Restoration of the Anterior Segment in a Cleft Palate in Conjunction with Surgically Facilitated Orthodontic Therapy

An Interdisciplinary Approach

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KEYWORDS

• Surgically facilitated orthodontic therapy (SFOT) • Restorative and cosmetic dentistry
• Cleft palate • Interdisciplinary

KEY POINTS

- Surgically facilitated orthodontic therapy can be an integral part of a comprehensive, interdisciplinary dentofacial therapy treatment plan that simultaneously addresses periodontal conditions, cosmetic/esthetic restorative space appropriation dilemmas, occlusion, and possibly airway-related improvements.
- Clear, consistent, and ongoing communication among restorative/cosmetic dentists, surgical specialists (dental and medical), patient, and family is essential to achieve optimal treatment outcomes.

CASE PRESENTATION

Patient Background

A healthy 26-year-old white woman presented to the restorative practice for esthetic improvement to her smile. She had resin-bonded veneers on teeth numbers 5, 6, 7, 8, and 12 and a resin-bonded Maryland bridge between numbers 9 and 11, spanning a unilateral alveolar oronasal fistula that was a sequel of unsuccessful unilateral cleft

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Fig. 1. Resin-bonded Maryland bridge 9 to 11 and resin-bonded veneers 6 to 8 (10 years old).

palate repair when she was 1 year old (**Figs. 1** and **2**). She was dissatisfied not only with the deteriorating esthetics of these restorations (which had been in place for approximately 10 years) and shifting of the bridge but also with her overall smile esthetics, and she desired improvement.

Medical history

The patient was in good systemic health.[1] Her medical history was unremarkable except for asthma, seasonal allergies, and a history of eczema. Her current medications included montelukast sodium, cetirizine, mometasone furoate monohydrate nasal spray, and eye drops (allergy related), which she took to manage her allergic/asthmatic symptoms.

Dental history

The patient was born with a left unilateral cleft lip and palate. Although the lip repair was successful at age 3 months, the attempted closure of the bony palatal cleft at age 1 year was not. The remaining bony and soft tissue defect extended through the alveolar process and oral mucosa, leaving an alveolar communication between the oral and nasal cavities (oronasal fistula) in the number 10 position.

The craniofacial defect created by the unilateral (left) maxillary cleft resulted in an hourglass-shaped upper arch form and a bilateral crossbite (**Figs. 3** and **4**). She

Fig. 2. Unsuccessful unilateral cleft palate repair. Failing resin-bonded Maryland bridge.

Fig. 3. Occlusal view of maxillary arch showing hourglass-shaped form.

was originally seen by the treating periodontist in 2004 for management of a recession defect, which was corrected by a connective tissue graft alone via a tunneling procedure.

Following connective tissue graft healing, her dentist at that time managed cosmetic concerns by composite bonding in the anterior maxilla.

Figs. 5–7 show the pretreatment appearance of the dentition at roughly 6 years after treatment, showing the resin-bonded bridge in place at the start of current treatment (see **Figs. 1–4**). **Fig. 8** shows a full-face pretreatment view of the patient; **Fig. 9** shows her initial full-mouth radiographic series from February 2010. The relapse in recession underscores the biological short-coming of connective tissue grafting for root coverage purposes, which results in a long-junctional epithelium compared with the more desirable outcome of periodontal regeneration (cementum, alveolar bone, and periodontal ligament).[2]

She had undergone 2 previous periods of orthodontic treatment, during which teeth numbers 4 and 13 were extracted, and numbers 1 and 16 were retained (numbers 17 and 32 are retained and impacted). The resulting occlusion comprised an Angle class II molar relationship on the right (**Fig. 10**), and a class I relationship on the left (in the area of the cleft-related arch deficit; **Fig. 11**). Her history also included alveolus repair, palate repair including velopharyngeal flap, rib grafting (as part of the attempted cleft repair), and alar and lip revisions; a noticeable alar discrepancy remains on the left side (see **Figs. 1**, **3**, and **8**).

Fig. 4. Frontal smile view of dentition (February 2010).

Fig. 5. Frontal retracted view of dentition (February 2010).

Overall, her oral hygiene was good, and she remains on a preventive recall schedule with adult prophylaxis and oral examination at 6-month intervals.

DIAGNOSTIC AIDS

The initial consultation for the interdisciplinary team described in this article took place in February 2010, involving the patient, restorative dentist, periodontist, and orthodontist; a standard full-mouth radiographic series and high-quality diagnostic casts were obtained.

Pretreatment cone beam computed tomography (CBCT) was also obtained as a part of diagnostics and treatment planning. In addition, secondary CBCT was secured for comparison with posttreatment results at 4 months after surgically facilitated orthodontic therapy (SFOT).

Fig. 12 shows a problem-management algorithm, with various dentoalveolar and orthodontic considerations that must be considered for SFOT treatment planning.

SMILE EVALUATION

After the initial group consultation, a pretreatment orthodontic setup was performed in the orthodontist's office in April 2010, consisting of panoramic and lateral cephalometric radiographs, plus a tracing and analysis (Figs. 13–15). This setup was followed

Fig. 6. Right smile; February 2010 (before surgery).

Fig. 7. Left smile; February 2010 (before surgery).

by a diagnostic wax-up, which was performed by the laboratory technologist (Smiles Inc, Boise, ID) working with the restorative dentist, to provide a preview of the smile design based on the results the patient desired.

Diagnosis and Treatment History

The restorative dentist had first seen the patient in February 2010 for the initial consult; the following month her father accompanied her for a follow-up visit. The outcome of that visit's discussion then encompassed the collaborative involvement of a periodontist and an orthodontist for an integrated treatment planning approach (see **Fig. 12**).

After orthodontic bracketing and arch wires were placed (with the initial intention of erupting number 9 and ultimately extracting it, leading to placement of an implant with a cantilevered pontic into number 10 position), a discussion took place regarding changing the treatment plan, which resulted in modification of the initial diagnostic wax-up.

The scenario expressed here underscores the interdisciplinary team approach of constant evaluation and reevaluation analysis that is performed during treatment of such cases to ensure that the outcome goal meets or exceeds the best possible biological, functional, and esthetic goals for the patient.

Fig. 8. Full-face pretreatment view.

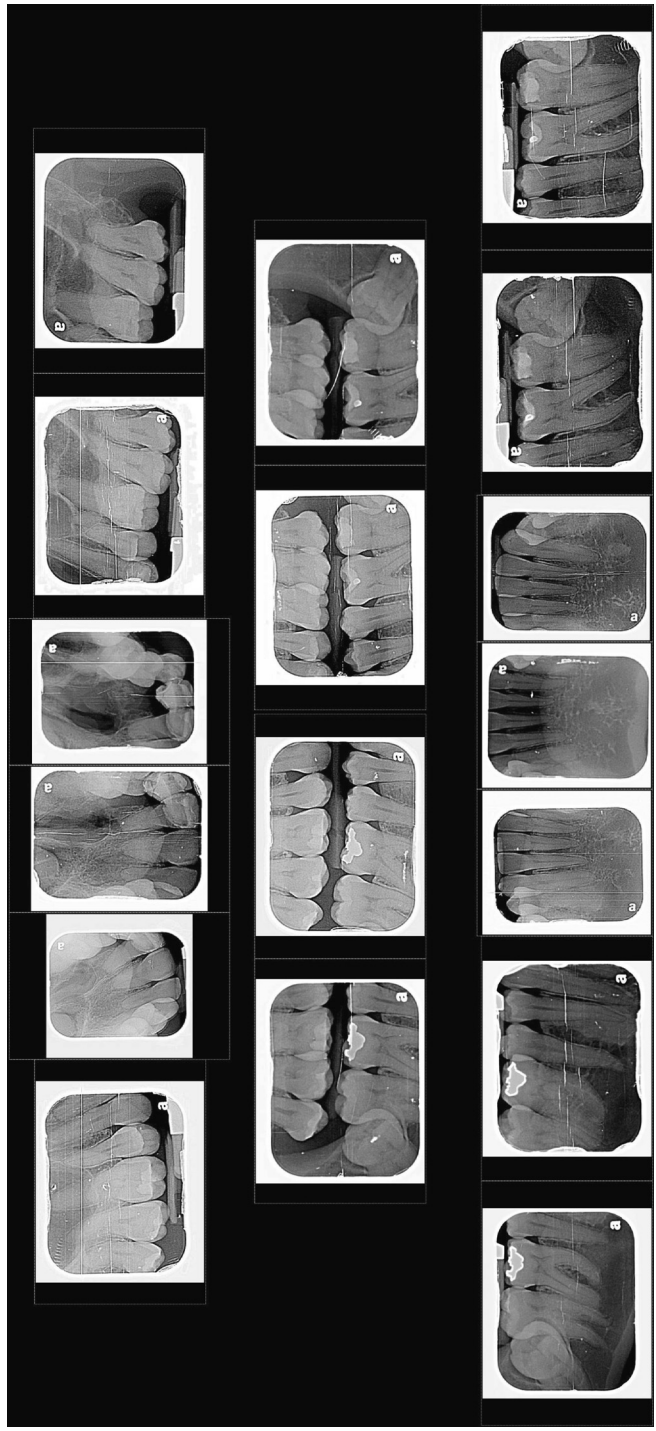

Fig. 9. Initial full-mouth radiographs (February 2010).

Fig. 10. Occlusion, right side, showing class II molar relationship and crossbite.

Cone beam computed tomography imaging

CBCT imaging of the patient's maxillary arch was performed before initiating SFOT and as a part of diagnostics, then at 4 months after completion of SFOT, to validate and verify bone augmentation results as well as to compare the corticotomy-assisted tooth position after regional acceleratory phenomenon (RAP) (Fig. 16).

SEQUENCING OF TREATMENT (PHASES)

Treatment Sequence Overview

In February 2010, after conducting the initial patient consultation, comprehensive examination, charting, and prophylaxis, the cosmetic dentist referred the patient to a periodontist (whom she had seen several years earlier in connection with aesthetic correction of the soft tissue cleft defect). The periodontist in turn suggested that she see an orthodontist, who ultimately proposed the SFOT treatment sequence.

In March 2010, both the patient and her father returned for another consultation with the cosmetic dentist, to review the wax-up and discuss her aesthetic goals.

In June 2010, the cosmetic/restorative dentist arranged a joint consultation with the periodontist and orthodontist regarding formation of an interdisciplinary team.

An initial step in the treatment plan was endodontic treatment of tooth number 9 in July 2010, because of the amount of reduction anticipated in preparing this tooth for

Fig. 11. Occlusion, left side, showing class I molar relationship and crossbite.

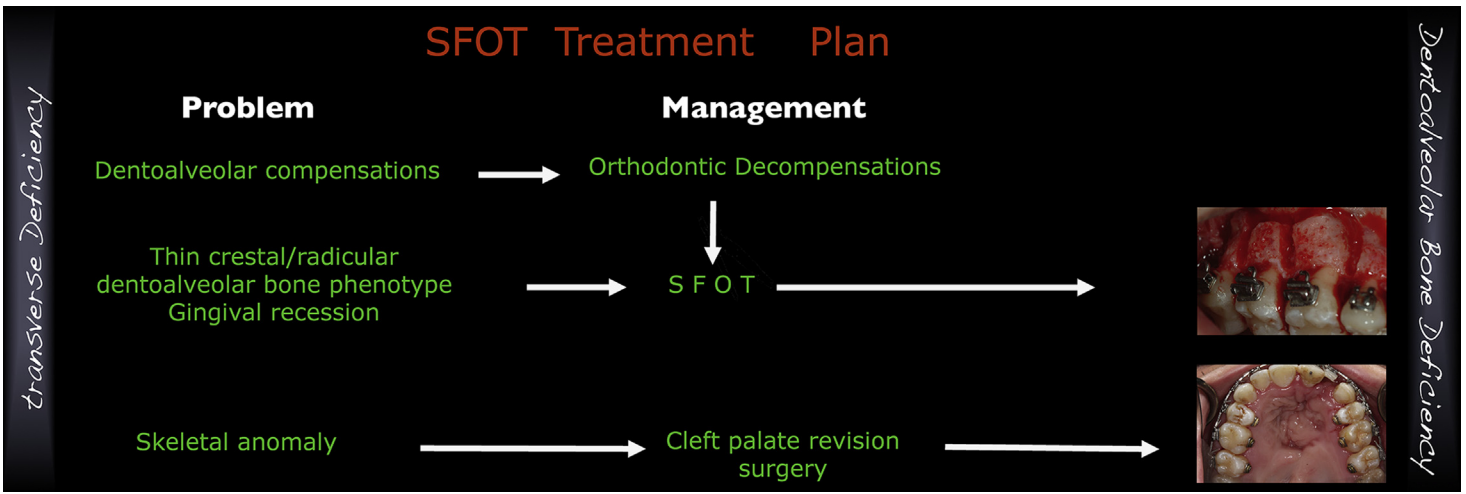

Fig. 12. Integrated treatment plan with periodontal-orthodontal collaboration using SFOT.

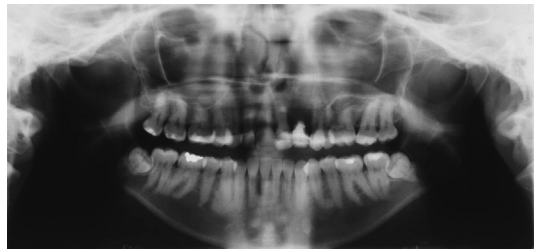

Fig. 13. Panoramic radiograph (2010, before treatment).

esthetic restorations. Orthodontic treatment was started in August 2010. During the orthodontic phase, the pontic in position number 10 was incorporated into the bracketing.

A 3-month to 4-month prophylaxis schedule was instituted in April 2011 because of plaque accumulation and to reduce inflammation in the presence of tooth movement, with emphasis on self-performed oral hygiene recommendations. The next prophylaxis was done in September 2011 (at which point the cosmetic dentist obtained photographs to update the periodontist on the patient's orthodontic progress) followed by another cleaning in December 2011, when she expressed a desire to have the orthodontic bracketing removed at this time. By her recare appointment in June 2012, the SFOT surgical phase and bone grafting of the posterior maxillary segments had been completed. The cosmetic dentist obtained new photographs, which were sent to the orthodontist and periodontist. **Figs. 17–19** show the 4-month post-SFOT arch form changes and periodontal phenotype transformation.

At this stage, there was discussion of connective tissue (CT) graft in position number 9, and the decision was weighed as to retaining this endodontically treated tooth as an alternative to extraction.

Another group consultation meeting took place in July 2012 for restorative treatment planning; the possibility of cantilevering the pontic in position number 10 from number 11 was discussed, because of the questionable prognosis of tooth number 9 and the possibility of moving to an implant. Based on evaluation and discussion during this

Fig. 14. Lateral cephalometric radiograph. Orthodontic work-up.

Steiner Analysis		
SNA	72.4	(81.4)
SNB	68.7	(77.7)
ANB	3.7	(3.7)
SN to GoGn	51.1	(34.0)
L1 to GoGn	79.7	(90.0)
U1 to SN	81.3	(102.0)
Lower 1 to A-Pg	2.6	(2.7)
Interincisal	146.7	(125.5)
Y Axis	63.6	(59.4)
Maxillary Depth	85.2	(90.0)

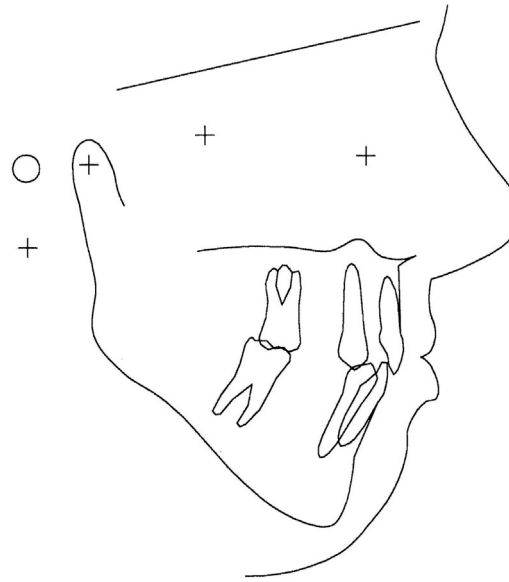

Fig. 15. Cephalometric tracing (Steiner analysis). Orthodontic work-up.

group consult, the option of placing a bridge from number 9 to number 11 became the final restorative goal because the periodontal prognosis associated with number 9 was determined to be fair.

A new photographic series was taken in August 2012 to better visualize and assess the number 10 position pontic site. Then, a cosmetic wax-up was done based on the final decision to retain number 9 for a bridge spanning numbers 9 to 11 (August 2012). Whitening trays were also fabricated in August 2012 in conjunction with an in-office whitening procedure (Venus, Heraeus Kulzer GmbH, South Bend, IN). The patient continued to use at-home trays for the lower arch to continue whitening until her final impressions were obtained.

By September 2012 the patient had reviewed all treatment objectives; approved the cosmetic wax-up; signed the consent for cosmetic restorations and goals; and, after

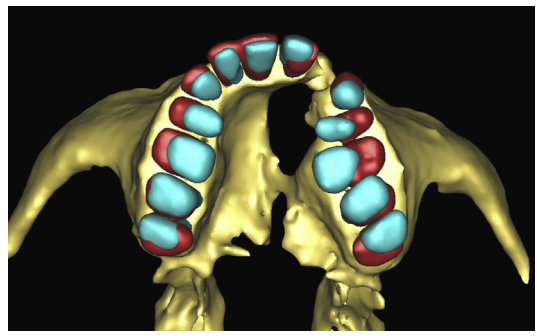

Fig. 16. CBCT before SFOT.

Fig. 17. Right lateral view 4 months after SFOT.

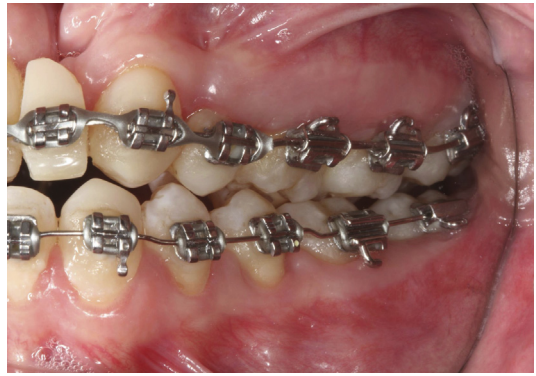

Fig. 18. Left lateral view 4 months after SFOT.

Fig. 19. Occlusal view 4 months after SFOT showing arch form changes and periodontal phenotype transformation.

pretreatment photographs were obtained and shared with the orthodontist and periodontist and an updated full-mouth radiographic series was obtained, the treatment team and patient moved forward with tooth preparation and provisionalization (which extended to February 2013, when the final restorations were placed).

Evaluation of occlusion and function as well as routine office visits were done between October and early December 2012, at which point new provisionals were constructed to accommodate site development of the number 10 pontic position (Fig. 20). The periodontist reevaluated the tissues in the left anterior segment postsurgically in January 2013 and observed normal healing of the graft. In consultation with the restorative doctor and while the patient was in provisionals, final crown lengthening was performed in conjunction with a rotated palatal pedicle epithelialized CT graft in an attempt to gain an improved vertical soft tissue mass and form at the number 10 site.[3]

In February 2013, final maxillary and mandibular full-arch polyvinyl siloxane impressions were obtained, together with a bite registration. Photographs and stump shade were obtained for laboratory use.

Overall, after the interdisciplinary treatment with SFOT, the interincisal angle was successfully improved, with a better anterior protected articulation scheme, and, in theory, a more patent airway because of the increased oral cavity volume and associated increased in oral cavity/tongue volume ratio.[4] SFOT provided a novel approach to treating a complex problem to afford a highly esthetic outcome.

Restorative/cosmetic dentistry

After completion of SFOT and team approval of the restorative treatment plan (which consisted of all-ceramic [e.max] restorations on teeth numbers 5, 6, 7, 9 to 11, and 12), a diagnostic wax-up was done for the periodontist to use and work backward to see how and what surgery would be required to meet the prosthetic outcome requirements/goals. The wax-up was done on diagnostic casts done after orthodontia.

Such a wax-up is a piece of the puzzle that many practitioners try to avoid; this can be a pitfall in that a preliminary view can be obtained of patient preferences that can be captured in provisionalization. Then, in the provisional phase, patients can become accustomed to the intricacies of the smile contour represented by the provisional, and make any modifications based on their individual preferences, which may shift over the course of time during treatment. The cosmetic wax-up was reviewed and accepted by the patient.

Fig. 20. Final provisionals in place (December 2012).

The restorative treatment plan comprised several phases, including provisionalization. Provisionalization provides the clinician the opportunity to query the patient on specifics of smile design and elicit feedback that can be used to design the final restoration, which is a different material and reflects/transmits light differently from the provisional (see **Figs. 20** and **21**).

Because the patient also reported a history of nocturnal bruxism, she was given a maxillary hard exterior/soft interior occlusal guard (comfort guard) to wear at night to protect her dentition and newly placed restorations.

Laboratory specifications

After casts were created from impressions, and the diagnostic wax-up was performed to idealize shape, position, and form with function; all-ceramic crowns were fabricated for teeth numbers 5, 6, 7, 8, and 12; tooth number 9, number 10 pontic, and number 11 comprised an all-ceramic bridge. Custom characterizations were done using Empress universal shade 110/120 and e.max Ceram Glaze Paste to produce appropriate gloss in white and pink ceramics. Because of proclination of tooth number 7, adjustments were made to harmonize as much as possible with mandibular occlusion and incorporate American Academy of Cosmetic Dentistry (AACD) smile design principles.

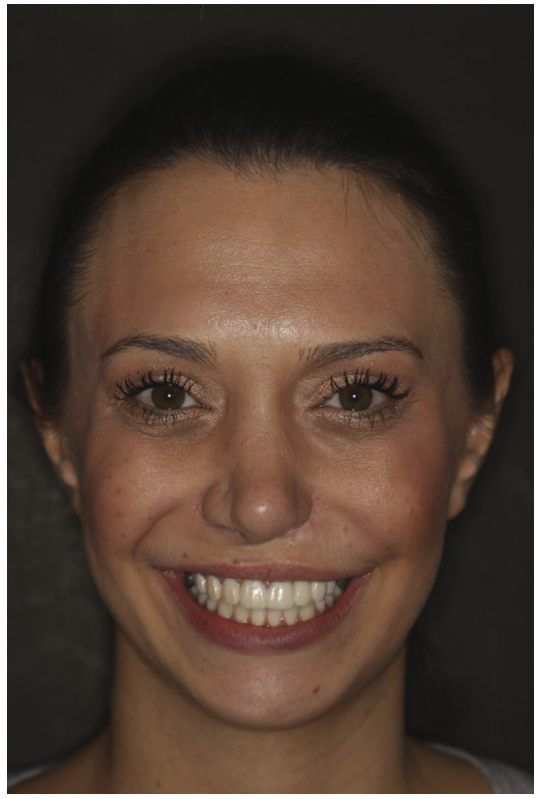

Fig. 21. Headshot provisionalization.

Pink tissue porcelain was used to blend with the color of the natural dentition. e.max Ceram IG3 powders were used as the base layer for intensity, e.max Ceram G3 was then layered over the base layer, and e.max glaze paste was used for finish to a gloss.

Smile design principles

The restorative/cosmetic dentist analyzed the patient's smile according to smile design parameters established in connection with the AACD accreditation criteria,[5] and as discussed/interpreted in a recent review by Mistry.[6] In addition, The AACD guide to accreditation criteria, *Contemporary Concepts in Smile Design: Diagnosis and Treatment Evaluation in Comprehensive Cosmetic Dentistry* discusses how the smile line, in conjunction with other factors, helps determine the incisal edge position, influences the lengths of the maxillary central incisors, and identifies an ideal or pleasing range of 10 to 12 mm for length of maxillary centrals.

In this patient's case, the parameters assessed included axial line angles and elements of the Golden Proportion, notably the avoidance of square-looking teeth, as well as ensuring that the interpupillary eye line is parallel with the plane of occlusion. This principle also focuses on symmetry of central incisors proceeding distally, in which the usual ratio is 10-mm length and 8-mm width, with broadening discrepancies progressing distally.

Considerable negative space was present in the buccal corridors. Because the basic goal of cosmetic dentistry is to impart fullness to the arch form along the buccal corridors, addressing this was an integral part of the treatment plan.

Gingival esthetics

This patient's initial gingival height reflected excessive gingival display (EGD; the so-called gummy smile), in addition to the pronounced recession defect on the facial aspect of tooth number 9 (see **Figs. 4**, **7**, **8**; **Figs. 22** and **23**).

After reevaluation of the cosmetic wax-up, the team discussed with the patient various options for correction of her EGD; lip repositioning surgery would not have been an option for this patient case because of the vestibular/alveolar defects resulting from the cleft, and thus a predictable result was unlikely. Hence, she decided on the option of esthetic clinical crown lengthening on teeth numbers 5 to 12, which the periodontist performed in November 2012 at the same time as the rotated palatal pedicle epithelialized CT graft.

Fig. 22. Pretreatment, retracted view, gingival esthetics, showing severe recession defect, facial aspect of tooth no. 9.

Fig. 23. Recession defect, tooth no. 9, soft tissue alveolar defect, position no. 10.

The original treatment plan included erupting tooth number 9, treating it endodontically, and placing an implant in this position with a cantilevered lateral incisor.

Although placing an implant was ultimately rejected, endodontic treatment was required at the outset to enable the eruption of tooth number 9 because of the required reduction to create vertical space in order for eruption to occur, and the team wished to avoid pulpal problems during orthodontia, which might have jeopardized the facial bone. Therefore, endodontic treatment was completed before starting orthodontia (**Fig. 24**).

Tooth number 9 and the bone surrounding it were determined to be sound, and thus suitable for use as an abutment for the bridge from numbers 9 to 11, hence the team decision was made in July 2012 to retain tooth number 9. Its prognosis was determined as fair to good in the short and long terms.[7]

The treatment plan required approximately 3 years, including the period of SFOT and alveolar cleft repair, before cementation of final bridge.

Fig. 25 shows the initial cosmetic result in the first year. **Figs. 26–31** show the final esthetic views 3 years after initiation of the interdisciplinary treatment plan (June 2013). **Fig. 32** shows the 3-year full-mouth radiographic series.

DISCUSSION

The overall objective of the interdisciplinary approach used in this case had the focal point of completing SFOT in order to achieve the foundation that the interdisciplinary treatment team needed to provide the final result desired by the patient.[8] The interdisciplinary approach has received considerable recent attention in the literature, notably with regard to its importance in interactions between restorative dentists, orthodontists, and periodontists,[9] minimizing the occurrence of quality-of-life issues in patients with cleft palates,[10] and providing a more idealized treatment scenario even in the context of a nonsurgical approach to cleft management.[11]

By integrating SFOT with such an interdisciplinary approach, we were able to provide this patient with an outcome that has historically only been achieved with orthognathic surgery. SFOT increases oral cavity volume, produces better anterior tongue posturing opportunities, gains space to facilitate optimal esthetic and restorative dentistry, and achieves occlusion goals that help to maintain postorthodontic stability.[12–21] In addition, SFOT allows the orthodontic walls to be redefined and effectively changes the periodontal phenotype of at-risk periodontiums and allows patients the benefit of a reduction in orthodontic treatment time.[22–24]

Fig. 24. Periapical radiograph of root canal treatment final fill, tooth no. 9.

Fig. 25. Final view of anterior segment.

Fig. 26. Final esthetics, frontal retracted view, maximum intercuspation.

Fig. 27. Final esthetics, frontal retracted view, open.

Fig. 28. Right lateral view 3 years after surgery.

Fig. 29. Left lateral view 3 years after surgery.

Fig. 30. Occlusal view 3 years after surgery.

Fig. 31. Headshot 3 years after surgery.

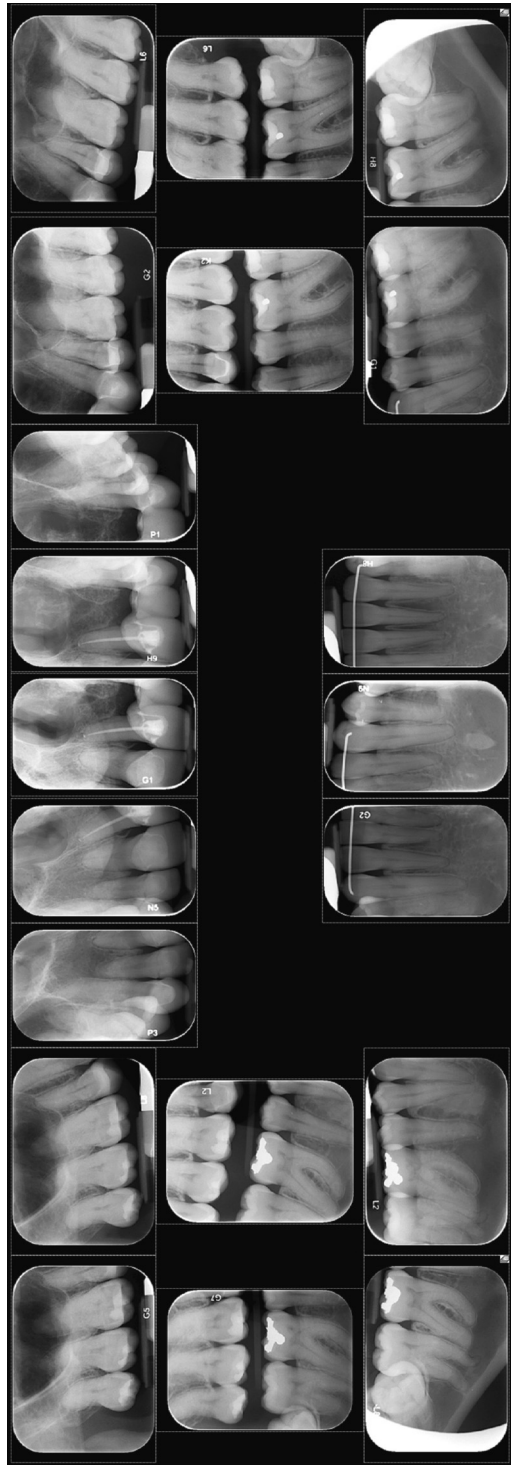

Fig. 32. Full-mouth radiographic series 3 years after surgery.

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