Case Report

Detailed three-dimensional orthodontic tooth repositioning to improve restorative outcome: *A case report*

Davide Mirabella[a]; Ugo Macca[b]; Carolina Pancari[b]; Gabriella Giunta[c]; Luca Lombardo[d]

ABSTRACT

The case describes the interdisciplinary treatment of a 23-year-old woman with a Class III malocclusion, missing an upper right lateral incisor, abrasion of the maxillary incisal edges, anterior gingival margin discrepancies, and gingival recession. Initially, the patient was treated with fixed appliances combined with orthognathic surgery. The extraction of the upper left lateral incisor and bilateral canine substitution plan was chosen. At the end of the surgical and orthodontic treatment, the restorative treatment with six veneers was accomplished to improve smile esthetics. Despite the missing lateral incisors, the patient showed a natural, good-looking final result. A symmetric incisal plane was established, a functional occlusion with average vertical and horizontal overlap was set, and the bone scallop and consequently the gingival margins were leveled. The interdisciplinary approach hid all of the initial esthetic defects of the case. The result highlights how to obtain a remarkable improvement of the smile outcome with a well-functioning masticatory system. (*Angle Orthod.* 2022;92:415–425.)

KEY WORDS: Interdisciplinary treatment; Gingival margins

INTRODUCTION

Dental and gingival esthetics help create a smile that shows harmony and balance between its components. A defect in the surrounding tissues cannot be compensated for by the quality of the dental restoration and vice versa.[1] Sometimes, the desired esthetic changes require orthodontic treatment or orthognathic surgery to correct tooth and gingival positions and to facilitate the esthetic location of the teeth.[2] If the teeth need to be lengthened or are disproportionate in size, some veneers may also be required to correct tooth shape discrepancies after orthodontic therapy is completed.[3] In today's interdisciplinary dental world, treatment planning must begin with well-defined esthetic objectives.[4] One of the most relevant is to establish anterior guidance.[2]

Many adults with skeletal Class III malocclusion have additional dental and periodontal problems that require interdisciplinary treatment approaches.[5] Class III malocclusion is characterized by skeletal components, dental components, or a combination of both. Skeletal components consist of a large or protrusive mandible or a retrusive maxilla.[6] Often, there is a poor relationship between the maxilla and the mandible in the sagittal plane and a retruded maxilla is frequently accompanied by skeletal constriction in the transverse plane.[6–7] Dental components are characterized by a protrusive mandible dentition and retrusive maxillary dentition.[6]

The difficulty of treating patients with Class III malocclusion increases with time and, in most cases, orthognathic surgery is the only way to achieve a corrected occlusion and a pleasant esthetic profile.[8]

The aim of presenting this case report is to highlight the importance of interdisciplinary treatment in a patient with a skeletal Class III malocclusion, missing right lateral maxillary incisor, abrasion of the maxillary incisal edges, anterior gingival margin discrepancies, and gingival recession.

[a] Visiting Professor, Postgraduate School of Orthodontics, University of Ferrara, Ferrara; and Private Praactice, Catania, Italy.

[b] Private Practice, Siracusa, Italy.

[c] Visiting Professor, University of Catania, Catania, Italy; and Private Practice, Verona, Italy.

[d] Professor and Chairman, Postgraduate School of Dentistry, University of Ferrara, Ferrara, Italy.

Corresponding author: Dr Carolina Pancari, Via Generale Cascino 42, Comiso (RG) 97013, Italy (e-mail: carol.pancari@gmail.com)

Accepted: November 2021. Submitted: June 2021.
Published Online: December 30, 2021

Figure 1. Pretreatment facial and intraoral photographs.

Diagnosis and Etiology

A 23-year-old woman presented to the office for treatment. Her chief complaint was her facial and dental appearance that was not resolved after 3 years of orthodontic treatment with fixed appliances. The facial photographs showed a concave profile and skeletal asymmetry, with mandibular deviation to the left, a retrognathic maxilla, and severe mandibular protrusion. The smile was not pleasing, the upper dental midline was deviated to the right, and the incisal plane was canted. Intraoral examination showed abrasion of the right maxillary central incisor combined with different levels of anterior gingival margins, a congenitally missing right lateral incisor, and an inclined occlusal plane. The maxillary right lateral incisor edentulous space had been totally closed by distal movement of the anterior portion of the upper arch and the maxillary right canine showed gingival recession and an extreme buccal root torque. In the mandibular arch, mild incisor crowding was present. The occlusal exam revealed severe right and left Class III molar and canine relationships, bilateral crossbite, and negative overjet (Figures 1 and 2). The panoramic radiograph confirmed the absence of the right maxillary lateral incisor and showed an impacted upper right third molar and a mild degree of apical root resorption of the maxillary right first premolar. Cephalometric analysis showed a retrognathic maxilla and a prognathic mandible, proclined maxillary incisors, and an acceptable inclination of the lower incisors (Table 1, Figure 3).

Treatment Objectives

Treatment goals were to improve both facial and dental appearance. Skeletal treatment objectives were to increase maxillary projection, decrease mandibular projection, achieve mandibular symmetry, and idealize upper incisor position with respect to the basal bone. Occlusal treatment objectives were to achieve Class II molar and Class I canine relationships, resolve the

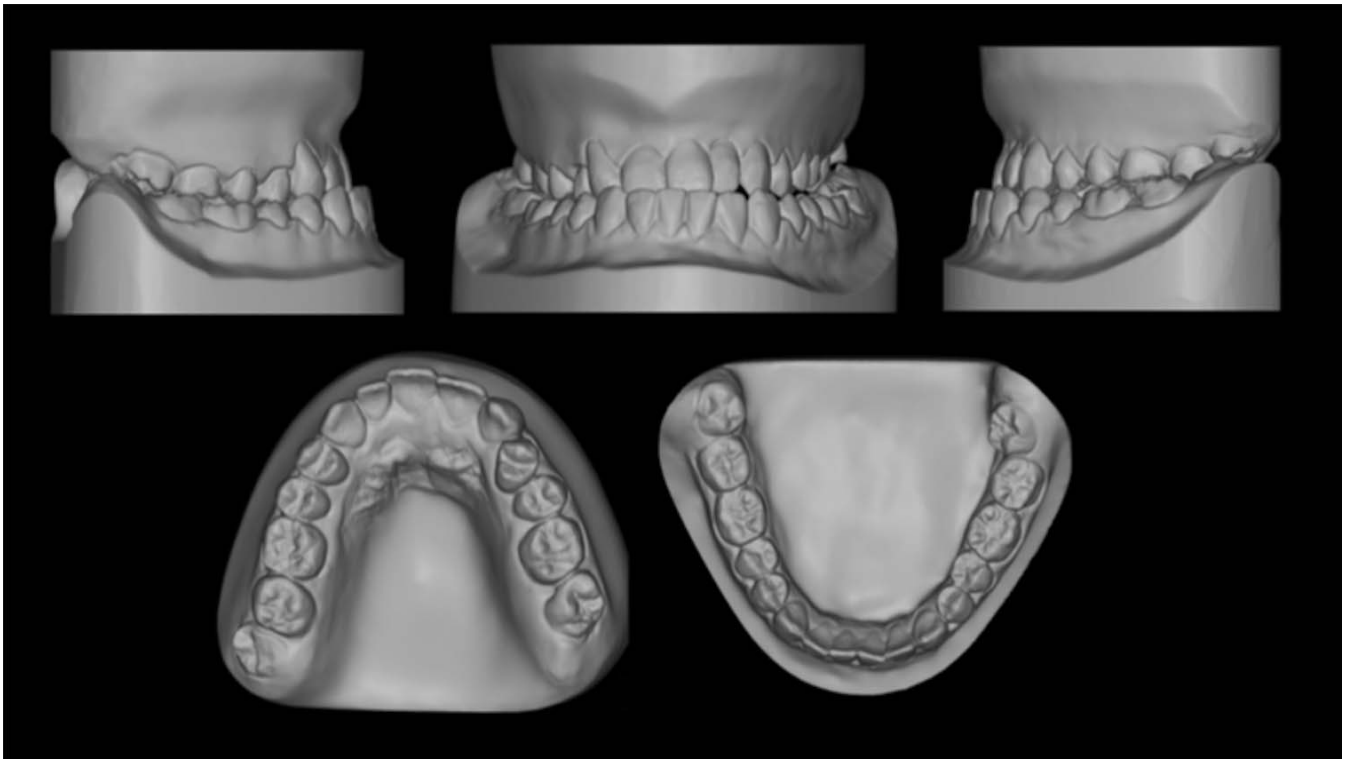

Figure 2. Pretreatment dental casts.

bilateral crossbite, achieve ideal overbite and overjet, center the upper dental midline, and relieve the arch length deficiency. Dental objectives were to establish proper dental proportions and symmetry, achieve appropriate heights of gingival contour, achieve uniform space distribution and tooth alignment, and highlight the central incisors.

Table 1. Pretreatment and Posttreatment Cephalometric Measurements

Measurement	Pretreatment	Posttreatment	Norm
Horizontal skeletal			
SNA (°)	74.5	72.8	82.0
SNB (°)	76.7	71.0	80.0
ANB (°)	−2.2	1.8	2.0
Maxillary skeletal (A-Na Perp) (mm)	0.8	0.9	1.0
Mandible skeletal (Pg-Na Perp) (mm)	4.4	1.7	−2.0
Wits appraisal (mm)	−7.0	−2.1	−1.0
Vertical skeletal			
FMA (MP-FH) (°)	32.3	31.3	26.0
MP–SN (°)	49.2	50.0	33.0
Palatal–mandibular angle (°)	33.6	34.1	28.0
Palatal–occlusal plane (PP-OP) (°)	13.3	13.5	10.0
Mandibular plane to occlusal plane (°)	20.3	20.6	17.4
Anterior dental			
U–incisor protrusion (U1-APo) (mm)	3.1	3.2	6.0
L1 protrusion (L1-APo) (mm)	4.3	2.0	1.0
U1–palatal plane (°)	118.1	115.1	110.0
U1–occlusal plane (°)	48.6	51.4	57.5
L1–occlusal plane (°)	81.4	75.3	72.0
IMPA (°)	78.3	84.1	95.0

Treatment Alternatives

The following three different approaches were discussed with the patient:

1. Orthognathic surgery plus extraction of the upper left lateral incisor and bilateral canine substitution.
2. Orthognathic surgery plus extraction of the upper left first premolar and unilateral canine substitution.
3. Orthognathic surgery plus space opening for a single implant.

It was assumed that orthognathic surgery was the treatment of choice to solve the severe skeletal imbalance and mandibular asymmetry. Therefore, orthognathic surgery and upper left lateral incisor extraction treatment were chosen. This alternative would have allowed centering the upper dental midline and uprighting the maxillary incisors before orthognathic surgery. In addition, by means of detailed dental repositioning, it would have enhanced the postorthodontic outcome. Extraction of the upper left lateral incisor was chosen not only to maximize retroclination of the maxillary anterior segment but also to center the upper dental midline in the least amount of time. Extraction of the upper first left premolar would have

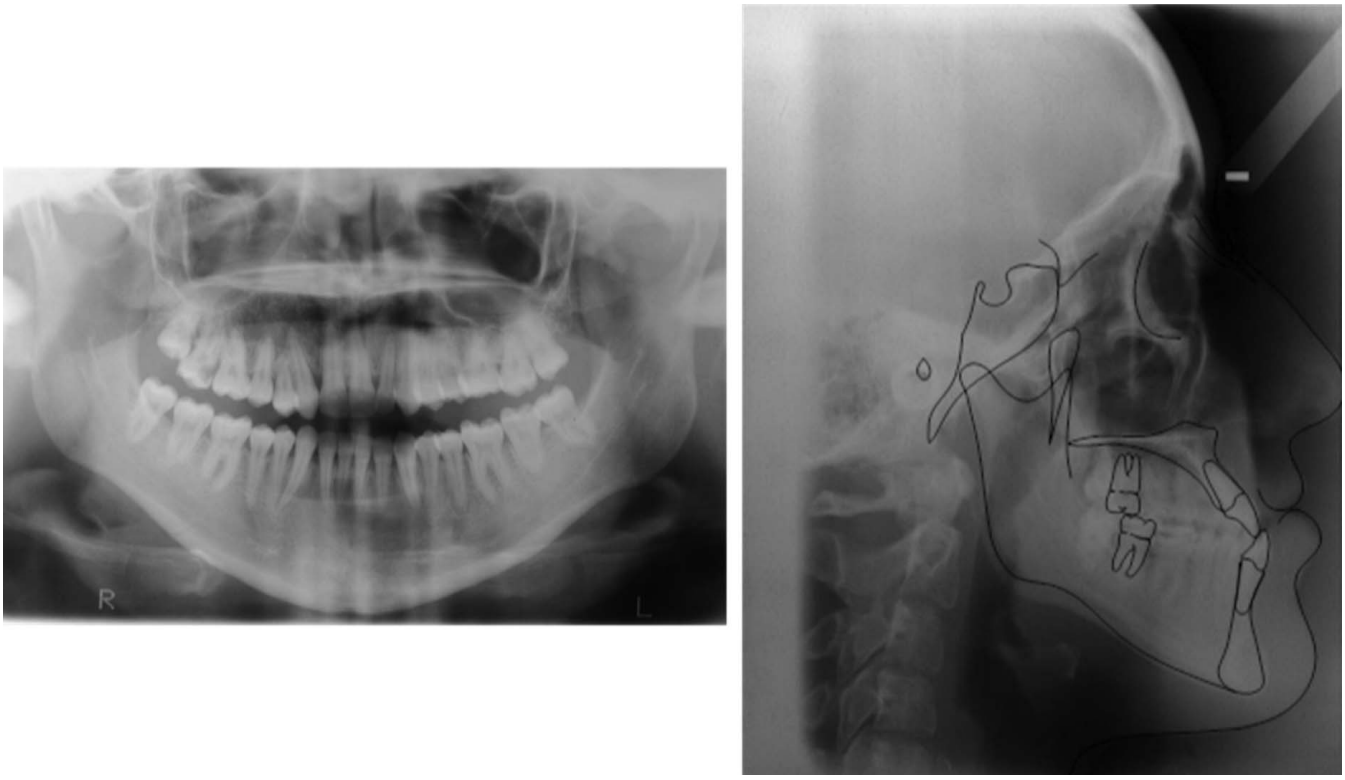

Figure 3. Pretreatment radiographs.

allowed achievement of the same treatment goals but would have required a longer treatment time. Therefore, because of the previous history of unsuccessful orthodontic treatment, the fastest treatment alternative was suggested. Both extraction options required restorations with porcelain veneers to improve the esthetic result. The following two restorative alternatives could be considered: (1) four ceramic units to restore only the central incisors to alter their shape and the maxillary canines to resemble maxillary lateral incisors and (2) six ceramic units to also restore the maxillary premolars to give them the shape of maxillary canines and provide more uniformity in size, texture, and color.

In the third orthodontic option that involved reopening space for the right maxillary lateral incisor and restoration with a ceramic crown on an osteointegrated titanium implant, it was possible to create a Class I occlusion, but this solution may sometimes involve complications related to bone loss around the implants attributed to perimplantitis and esthetic drawbacks such as recession, metal showing, and lack of papilla. At this young age, it was also possible that the natural eruption of teeth continues in combination with the stability of the ankylotic implant, producing an unpleasant difference in the heights of gingival contour.

Figure 4. To facilitate intrusion mechanics, the bracket was placed at the edge of the right maxillary central incisor.

Figure 5. Elastic chain on a 0.019 × 0.025-inch stainless steel archwire was used to close extraction spaces in the maxillary arch.

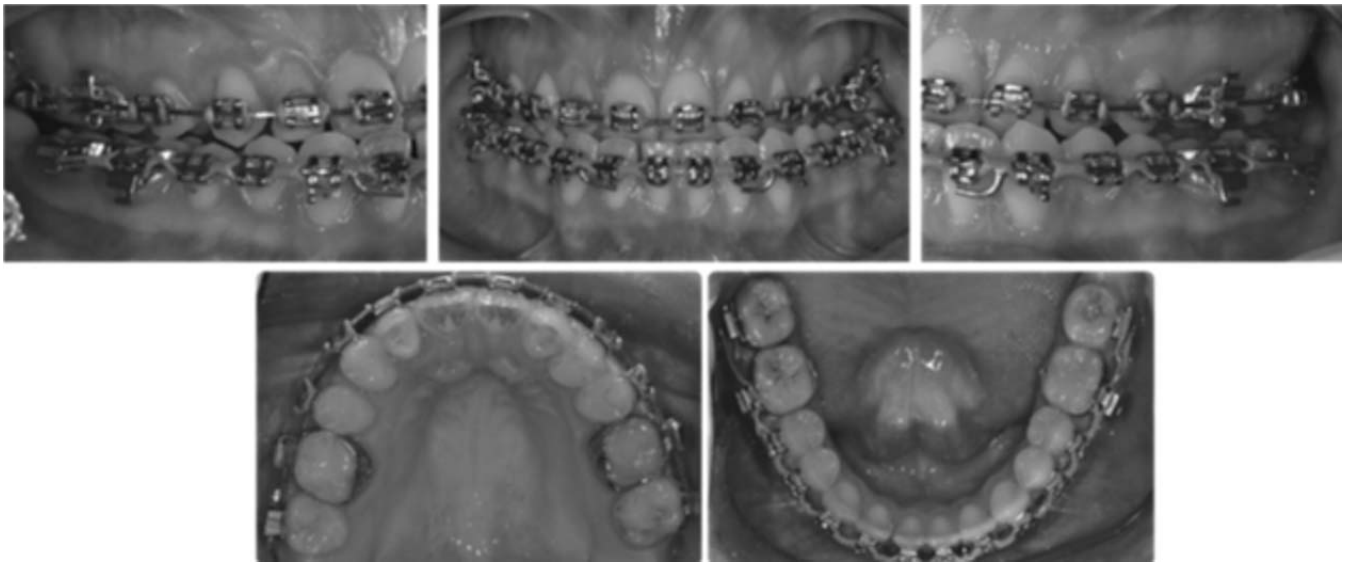

Figure 6. Presurgical orthodontic treatment.

Figure 7. Postsurgical orthodontic facial and intraoral photographs.

Figure 8. Mock-up comparison between 4 and 6 veneers.

For every alternative considered, the restorative choice was ceramic laminates instead of full crowns to combine an excellent esthetic result with a minimally invasive treatment.[9]

Treatment Progress

The maxillary left lateral incisor and all third molars except for the upper right were extracted. It was preferable to move the upper right third molar mesially and extract the upper right second molar because it was highly damaged by caries.

Root canal therapy was required to eliminate sensitivity following occlusal reduction during maxillary canine extrusion. Vertical clearance was created progressively and checked regularly every 2 weeks. Endodontic treatment was completed before starting orthodontic treatment.[10,11] Orthodontic brackets were placed on all teeth in both arches. The maxillary central incisor gingival margins were leveled through intrusion of the maxillary right central incisor. This was planned at the bonding stage by placing the bracket closer to the incisal edge (Figure 4). Tooth alignment was obtained with 0.016-inch heat-activated nickel titanium archwires; leveling was achieved by 0.019 × 0.025-inch heat-activated nickel titanium archwires and completed by 0.019 × 0.025-inch stainless steel (SS) archwires.

During the working stage, an elastic chain on a 0.019 × 0.025-inch SS archwire was used to close extraction spaces in the maxillary arch (Figure 5). Extrusion of maxillary canines was obtained by placing progressive 1-mm vertical steps into the 0.019 × 0.025-inch SS archwire monthly.[10] During extrusion, palatal root torque was placed into the archwire to obtain palatal movement of both maxillary canine roots. The maxillary canines, which had been reshaped as lateral incisors, were bonded with central incisor brackets (torque +17°) to provide additional palatal root torque.

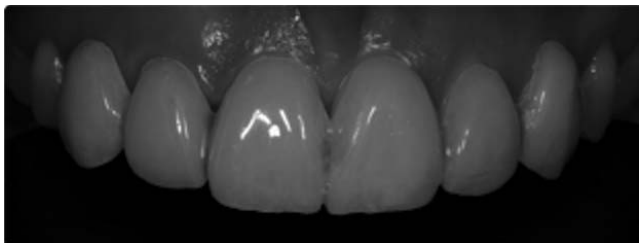

Figure 9. APT template in space.

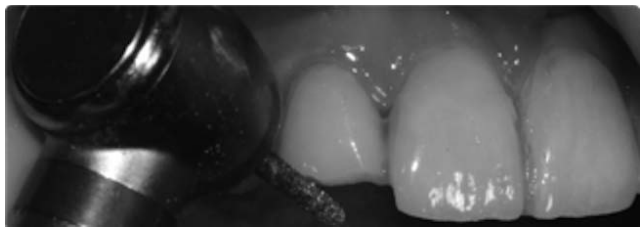

Figure 10. APT technique used to obtain uniform thickness of preparations.

Two-jaw orthognathic surgery was performed after 18 months of presurgical orthodontic treatment (Figure 6). The maxilla was advanced about 2 mm, and the mandible was set back about 4 mm. Postsurgical treatment lasted about 6 months (Figure 7).

At the end of orthodontic treatment, the final restorative treatment plan was defined together with the patient. A wax-up was made in the laboratory, and the configuration was assessed intraorally before tooth preparations were made. The restorations were previewed in the patient's mouth with four or six veneers (Figure 8) using two different acrylic mock-ups. The patient chose the option with six veneers. The esthetic preevaluative temporaries (APT) technique was used not only to evaluate the esthetics and phonetics but also to obtain uniform thickness of the preparations (Figure 9).[12] Tooth preparation was guided by the mock-up spot bonded to the teeth. A 1.6 cylindrical diamond bur was used to reduce the incisal margin through the mock-up (Figure 10). A 0.7-mm deep cut was made using half the bur to create a vertical groove at the center of the crown (Figure 11). Three sets of silicone putty index were fabricated from a wax-up as preparation guides. They were sectioned horizontally and palatally. The horizontally sectioned silicone index was used for buccal clearance (Figure 12), the second had the same purpose for the cervical third, and the palatal index was used to check incisal edge prepara-

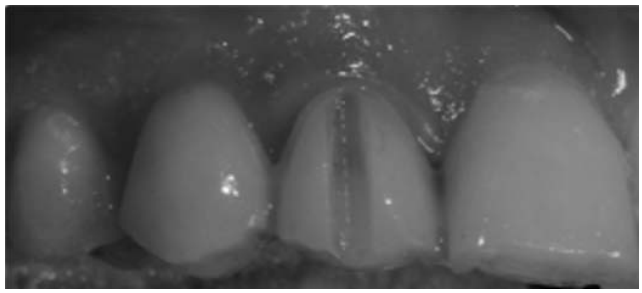

Figure 11. A 0.7-mm deep cut was made with a bur to create a vertical groove at the center of the crown.

Figure 12. Horizontally sectioned silicone index.

tion (Figure 13).[13] Tooth preparation was finished and polished, and a final impression was taken. The final restorations, six lithium disilicate veneers, were placed, and photographs were taken and shown to the patient. After her acceptance, the laminates were cemented one by one under rubber dam with total etch adhesion and a heated light-cured composite (Figure 14).

Treatment Results

At the end of treatment, facial appearance and skeletal balance were improved, and mandibular asymmetry and prognathism had been corrected. Class II molar and Class I canine relationships were achieved. The cephalometric changes included an increase in the ANB angle (Figures 15 and 16, Table 1). Despite the missing lateral incisors, the patient showed a natural, attractive final result (Figures 17 and 18). A symmetric incisal plane was established, a functional occlusion with average vertical and horizontal overlaps was set, and the bone scallop and consequently the gingival margins were leveled. Long-term records were collected 10 years after treatment, and they showed slight recession on the maxillary first premolars (transformed into maxillary canines) and on the right maxillary central incisor (Figure 19).

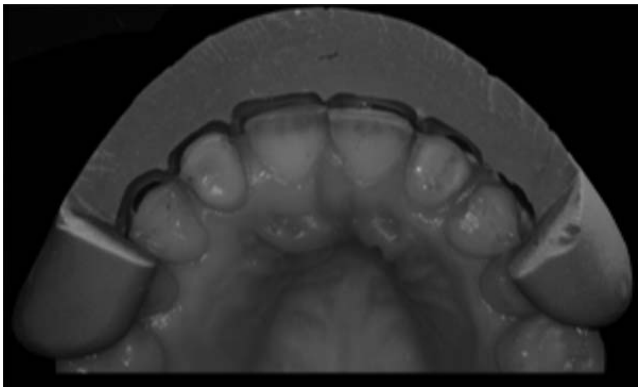

Figure 13. Palatal-sectioned silicone index.

Figure 14. Final result.

DISCUSSION

A patient with Class III malocclusion with a missing right maxillary incisor, abrasion of the maxillary incisal edges, anterior gingival margin discrepancies, and right maxillary canine recession underwent successful treatment enabled by well-communicated interdisciplinary procedures. Treatment planning for missing maxillary lateral incisors may be accomplished by space closure or space reopening. Many clinicians prefer to create space for missing lateral incisors with single tooth implants or resin-bonded bridges.[14] Implant substitution is considered an optimal solution to obtain ideal occlusion and has the advantage of not causing damage to adjacent teeth.[15,16] Despite these advantages, implant substitution may have complications in the short and long term such as blue coloring of the labial gingiva, visibility of metal or porcelain, and overeruption of adjacent teeth.[14]

Previous publications demonstrated that space closure can result in the permanent and biological compatibility of the finished result.[17–19] The result and all of the changes in the long term will appear natural compared with what might happen when a foreign body, such as an implant, is present.[16] In both treatment alternatives, restoration of the maxillary anterior teeth could be recommended to improve the overall esthetic outcome.[20]

The lateralized canines are about the same length as the central incisors, and their gingival margins are at the same height as the central incisors. However, the lateral incisors and first premolars are smaller and gingival margins are lower.[19,21] To obtain ideal heights of contour of the anterior teeth, it is necessary to perform individualized canine extrusion and premolar intrusion during the mesial movement. In this type of approach, it is suggested that the maxillary canines, displaced mesially, have the same crown torque as the maxillary lateral incisors, and the first and second maxillary premolars have optimal torque when they are displaced mesially.[19]

Orthodontic forced eruption was used for the maxillary right canine, which displayed gingival recession, to achieve both hard and soft tissue regeneration

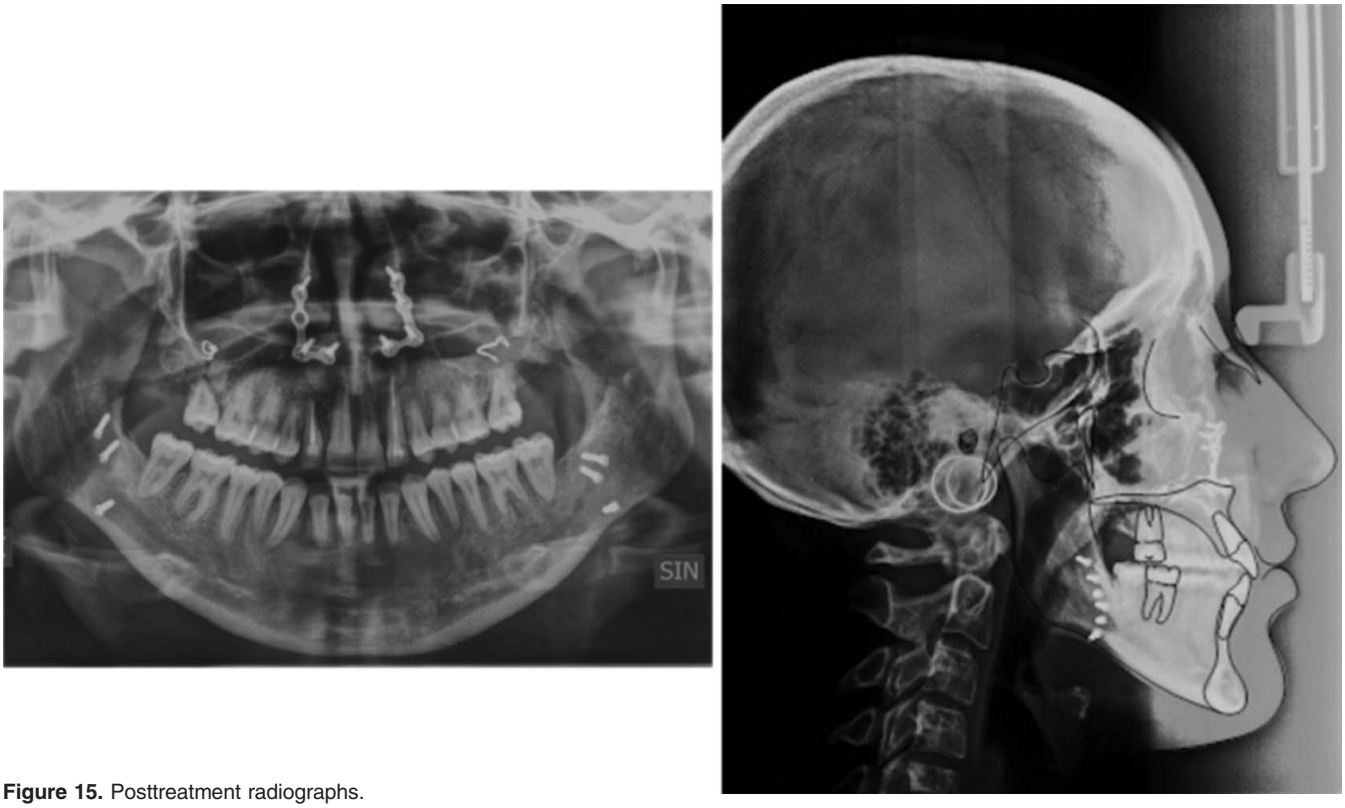

Figure 15. Posttreatment radiographs.

Figure 16. Superimposition of pretreatment and posttreatment lateral radiographs.

nonsurgically.[10] Elongation of the tooth in its alveolus causes stretching of the gingival and periodontal ligament fibers. The result is a coronal shift of the bone at the base of the defect as the tooth moves occlusally.[22] This bone growth is regeneration, which is vertical tissue translation together with the root, not a new proliferation to cover the root, which would be possible only with a gingival graft. At the end of orthodontic extrusion, the clinical crown is shorter than it was at the beginning of the treatment, and the root length remains the same. The tooth may often require some kind of restoration.

The most disturbing crown length discrepancy occurs when one maxillary central incisor is shorter than the other as a result of a gingival margin discrepancy. Indeed, when the tooth is abraded and shortened, compensatory eruption occurs, causing uneven gingival margin levels. Length differences can be corrected through the following three different means: (1) gingival surgery to correct the soft tissue form, (2) intrusion of the shorter tooth until the gingival margins are aligned[21] followed by restoration of the incisal edge,[4] or (3) extrusion of the longer tooth to permit the gingival margin to come down with it. The extrusion is viable as long as the central incisors remain longer than the lateral incisors after treatment.[21] The intrusion of the abraded, shorter tooth can be successful in a nonperiodontal case when the central

Figure 17. Posttreatment photographs.

incisor probing depths are the same but the crown lengths are different. The key factors that determine the most correct approach to correct crown length differences are the sulcus depth, the location of the cementoenamel junction relative to bone level, the amount of existing tooth structure, the root-to-crown ratio, and the shape of the root.[4]

Bracketing and alignment must often be accomplished to improve the esthetic restorability of the abraded teeth.[2] Determination of the tooth position is guided by the gingival margin levels and not by the incisal edges. Therefore, to determine the ideal gingival levels, it is necessary to establish the correct length-to-width ratio of the central incisors and correct the symmetry between the maxillary right and left central incisors and the desired amount of gingival display.[4] Alignment of the gingival margins in cases of abraded teeth increases the discrepancy of the incisal edges. Prosthetic compensation can be achieved with veneers or full crowns. The preparation for a veneer removes from 3% to 30% of the tooth structure compared with 63% to 72% for preparation of a full-coverage crown both for metal-ceramic and metal-free types.[9]

CONCLUSIONS

- This Class III orthognathic case required demanding interdisciplinary treatment.
- The dental goal was to set the best possible scenario to allow the restorative specialist to perform at the maximum level. The main orthodontic requirements were to establish a symmetric incisal plane, create a functional occlusion with average vertical and horizontal overlaps, and level the bone scallop and consequently the gingival margins.

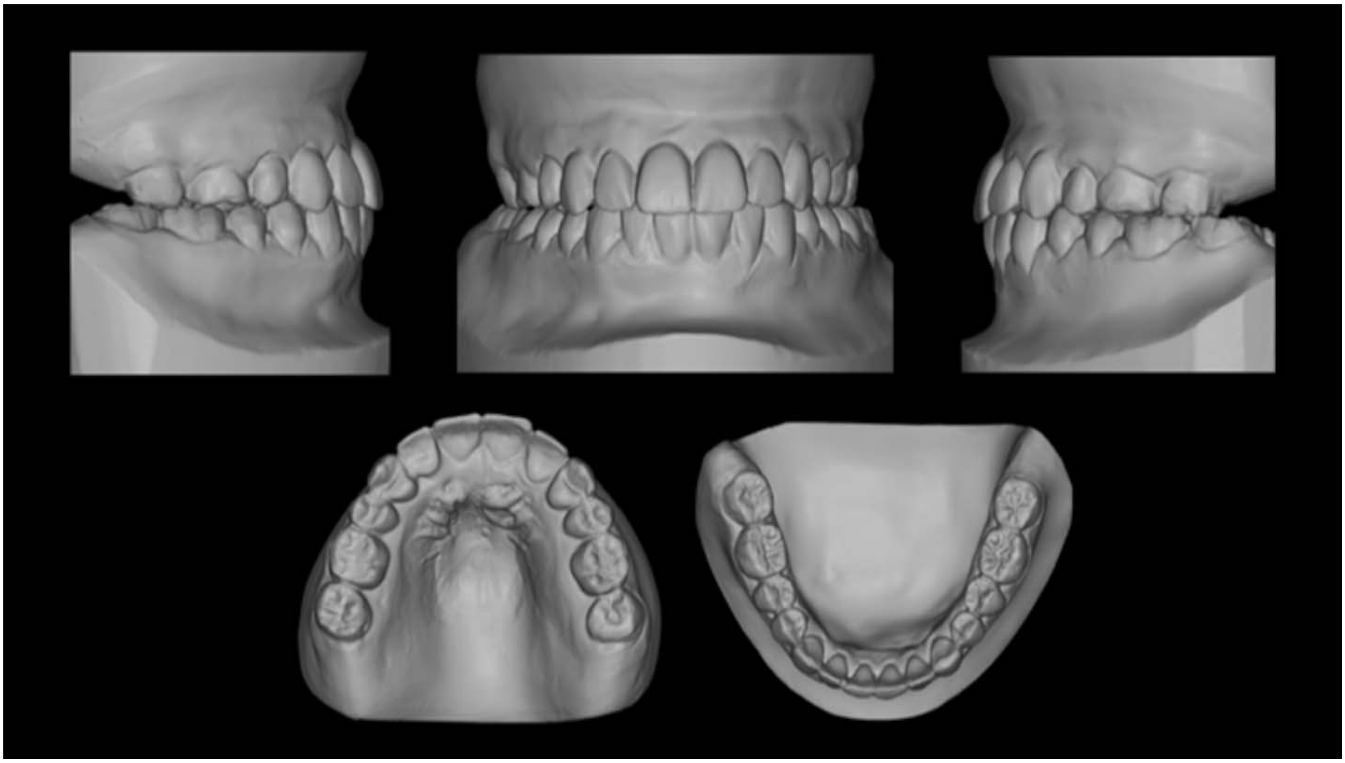

Figure 18. Posttreatment dental casts.

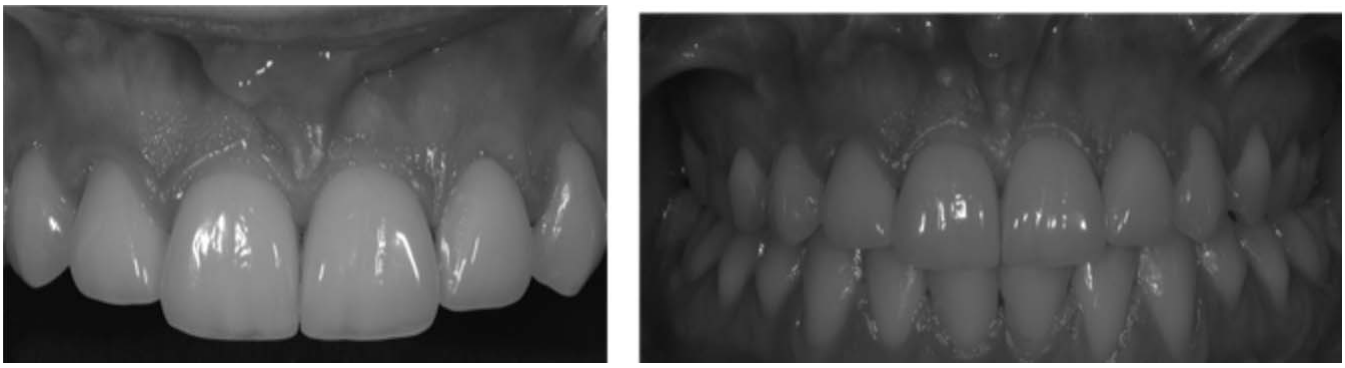

Figure 19. Photographs 10 years posttreatment.

- Harmony in the smile was achieved through the correct location of the teeth vertically, palatal-buccally, and laterally and by bone-level and gingival-level recontouring.
- The main effort was to perform a well-camouflaged canine substitution.
- In this case, six single units of tooth restoration treatments were done because tooth morphology was severely altered.
- The interdisciplinary approach is the key to hiding the initial esthetic defects of the case. The result highlights how to obtain remarkable improvement of a smile in a well-functioning masticatory system.

REFERENCES

1. Belser UC. Natural oral esthetics. In: Magne P, Urs B, eds. *Bonded Porcelain Restorations in the Anterior Dentition: A Biomimetic Approach*. 3rd ed. Chicago: Quintessenza; 2002: 57–98.
2. Kokich VG, Spear FM. Interdisciplinary management of anterior guidance: a case report. *Adv Esthet Inter Dent*. 2007;3(3):17–24.
3. Javaheri D. Orthodontics, veneers, or both. Treatment planning the crowded anterior dentition. *Dent Today*. 2003; 22(6):78–82.
4. Spear FM, Kokich VG, Mathews DP. Interdisciplinary management of anterior dental esthetics. *J Am Dent Assoc*. 2006;137(2):160–169.

5. Cozzani M, Lombardo L, Gracco A. Class III malocclusion with missing maxillary lateral incisors. *Am J Orthod Dentofacial Orthop*. 2011;139(3):388–396.
6. Eslami S, Faber J, Fateh A, Sheikholaemmeh F, Grassia V, Jamilian A. Treatment decision in adult patients with Class III malocclusion: surgery versus orthodontics. *Prog Orthod*. 2018;19(1):28.
7. Cozzani M, Lombardo L, Gracco A. Class III malocclusion with missing maxillary lateral incisors. *Am J Orthod Dentofacial Orthop*. 2011;139(3):388–396.
8. Lin J, Gu Y. Preliminary investigation of nonsurgical treatment of severe skeletal Class III malocclusion in the permanent dentition. *Angle Orthod*. 2003;73(4):401–410.
9. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for anterior teeth. *J Prosthet Dent*. 2002;87(5):503–509.
10. Amato F, Mirabella AD, Macca U, Tarnow DP. Implant site development by orthodontic forced extraction: a preliminary study. *Int J Oral Maxillofac Implants*. 2012;27(2):411–420.
11. Gibson CF, Mandelaris GA. Restoration of the anterior segment in a cleft palate in conjunction with surgically facilitated orthodontic therapy: an interdisciplinary approach. *Dent Clin North Am*. 2015;59(3):733–753.
12. Gürel G. Predictable and precise tooth preparation techniques for porcelain laminate veneers in complex. *Int Dentirstry Sa*. 2007;9(1):30–40.
13. Magne P, Belser UC. Novel porcelain laminate preparation approach driven by a diagnostic mock-up. *J Esthet Restor Dent*. 2004;16(1):7–18.
14. Rosa M, Zachrisson BU. The space-closure alternative for missing maxillary lateral incisors: an update. *J Clin Orthod*. 2010;44(9):540–549.
15. Kiliaridis S, Sidira M, Kirmanidou Y, Michalakis K. Treatment options for congenitally missing lateral incisors. *Eur J Oral Implantol*. 2016;9 Suppl 1.
16. Jamilian A, Perillo L, Rosa M. Missing upper incisors: a retrospective study of orthodontic space closure versus implant. *Prog Orthod*. 2015;16:2.
17. Kokich VO Jr, Kinzer GA. Managing congenitally missing lateral incisors. Part I: canine substitution. *J Esthet Restor Dent*. 2005;17(1):5–10.
18. Rosa M, Lucchi P, Ferrari S, Zachrisson BU, Caprioglio A. Congenitally missing maxillary lateral incisors: long-term periodontal and functional evaluation after orthodontic space closure with first premolar intrusion and canine extrusion. *Orthod Fr*. 2017;88(4):319–332.
19. Rosa M, Zachrisson BU. Integrating esthetic dentistry and space closure in patients with missing maxillary lateral incisors. *J Clin Orthod*. 2001;35(4):221–234.
20. Mirabella AD, Kokich VG, Rosa M. Analysis of crown widths in subjects with congenitally missing maxillary lateral incisors. *Eur J Orthod*. 2012;34(6):783–787.
21. Kokich V. Esthetics and anterior tooth position: an orthodontic perspective. Part I: crown length. *J Esthet Dent*. 1993; 5(1):19–23.
22. González-Martín O, Solano-Hernandez B, González-Martín A, Avila-Ortiz G. Orthodontic extrusion: guidelines for contemporary clinical practice. *Int J Periodontics Restorative Dent*. 2020;40(5):667–676.