Interdisciplinary approach for increasing the vertical dimension of occlusion in an adult patient with several missing teeth

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This case report describes the interdisciplinary treatment of a 39-year-old man with several missing teeth (including both maxillary lateral incisors), Class II malocclusion, deep overbite, and significant mandibular midline deviation. The treatment plan included placement of endosseous dental implants early in the orthodontic treatment to increase the vertical dimension of the occlusion for deepbite correction, canine substitution for the missing lateral incisors, and distalization of the mandibular right buccal segment with the aid of a temporary anchorage device. (Am J Orthod Dentofacial Orthop 2013;143:867-76)

Effective and efficient orthodontic management of partially edentulous patients is biomechanically challenging and often requires a thorough treatment plan to predictably achieve the desired tooth movements. Comprehensive orthodontic treatment in adults with several missing teeth requires an interdisciplinary approach to restore the occlusion. Associated with the missing teeth, these patients often have edentulous ridges with reduced buccolingual and vertical dimensions, altered occlusal planes caused by extrusion of unopposed teeth, migration of teeth into adjacent extraction spaces, and associated periodontal defects.

In patients with several missing teeth, certain types of tooth movement are significantly challenging with conventional mechanics. Overbite reduction, distalization, intrusion of posterior teeth, and retraction of anterior teeth are some movements that require a full complement of teeth in the buccal segments to minimize the side effects. Proffit et al[1] advocated skeletal anchorage devices for intrusion of posterior teeth, distalization of molars or the entire arch, retraction and intrusion of protruding maxillary incisors, and positioning of individual teeth when no other satisfactory anchorage is available. When restorative implants are used as an alternative or adjunctive to miniscrews, most of these types of tooth movements are possible in these patients.[2] Endosseous dental implants can be used for anchorage in these patients and also to increase or support the increased vertical dimension of the occlusion in adults with deep overbite and to reestablish the esthetics of the smile in the early phases of orthodontic treatment.

This case report describes the interdisciplinary team approach for a partially edentulous patient with endosseous dental implants placed early in the orthodontic treatment to increase the vertical dimension, a temporary anchorage device for unilateral en-masse distalization in the mandibular arch to correct a significant midline deviation and anterior crowding, and canine substitution for the congenitally missing lateral incisors.

ETIOLOGY AND DIAGNOSIS

A man, aged 39 years, with multiple missing teeth was referred by his prosthodontist for interdisciplinary treatment. His chief complaint was the missing teeth, and he wanted an esthetic smile. His medical history was noncontributory, and the extraoral examination showed facial symmetry, a convex soft-tissue profile caused by a retrognathic mandible, competent lips at

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Fig 1. Pretreatment photographs.

rest, and an obtuse nasolabial angle (Fig 1). He had a flat smile arc with asymmetric animation of the smile. There were no signs of temporomandibular joint disorders.

Intraorally, the patient had congenitally missing maxillary lateral incisors and third molars. Additionally, the maxillary right second molar and first premolar; maxillary left second premolar and first and second molars; mandibular left first molar; and mandibular right second molar were lost due to dental caries (Fig 2). As a result, supererruption and migration of teeth into the adjacent extraction spaces was observed. The maxillary dental midline was shifted to the right by 1 mm, and the mandibular dental midline was shifted by 4 mm to the left relative to the facial midline. The canines on the left side were in crossbite. Overbite was 5 mm, and overjet was normal. The molar relationship was Class II on the right side. The canine relationships were Class I on the right and Class II on the left. There was 4 mm of anterior spacing in the maxillary arch and 3 mm of residual edentulous space mesial to the maxillary right first molar. Arch length-tooth size discrepancy of 6 mm was evident in the mandibular arch, not considering the edentulous 9-mm space of the missing mandibular left first molar. The second molar was mesially tipped and supererupted.

The panoramic radiograph (Fig 3) showed large restorations on the mandibular right first molar, mandibular left second molar, and maxillary left first premolar, and a full-coverage restoration on the maxillary right first molar. The cephalometric analysis (Fig 4; Table) indicated a mild Class II skeletal base, and a convex soft- and hard-tissue profile caused by the retrognathic mandible in relation to the cranial base. Vertically, the patient had a slightly increased

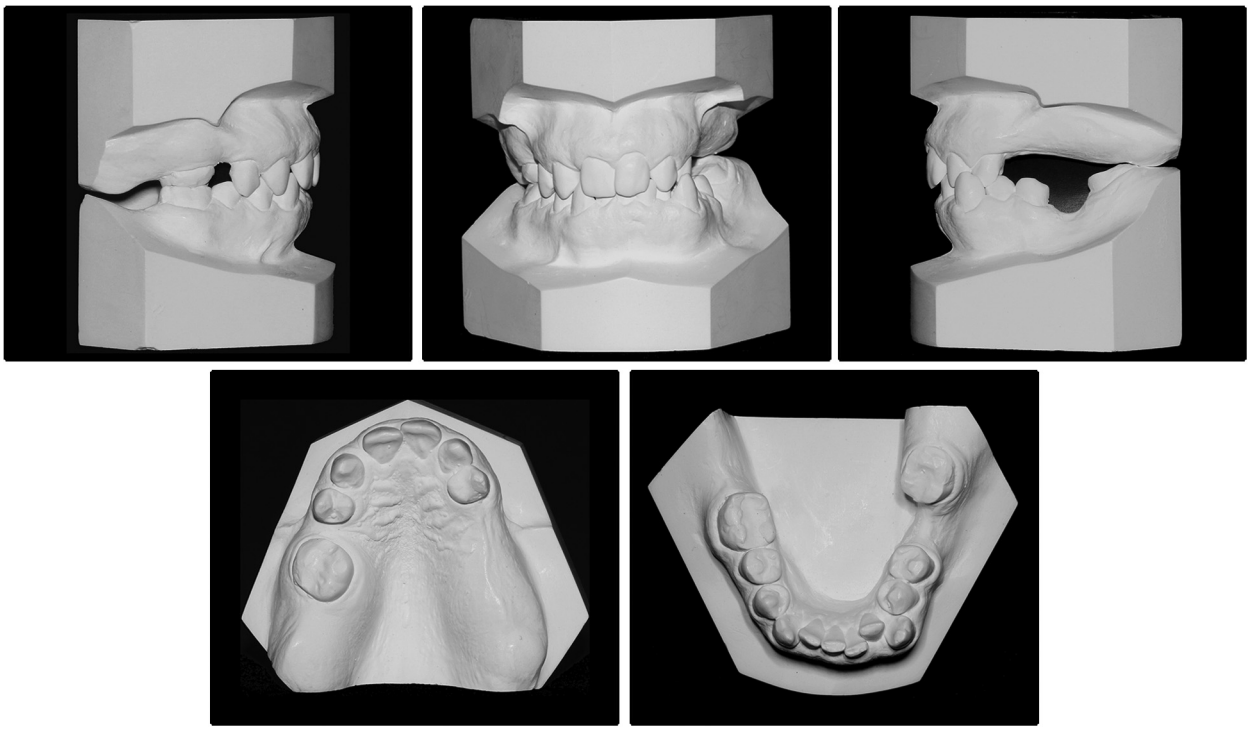

Fig 2. Pretreatment dental casts.

Fig 3. Pretreatment panoramic radiograph.

mandibular plane angle. The maxillary and mandibular incisors were retroclined, and the upper and lower lips were retrusive in relation to the E-line. Periodontal health was adequate, with no probing depth greater than 4 mm.

TREATMENT OBJECTIVES

The treatment objectives were to (1) maintain the facial profile, (2) achieve normal overbite and overjet, (3) restore prosthetically the missing teeth, (3) alleviate crowding in the mandibular anterior region, (4) correct the mandibular dental midline, and (5) improve smile esthetics.

TREATMENT ALTERNATIVES

Opening space for the missing lateral incisors for implant-supported crowns is a possible approach for the management of missing maxillary lateral incisors instead of canine substitution. However, with this approach, the number of necessary skeletal anchorage units in the maxilla would have to increase, one in each quadrant, to retract the canines with maximum anchorage. Furthermore, the similar morphology of the maxillary premolars to that of a canine also influenced the treatment plan in favor of canine substitution.

Extraction of a mandibular incisor could have been considered. However, this approach would still require 2 mm of distalization of the mandibular right buccal segment to achieve an adequate occlusion.

Finally, mandibular left second molar intrusion and protraction into the first molar extraction space was an option. Intrusion of the molar by 4 mm and protraction of 6 mm into the long-standing edentulous space would be difficult and time-consuming; thus, extraction of the second molar with a prosthodontic implant for the missing first molar was considered.

All treatment options were discussed, and the patient decided to have canine substitution and endosseous dental implants for the missing teeth.

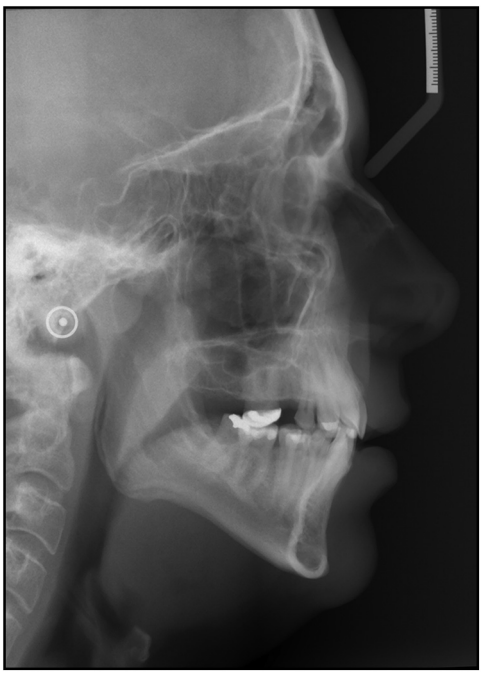

Fig 4. Pretreatment lateral cephalometric radiograph.

TREATMENT PLAN

1. Bilateral canine substitution for the missing maxillary lateral incisors with subsequent reshaping and composite restorations of the substituted canines.
2. Placement of provisional crowns on the maxillary right first molar to increase the vertical dimension of the occlusion by 2 to 3 mm anteriorly.
3. Placement of endosseous dental implants in the sites of the maxillary left first molar and second premolar with temporary crowns fabricated to support the newly established vertical dimension of the occlusion.
4. Distalization of the mandibular right segment by 3 mm to alleviate the crowding and shift the midline to the right side using a skeletal anchorage device.
5. Elimination of the left canine crossbite and achieve normal overbite.
6. Open space for a maxillary right second premolar endosseous dental implant by distalization of the first molar to maintain the Class II molar relationship and a 3-mm protraction of the first premolar and canine while shifting the midline to the left by 1 mm.
7. Extraction of the mandibular left second molar and placement an endosseous dental implant for the missing first molar after the orthodontic treatment.
8. Maintenance of the facial profile.

Table. Cephalometric analysis

Variable	*Norm*	*Pretreatment*	*Posttreatment*	*Change*
SNA (°)	82	81.2	81.8	0.6
SNB (°)	80	78.7	77.7	1
ANB (°)	2	2.5	4.1	1.6
FMA (°)	25	30.6	33.3	2.7
IMPA (°)	90	85.2	85	0.2
U1-NA (°)	22	19.8	19	0.8
U1-NA (mm)	4	4.1	3	1.1
L1-NB (°)	25	19.8	21.4	1.6
L1-NB (mm)	4	4.1	5	0.9
Interincisal angle (°)	131	136.9	138.1	1.2
Upper lip to E-line (mm)	−6	−3.8	−4.2	−0.4
Lower lip to E-line (mm)	−2	−1.2	−2	−0.8

TREATMENT PROGRESS

The maxillary anterior teeth were bonded with a 0.022-in preadjusted edgewise appliance, and a 0.016-in nickel-titanium archwire was placed. The patient was referred to the prosthodontist for a temporary crown on the maxillary right first molar to increase the vertical dimension of the occlusion and reduce the overbite by 2 to 3 mm. A molar tube was bonded after cementation of a temporary crown, and the mandibular arch was bonded. An initial aligning archwire was placed, and a 2.4 × 10-mm MDI (Mini Dental Implant) miniscrew (3M ESPE, St Paul, Minn) was placed distal to the mandibular right molar on the alveolar ridge with a composite buildup over the attachment head of miniscrew, where a molar tube was bonded.

The patient reported miniscrew failure after 1 week. The failed miniscrew was removed; 2 months later, another 2 × 9-mm Lomas miniscrew (Mondeal, Tuttlingen, Germany) was placed on the right external oblique ridge. A 0.016 × 0.022-in nickel-titanium archwire was placed in the maxillary arch, and an 0.018-in stainless steel archwire was placed in the mandibular arch, bypassing the left lateral incisor and canine. The second miniscrew also failed, and the patient was referred to the oral maxillofacial surgeon for placement of a Stryker miniplate (Stryker, West Chester, Pa) (Fig 5) in the mandibular right segment distal to the first molar and 2 Straumann endosseous dental implants in the maxillary left quadrant (Straumann, Basel, Switzerland). To prevent soft-tissue growth over the miniplate, rubber dam material was placed at the interphase between the miniplate and the alveolar mucosa. Two months later, the endosseous dental implants were restored with temporary crowns to the newly established vertical dimension of the occlusion. A molar tube was bonded on the maxillary left first molar crown, and

Fig 5. Placement of endosseous implants in the maxillary arch on the left side and a miniplate in the mandibular arch on the right side.

Fig 6. Intraoral photographs after orthodontic treatment.

a 0.016 × 0.022-in beta-titanium archwire with an active open-coil spring was placed between the maxillary right first molar and premolar to open space for restoring the missing second premolar with an implant. A force of 200 g was applied from the miniplate to the mandibular right canine to distalize the buccal segment.

Maxillary and mandibular midlines were coincident after 5 months of continuing the same mechanics, and space was available for the mandibular left lateral incisor and canine, which were bonded and brought into the arch with a 0.016-in nickel-titanium archwire. A 0.019 × 0.025-in stainless steel archwire was placed in the maxilla with a passive coil spring to maintain the space for the right second premolar. Progressively stiffer archwires were placed in the mandibular arch, and artistic bends were made where indicated. Two months before

Fig 7. Photographs after interdisciplinary treatment.

debonding, endosseous dental implants were placed for the missing maxillary right second premolar and mandibular left first molar. After 21 months of active treatment (Fig 6), the appliances were removed. Vacuum-formed retainers were delivered for both arches immediately. The patient was referred to his prosthodontist and oral surgeon for further restorative procedures and miniplate removal, respectively.

TREATMENT RESULTS

The patient reported to the clinic after the restorative procedures for posttreatment records (Figs 7-10). A clinical examination showed that the specific and realistic treatment objectives were attained. Good alignment and posterior occlusion, adequate overjet and overbite relationships, and a Class I canine relationship after bilateral maxillary canine substitution were achieved. The maxillary midline was shifted to the right by 1 mm in relation to the facial midline and matched the mandibular midline, and a consonant smile arc with adequate incisor display was obtained.

The posttreatment panoramic radiograph (Fig 9) showed no significant bone loss or root resorption. The posttreatment cephalometric analysis (Fig 10; Table) showed a slight increase in the vertical and sagittal dimensions as shown by the SNA, SNB, ANB, and FMA angles (Table). The maxillary incisors were slightly retracted; the upper and lower lip positions improved in relation to the E-line. The superimpositions (Fig 11) of the pretreatment and posttreatment cephalometric tracings showed a slight increase in the mandibular plane angle as a result of the maxillary molar restorations, and minimal changes in the anteroposterior positions of the incisors and soft-tissue profile. The mandibular right distalized segment was upright,

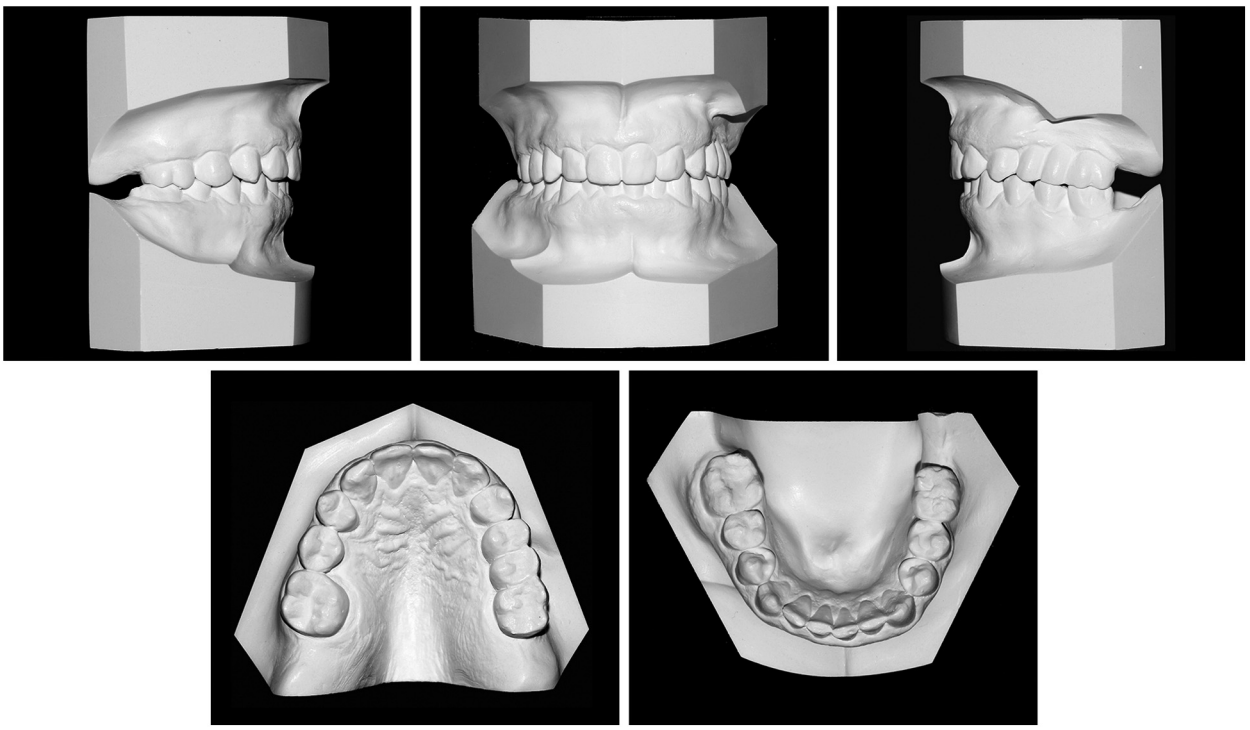

Fig 8. Posttreatment dental casts.

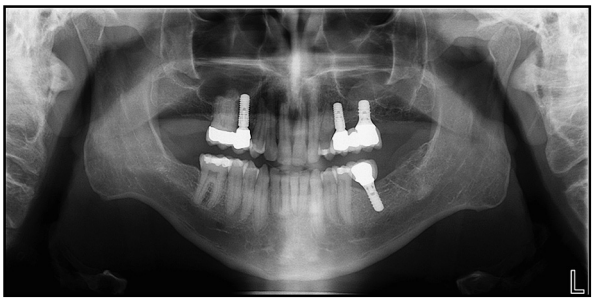

Fig 9. Posttreatment panoramic radiograph.

indicating good delivery of the mechanical plan. Clinically, at the end of treatment, there was no mobility or discomfort, and greater emphasis was placed on good oral hygiene for long-term success and maintenance of the treatment results. Interdisciplinary treatment lasted for 29 months, and the patient was extremely pleased with the posttreatment results.

DISCUSSION

Management of a deep overbite with many missing posterior teeth is difficult, if not impossible, since anchorage units are absent or deficient. An effective and efficient alternative in these patients is to increase the vertical dimension of the occlusion. Reconstruction of the dental occlusion is possible if the functional and biologic principles are maintained.[3] A starting point

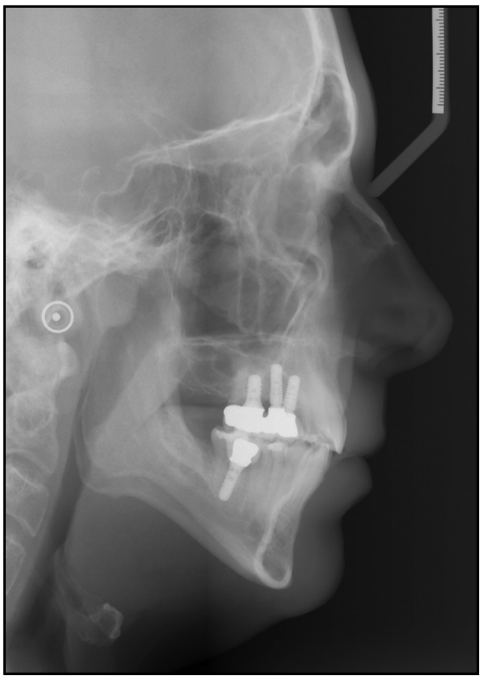

Fig 10. Posttreatment cephalometric radiograph.

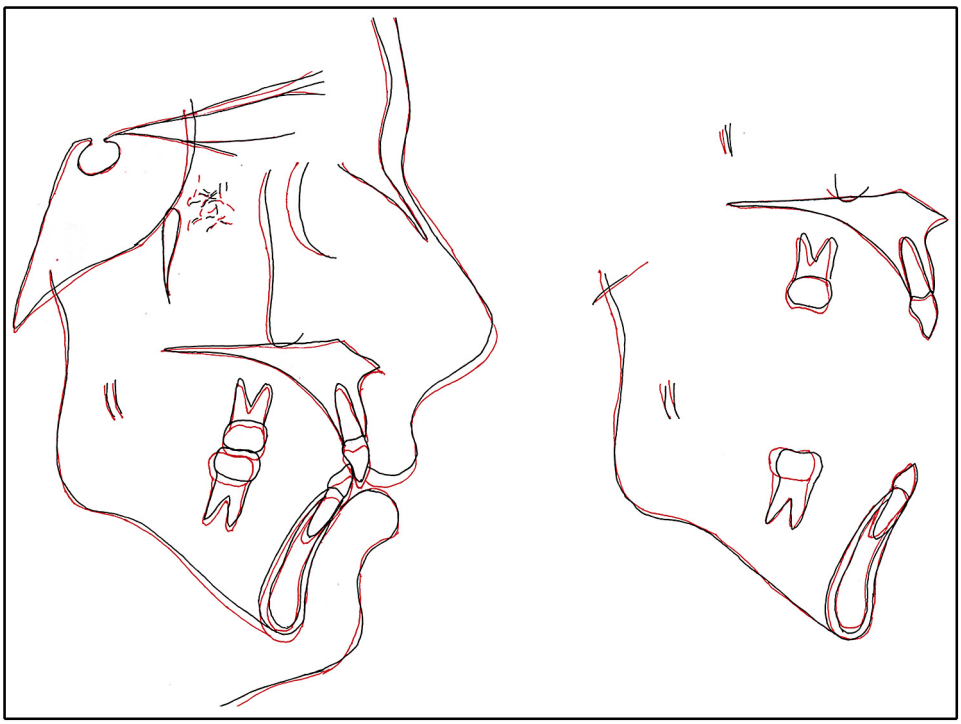

Fig 11. Overall and regional superimpositions of pretreatment and posttreatment cephalometric tracings.

for any therapeutic alteration of the vertical dimension of the occlusion must be with the mandibular condyles in centric relation, and the change in the vertical dimension of the occlusion should be within the range of neuromuscular adaptation for each patient. Determining both of these parameters is difficult in each patient, and appliance therapy—eg, removable prostheses or fixed transitional crowns—can be used to increase the vertical dimension of the occlusion.[4] The patient's perception of comfort helps to determine whether the increased vertical dimension of the occlusion is acceptable.

In this patient, the vertical dimension of the occlusion was increased posteriorly by 1 mm with the aid of a temporary plastic crown on the maxillary right molar that opened the vertical dimension of the occlusion anteriorly by 2 to 3 mm. The patient was comfortable with the newly established occlusion, and the impact of the therapeutic change in the vertical dimension of the occlusion on the facial esthetics was minimal.[5] The clinician can increase the vertical dimension if a strict rotation around the hinge axis is used, the facial type is unaffected, and adequate lip closure is maintained.

The vertical dimension was increased using restorations on the right first molar and endosseous dental implants on the left. To be able to achieve bilateral occlusal stability, the dental implants were placed early in the orthodontic treatment. The implants facilitated the distalization process for midline correction in the mandible by reducing the overbite and aided in control of the maxillary anterior teeth during tooth movement. Furthermore, restoration of the smile esthetics was possible in the initial phase of treatment, addressing the patient's main concern.

Placement of endosseous dental implants early in the orthodontic treatment increases the risk of improper site placement because of the unpredictability of the final position of the implants. However, this risk was minimized in this patient since the posterior left buccal segment in the mandibular arch was to remain stationary; thus, this served as a reference for the precise location of the maxillary left implants. A block graft could have been considered to achieve symmetric crown lengths with the right buccal segment. However, the vertical discrepancy was small, and the margins of the crowns were not exposed with the patient's smile line (Fig 7). Additionally, the grafting procedure would have delayed implant placement and loading; thus, the orthodontic treatment would have been delayed. More importantly, a significant increase in the height of the ridge with grafting has been reported to be elusive.[6]

Canine substitution, endosseous dental implants, fixed partial dentures, and autotransplantation are the treatment options for congenitally missing lateral incisors.[7] Determining the treatment approach depends on the type of malocclusion; the facial profile; the size, shape, and color of the canines; and the smile line.[8,9] The decision for canine substitution was based on numerous factors. First, the patient had multiple missing teeth, making canine retraction for lateral incisor space development difficult. Second, this patient had favorable canine morphologic tooth characteristics for lateral incisor substitution, such as narrow buccolingual and mesiodistal dimensions at the cementoenamel junction, narrow midcrown buccolingual widths, and relatively flat labial surfaces.[8] Since the canines were narrow mesiodistally, interproximal reduction was not necessary, but the mesioincisal and distoincisal aspects were restored to have similar lateral incisor contours.[10] Third, the color of the canine was similar to that of the adjacent teeth, and the premolar had the normal sharp incisal tip morphology of the canine. Finally, the gingival margin of the central incisor was higher by 0.5 to 1 mm than that of the canines, matching the ideal gingival margin relationship between the maxillary central and lateral incisors.

Functional changes in the occlusion are an important consideration, since canine-guided occlusion is not feasible when the first premolar is in the canine position. There is concern among some clinicians regarding the excessive functional load on the premolar with this occlusal arrangement. However, long-term periodontal and occlusal parameters appear not to differ between canine-guided and group-function groups.[11] According to Rinchuse et al,[12] current literature supporting canine-guided occlusion as the optimal type of functional occlusion in orthodontic patients is lacking. Group function and balanced occlusion with no interferences are also acceptable alternative functional occlusions in these patients.

In the mandibular arch, it was necessary to either extract the right first premolar or distalize the buccal segment using anchorage from bone anchor plates for correction of the crowding and the midline shift. The extraction option was not considered, since the patient was already missing many teeth. With skeletal anchorage devices, it is possible to move the mandibular molars or the entire dentition in 3 dimensions.[13] Clinically, distalization of the mandibular molars is the most difficult to achieve with traditional methods. Sugawara et al,[14] using the skeletal anchorage system, quantified the amount of distal movement of the molars, determined the type of tooth movement, and evaluated the 1-year posttreatment stability. They found that the mandibular first molars moved on average distally by 3.5 mm at the crown level and 1.8 mm at the root level, and the results were stable 1 year later.

In this patient, the miniplate was placed by the surgeon distally to the mandibular first molars after 2 successive miniscrew failures. The buccal segments were distalized by 3 mm, which was sufficient to alleviate crowding, shift the midline to the right, and achieve a stable occlusion. Since there was bodily displacement of the mandibular buccal segment, as observed on the panoramic radiograph, stability in the long term was expected.

The most critical factor for successful treatment of a partially edentulous patient is the planning process of the interdisciplinary team to formulate realistic treatment objectives and a sequence to ensure the quality of the final result.[15] This is especially important when endosseous dental implants are used initially; orthodontically for therapeutic, functional, or esthetic requirements; and later as permanent implant-supported prostheses after orthodontic treatment.

CONCLUSIONS

This case report documents the successful management of a partially edentulous adult patient with an interdisciplinary team approach. An increase of the vertical dimension supported by endosseous dental implants was obtained early in the orthodontic treatment; this facilitated the mechanics in the mandibular arch and reestablished the smile esthetics. Skeletal anchorage in the mandible allowed significant unilateral distalization for midline correction. The combination of well-planned treatment and precise execution of the mechanics plan resulted in good esthetics and occlusion.

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