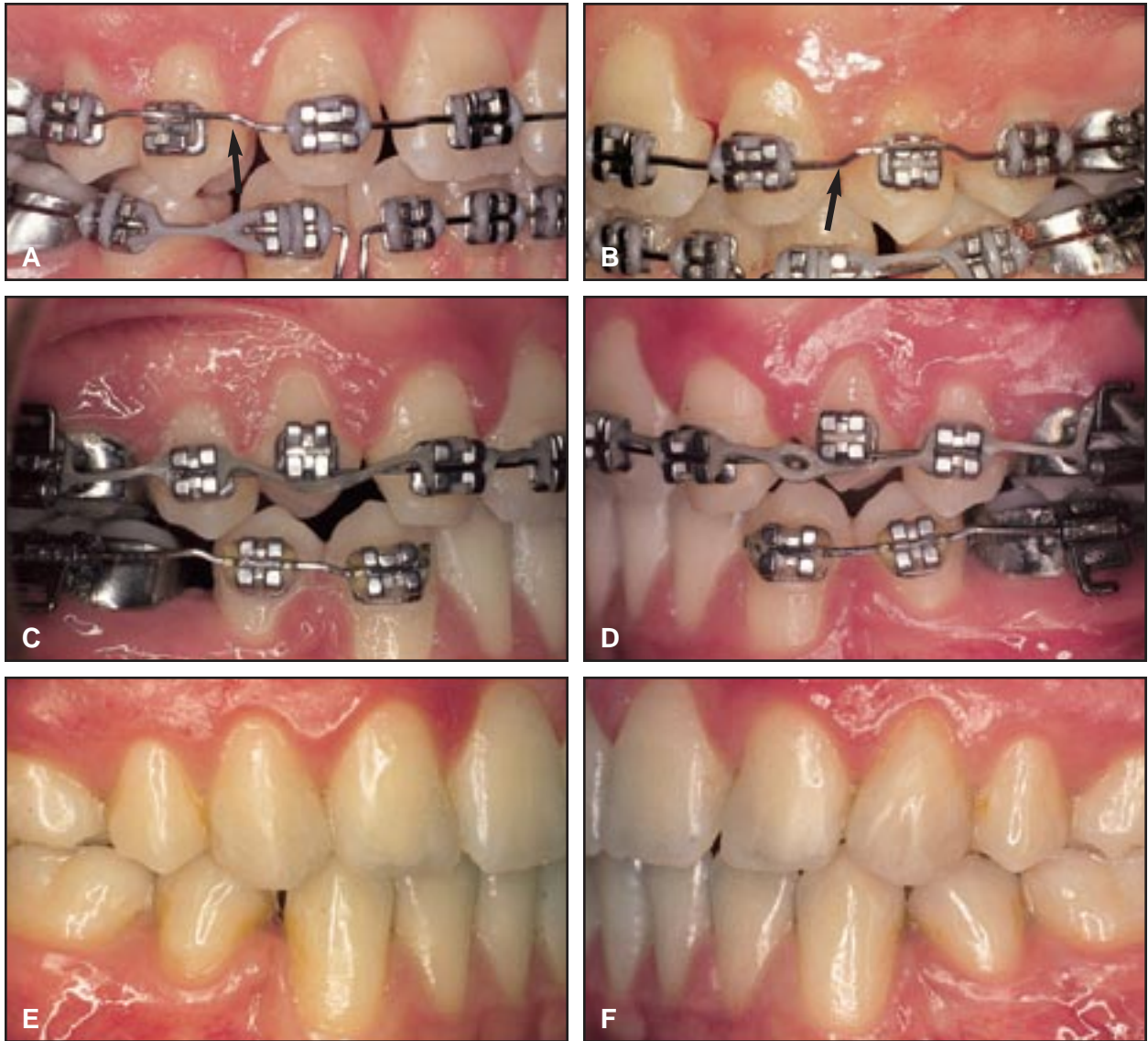


Fig. 6 Same case as in Figure 5, showing details of recontouring maxillary first bicuspid to shape, size, and form of natural cuspids. Labial gingival margins were placed at same level as those of central incisors by progressively increasing archwire intrusion bends (A,B) and using leveling wire in incisal tie-wing area (C,D). Build-up (E,F) was made with hybrid composite resin (Enamel Plus HFO).

mandibular incisors. This should be corrected by moving the cuspids labially, increasing their lingual root torque, and grinding their lingual surfaces. The axial inclinations of the cuspids should be planned with consideration of root parallelism, but also with regard to their crown mor-

phology, so as to reduce the risk of space reopening and loss of contact with the central incisors (Figs. 5E, 7B).

Cosmetic contouring of cuspids: As demonstrated in 1970 by Tuverson,³ it is possible to recontour a cuspid to almost an ideal lateral incisor

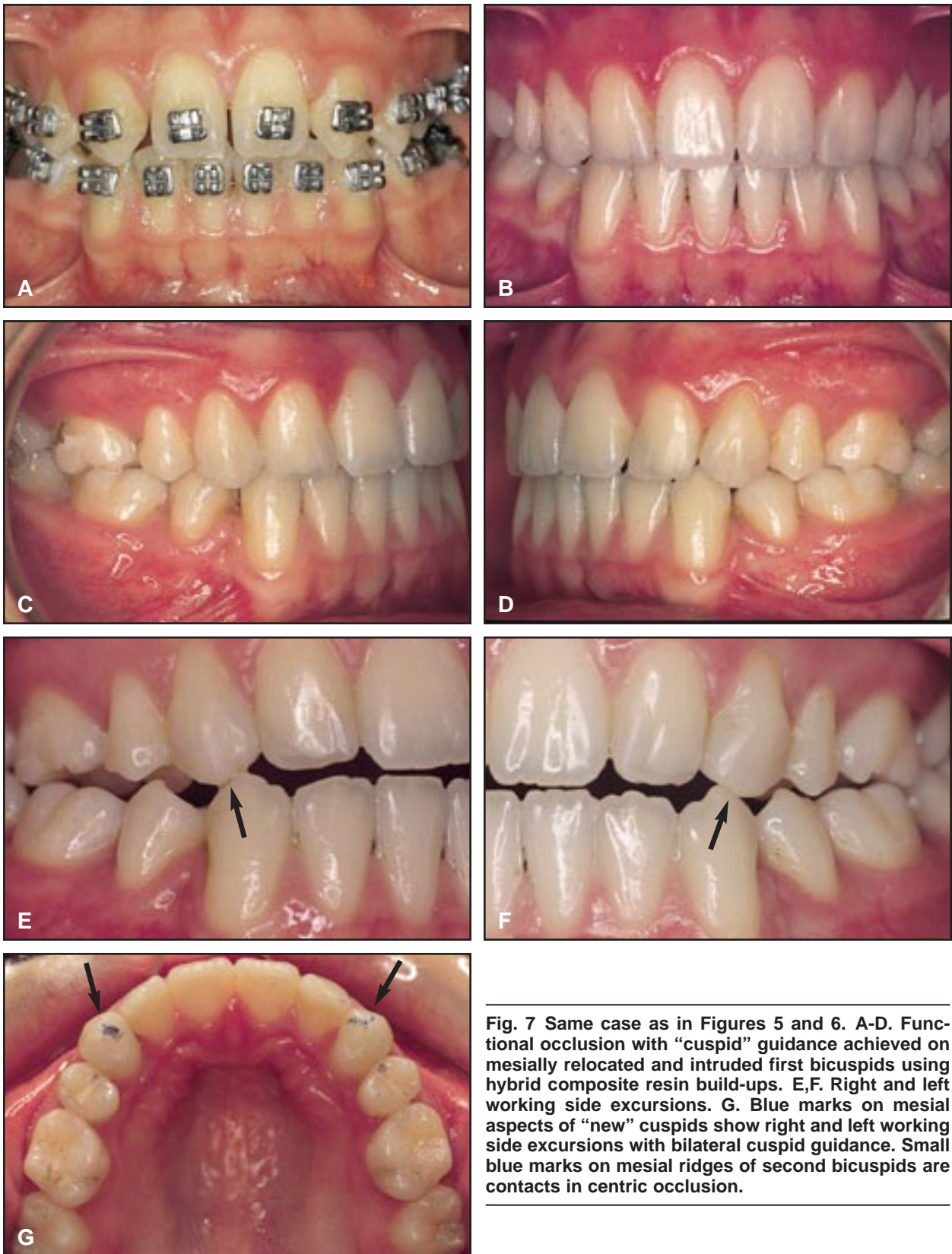


Fig. 7 Same case as in Figures 5 and 6. A-D. Functional occlusion with "cuspid" guidance achieved on mesially relocated and intruded first bicuspids using hybrid composite resin build-ups. E,F. Right and left working side excursions. G. Blue marks on mesial aspects of "new" cuspids show right and left working side excursions with bilateral cuspid guidance. Small blue marks on mesial ridges of second bicuspids are contacts in centric occlusion.

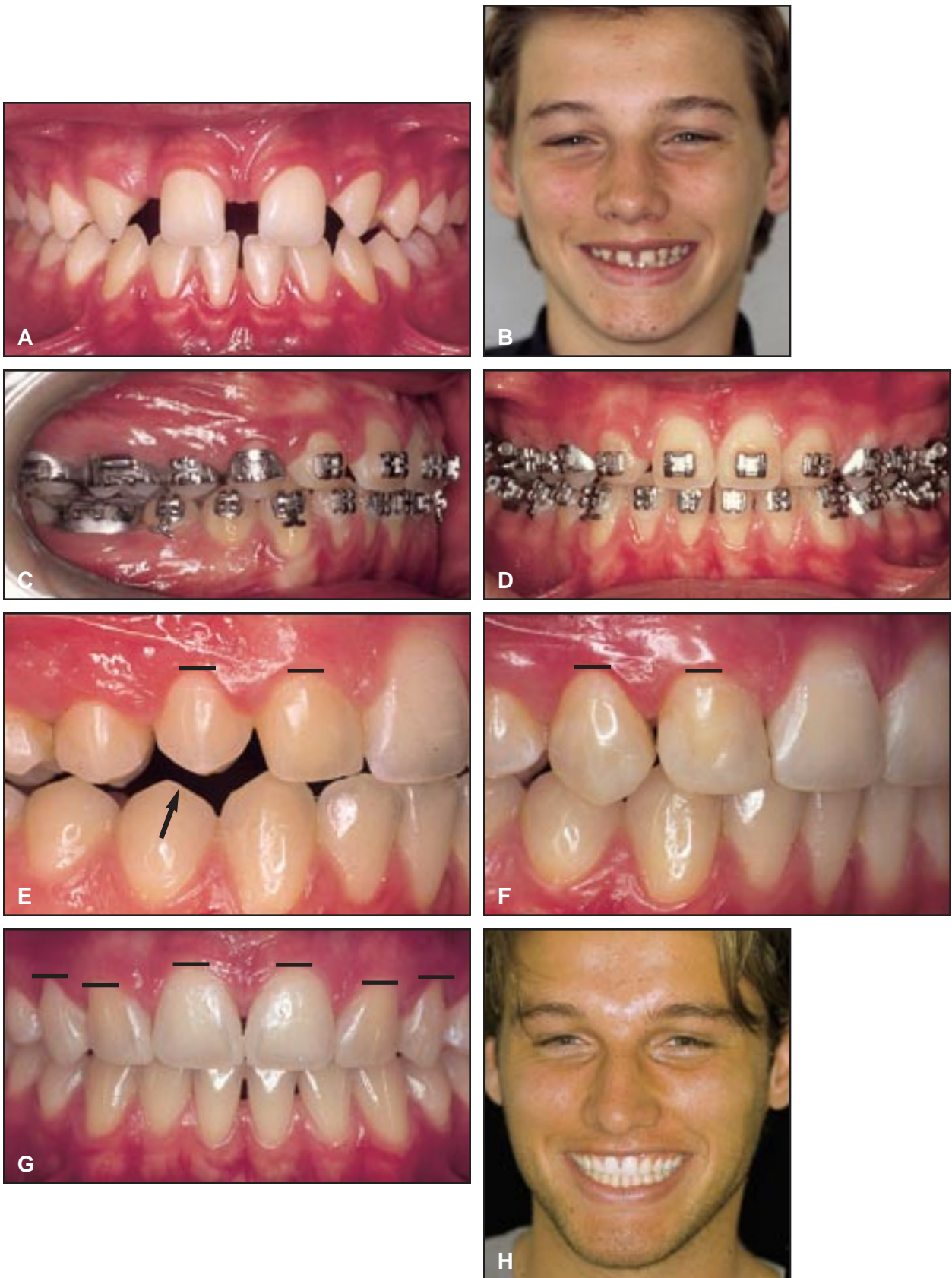


Fig. 8 Young boy with bilaterally absent maxillary lateral incisors at start of treatment (A,B). Among other details, orthodontic treatment included marked lingual root torque (compare A and G) and extrusion of cuspids (C,D) that were to replace lateral incisors, as well as intrusion of first bicuspids (E) and hybrid composite resin build-ups (Enamel Plus HFO) on these teeth (F) to replace cuspids. Crown torque of “new” lateral incisors and cuspids and marginal gingival levels of six anterior teeth at end of treatment (G) resemble conditions in natural dentition. Smile (H) is markedly improved compared with start (B).

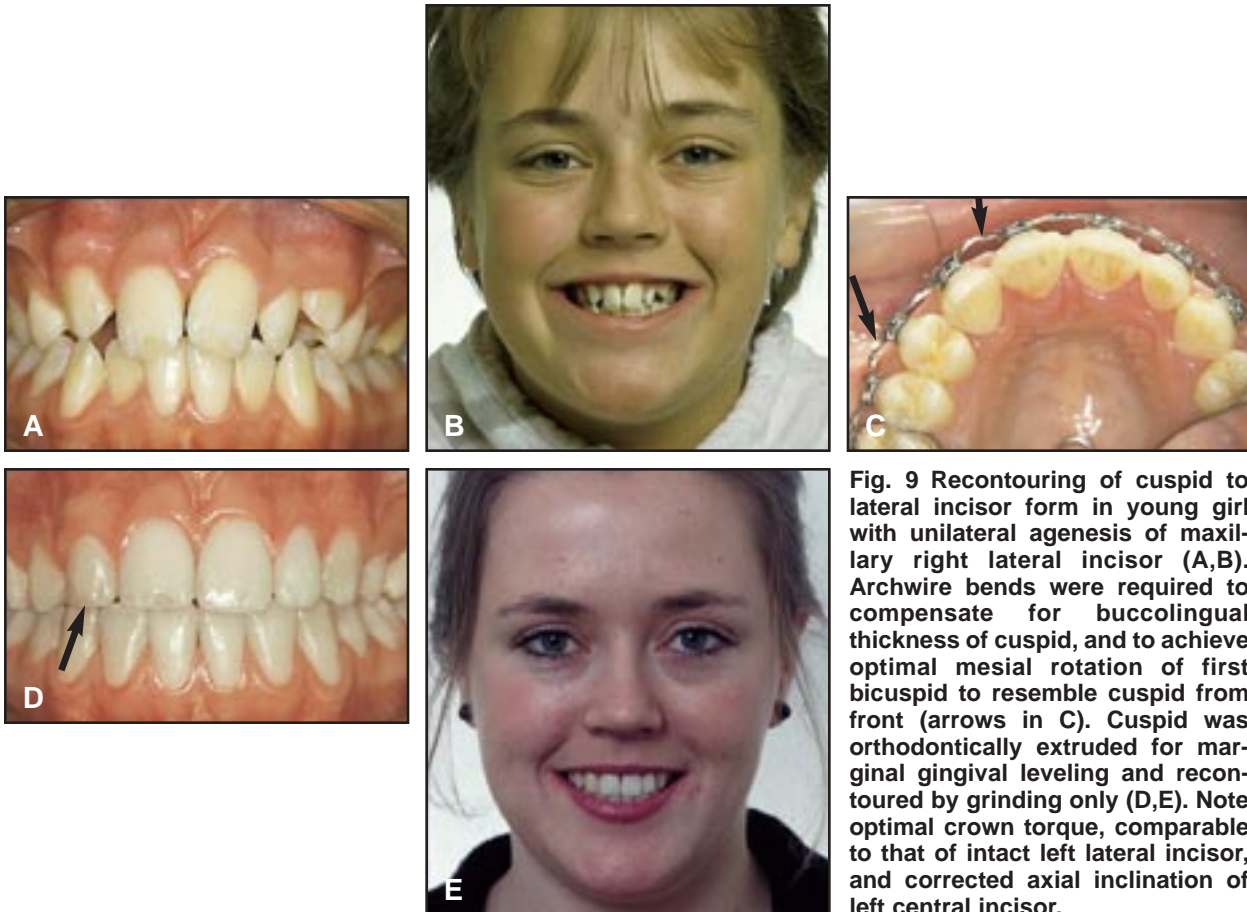


Fig. 9 Recontouring of cuspid to lateral incisor form in young girl with unilateral agenesis of maxillary right lateral incisor (A,B). Archwire bends were required to compensate for buccolingual thickness of cuspid, and to achieve optimal mesial rotation of first bicuspid to resemble cuspid from front (arrows in C). Cuspid was orthodontically extruded for marginal gingival leveling and recontoured by grinding only (D,E). Note optimal crown torque, comparable to that of intact left lateral incisor, and corrected axial inclination of left central incisor.

shape by grinding with diamond instruments. Iatrogenic effects of grinding, such as increased sensitivity to heat and cold and other pulp and dentin reactions, can be prevented with careful attention to two procedures: adequate cooling with abundant water and air spray, and preparation of smooth and self-cleansing surfaces.^{5,27} When this method has been used, no harmful pulp or dentin reactions have been observed, even with extensive grinding and incisal dentin exposure, whether in the short⁵ or long term.²⁷ Gross recontouring can be done in one session at the start of orthodontic treatment, with fine tuning delayed until the end, if necessary. Since the enamel layer near the labial cemento-enamel junction is sometimes thin,²⁷ it may be safer to avoid flattening the labial surfaces of the cuspids and accept a somewhat more rounded labial shape than is seen on intact lateral incisors. The mesiodistal dimension can also be reduced, particularly on the distal surface, which may be too convex compared to a lateral incisor. The mesial

margins may also be too convex, but this can be corrected with composite resin “corners”.^{30,31} Such restorations are relatively easy to make with one of the new hybrid resin restorative materials, and they will effectively conceal the difference in morphology incisal to the mesial contact points between cuspids and lateral incisors. To avoid color differences with the cuspid enamel, however, the restorations should be performed after any vital bleaching treatment. The amount of reshaping by grinding must also be planned with regard to the size discrepancies between the teeth and the morphology of the central incisors (more or less “square” or “oval”).²⁹

It is, of course, possible to use one or several esthetic porcelain laminate veneers to almost perfectly recontour the mesially relocated cuspids and bicuspid into “normal” lateral incisor and cuspid shapes, respectively.^{32,33} Porcelain veneers on the cuspids and first bicuspid are more expensive for the patient than grinding and resin build-ups, but may compare favorably with

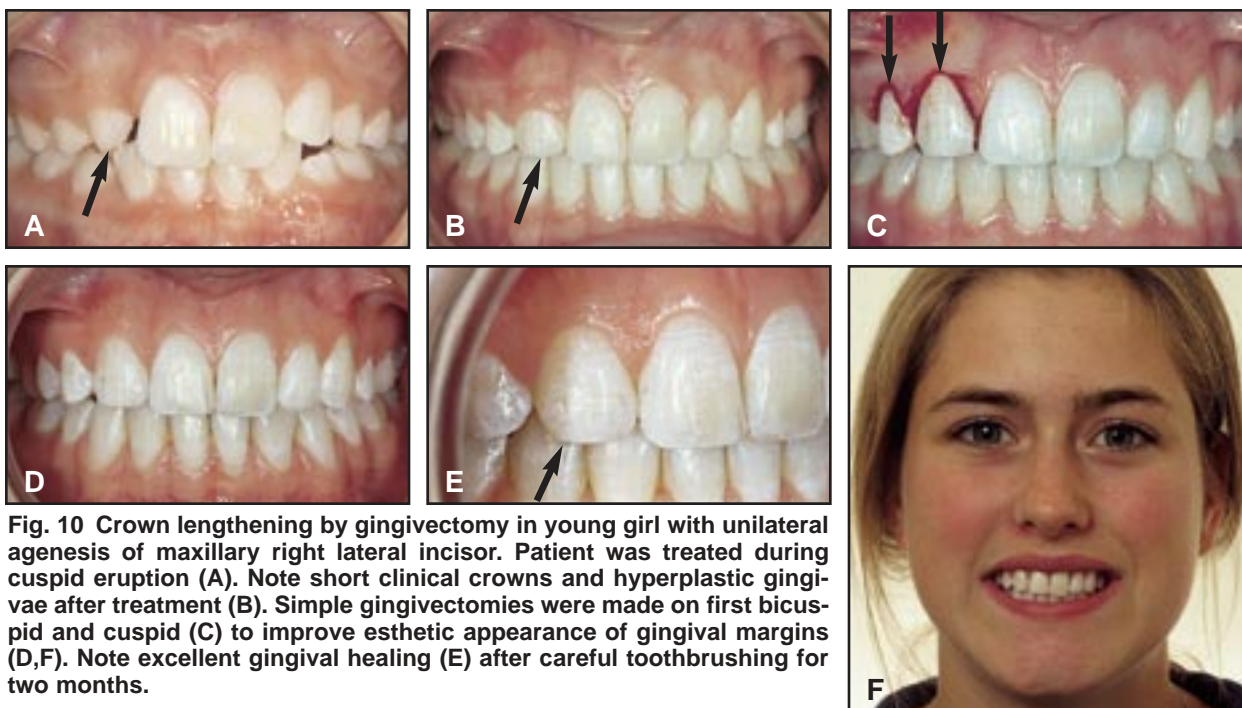


Fig. 10 Crown lengthening by gingivectomy in young girl with unilateral agenesis of maxillary right lateral incisor. Patient was treated during cuspid eruption (A). Note short clinical crowns and hyperplastic gingivae after treatment (B). Simple gingivectomies were made on first bicuspid and cuspid (C) to improve esthetic appearance of gingival margins (D,F). Note excellent gingival healing (E) after careful toothbrushing for two months.

the cost of restorations on single-tooth implants.

Minor surgery for crown lengthening: When space closure is performed in young patients at the same time that the cuspids are erupting, the marginal gingiva around the mesially moved cuspid may sometimes become hyperplastic, which can significantly reduce its crown length (Fig. 10B). A simple localized gingivectomy to the bottom of the clinical pocket (Fig. 10C) will increase the crown length (Fig. 10D-F). The same procedure can be used on the first bicuspid (Fig. 10C). As shown in a human experimental model,³⁴ nearly 50% of the excised tissue will regenerate and become clinically and histologically indistinguishable from normal gingiva. This means, for example, that if a labial probing pocket depth of 4mm is recorded on the cuspid, a gain of 2mm in crown length can be anticipated. Electrosurgery can be used,³⁵ but is no more effective than a scalpel. Even if the excision is extended into the alveolar mucosa, the coronal part of the regenerated gingiva will still become keratinized.³⁶ Careful oral hygiene procedures, using single-tufted brushes, are required for two months after the gingivectomy so that the regenerated gingiva will appear entirely normal³⁴ (Fig. 10E).

Whitening (vital bleaching): The problem of

relocated cuspids being more yellowish than the intact central and lateral incisors can now be solved relatively easily and predictably with either at-home or in-office vital bleaching procedures.^{37,38} It is generally agreed in esthetic dentistry that yellow discolorations are the easiest to improve. Nocturnal use of 10% hydrogen peroxide gel in a splint is a convenient way of bleaching teeth³⁷; if only the cuspids are to be whitened, the bleaching gel need only be injected in the cuspid reservoirs. In-office bleaching with stronger gel concentrations³⁸ may sometimes be preferable for single teeth. Recent evidence indicates that the clinical use of light and/or heat during in-office bleaching does not make teeth lighter than with bleach alone, once the teeth have rehydrated for two to five days following treatment.³⁹

Functional occlusion: Some clinicians might fear that placing a first bicuspid in the cuspid position might place an excessive functional demand on the bicuspid. Long-term studies of periodontal condition and occlusal function from two to 25 years after treatment (mean 9.7) have demonstrated no such effect,¹¹ indicating that an adequate group function occlusion can be obtained with the first bicuspids substituting for cuspids.^{4,6,11} As a working hypothesis, we believe

even cuspid-protected guidance can be achieved with space closure. This is done by intruding the first bicuspid and building them up with hybrid resin restorative material or porcelain laminate veneers (Figs. 7B-G, 8F-H).

After being intruded with proper torque control, the first bicuspid need to be enlarged to build new "cuspid" incisal tips, adequate contact points with the adjacent teeth, and new lingual surfaces. It may be argued that conventional composite resins do not offer the same esthetic enhancement and long-term durability as porcelain veneers. However, the newest hybrid resins—such as Renamel Hybrid,* Vitaescence,** and Enamel Plus HFO***—are claimed to produce a surface smoothness and translucency similar to microfill resins, with superior strength. The term "hybrid" means that these materials contain more than one type of filler particle for the best combination (or compromise) of strength and esthetics. Hybrid composites appear to provide satisfactory clinical results, at least in the short term, and they can be altered at any time by adding or grinding until an optimal result is achieved. Porcelain is even harder than enamel, and therefore is not an ideal material for reconstruction of a cuspid-protected occlusion. Even when a porcelain veneer is planned, however, it may be advisable to use direct hybrid resin restorations to determine the optimal size and morphology of the new lateral incisors and cuspids. They can be reevaluated and adjusted at subsequent visits, and the porcelain veneers can be placed when the patient is well out of treatment with a settled occlusion.

Conclusion

The problem in treating cases with missing maxillary lateral incisors and any coexisting malocclusions is not only when to close or open the spaces, but how to achieve the best esthetic and

functional results. The advent of osseointegrated implants seems to have increased the popularity of the space-opening option.⁴⁰ Another reason may be the difficulty of obtaining an optimal, natural-looking treatment result with space closure—particularly in unilateral agenesis cases. The present article has shown how the clinical concerns associated with space closure can be overcome.

As mentioned previously, a major advantage of space closure is that even though long-term continuous maintenance is required, the treatment result is *permanent*. This is important because the majority of patients with missing maxillary lateral incisors are children or adolescents. If spaces are reopened, the young patient has to wait until completion of facial growth before receiving final prostheses.¹²⁻¹⁵ During the interim period, which may last several years, the patient has to wear either a removable retainer or a fixed resin-bonded prosthesis that may be prone to fracture.^{41,42}

Another advantage of space closure is that it produces a *normal gingival topography* around mesially relocated cuspids, which is especially crucial in patients with high smile lines. Intact marginal and interdental gingival contours are difficult to produce and maintain with single-tooth implants and porcelain bridges.¹⁷⁻¹⁹

A third advantage of space closure is *cost*, since no implants or prosthetic replacements are needed.

When the methods suggested in this article are integrated, the treatment results can be almost indistinguishable from an intact dentition. Careful detailing throughout the orthodontic progress and finishing stages to achieve optimal positioning and crown torque of all teeth, coupled with new techniques and materials adapted from esthetic dentistry, can restore natural tooth shapes and sizes, provide normal gingival contours around all the teeth, and secure an optimally functioning occlusion with cuspid guidance (Figs. 5-8). Interdisciplinary cooperation among orthodontists and other dental specialists appears to be of increasing importance in achieving high-quality treatment results.

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