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Multidisciplinary treatment with a customized lingual appliance for an adult patient with severe Class III malocclusion and multiple missing teeth

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A 24-year-old man presented with a severe skeletal class III malocclusion, associated with an anterior and posterior crossbite in the left side, upper and lower lip eversion, skeletal asymmetry, midline discrepancy, diastemas in the maxillary and mandibular dental arches, and agenesis of maxillary lateral incisors and canines with retained deciduous teeth. Treatment was performed with the use of the Win Lingual System. When the 0.016 × 0.022-inch NiTi archiwire was applied, the deciduous teeth were extracted and replaced with temporary crowns connected to the appliance. After the aligning, leveling, and diastema closure phases, a modified Le Fort II osteotomy, a mandibular setback with a bilateral sagittal split osteotomy and a genioplasty were performed. Implants were placed in the canine site through a flapless guided surgery, and cantilevered temporary bridges were delivered. Final prosthetic rehabilitation included veneers for the central incisors and zirconia-ceramic cantilevered bridges for the canine and lateral incisors. After 36 months of active treatment, the patient showed an Angle Class I molar and canine relationship and an ideal overbite and overjet. His profile had improved, lips were competent, and gingival levels were acceptable. The lateral radiograph and cephalometric analysis showed a good balance of the skeletal pattern, a good profile of the soft tissue, and proper inclinations of the maxillary and mandibular incisors in relation to maxilla and mandible. After 2 years of follow-up, the patient had a pleasant smile and no relapse, or joint or muscular pain. (Am J Orthod Dentofacial Orthop 2019;156:401-11)

At the end of growth development, a severe skeletal Class III malocclusion can be treated with a combined orthodontic and surgical approach to provide full correction of the medium and lower third of the face in all 3 dimensions.[1] A combined orthodontic and surgical treatment generally requires 3 steps: presurgical orthodontic treatment, orthognathic surgery, and postsurgical orthodontic refinement. The orthognathic surgery in a skeletal Class III patient can involve both the maxillary or the mandible complexes,[2] according to the clinical esthetic evaluation.

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Tooth agenesis is associated with a smaller ANB angle and negatively correlates with the number of congenitally missing teeth.[3] Some studies have reported an association between tooth agenesis and skeletal Class III malocclusion, indicating a greater need for orthodontic treatment owing to its psychosocial impact on quality of life.[4-9] Hypodontia is described as the congenital absence of 1 or more teeth[10] and has a reported prevalence from 2.7% to 11.3%,[11] with permanent dentition affected more than the deciduous. The etiology is multifactorial with different aspects to consider: genetic factors,[12] environmental factors,[13] hereditary factors, local or systemic infections, radiations, drugs, and history of trauma.[12,14,15] The most prevalent missing teeth are the third molars, followed by the mandibular second premolars, the maxillary lateral incisors, and the maxillary second premolars.[12] Dental agenesis requires a multidisciplinary treatment, with options including space closure with canine transposition, space opening with implant, or Maryland bridge replacement of the missing tooth.[16,17] The choice depends on the clinical context that the

Fig 1. Pretreatment photographs.

clinician is faced with. Each treatment option has advantages and disadvantages, and a precise evaluation of the patient is required in choosing the best clinical approach.[18]

The present case report evaluates the multidisciplinary management of a skeletal Class III adult patient with maxillary lateral incisor and canine agenesis. An orthodontist, a maxillofacial surgeon, an implant surgeon, and a prosthodontist were involved in the treatment.

DIAGNOSIS AND ETIOLOGY

A-24-year-old man presented with a chief compliant of an unesthetic smile and difficulty during chewing. The extraoral examination revealed a reduced height of the middle third of the face and an increased height of the lower third, reduced maxillary incisors display during smiling, diastemas, and 3 mm mandibular asymmetry on the left side. From a lateral view, the patient revealed a significant prominence of the jaw, upper and lower lip eversion, and a closed nasolabial angle (Fig 1).

The intraoral examination showed a severe maxillary discrepancy with an anterior and posterior left crossbite. Moreover, the patient had diastemas in the maxillary and mandibular dental arches. Deciduous maxillary lateral incisors and canines were retained in the dental arch. An Angle molar Class III, a midline discrepancy, and a reduced dimension of the maxillary central incisors were also evaluated (Figs 1 and 2).

A centric occlusion–centric relation (CO-CR) discrepancy was evident for a premature contact on the maxillary second molar, which caused an anterior movement of the jaw to obtain a stable occlusion.

Orthopanoramic examination revealed the agenesis of the permanent maxillary lateral incisors and canines.

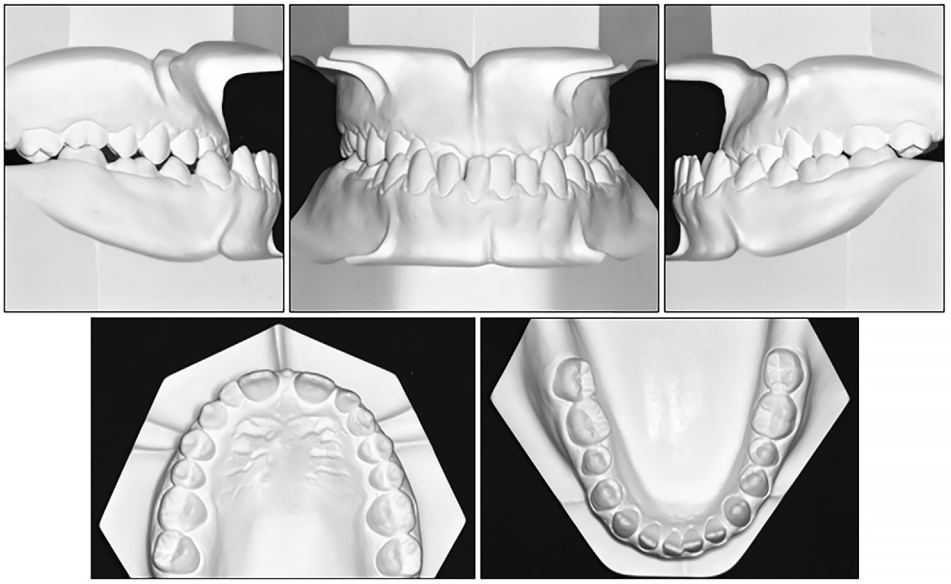

Fig 2. Pretreatment dental casts.

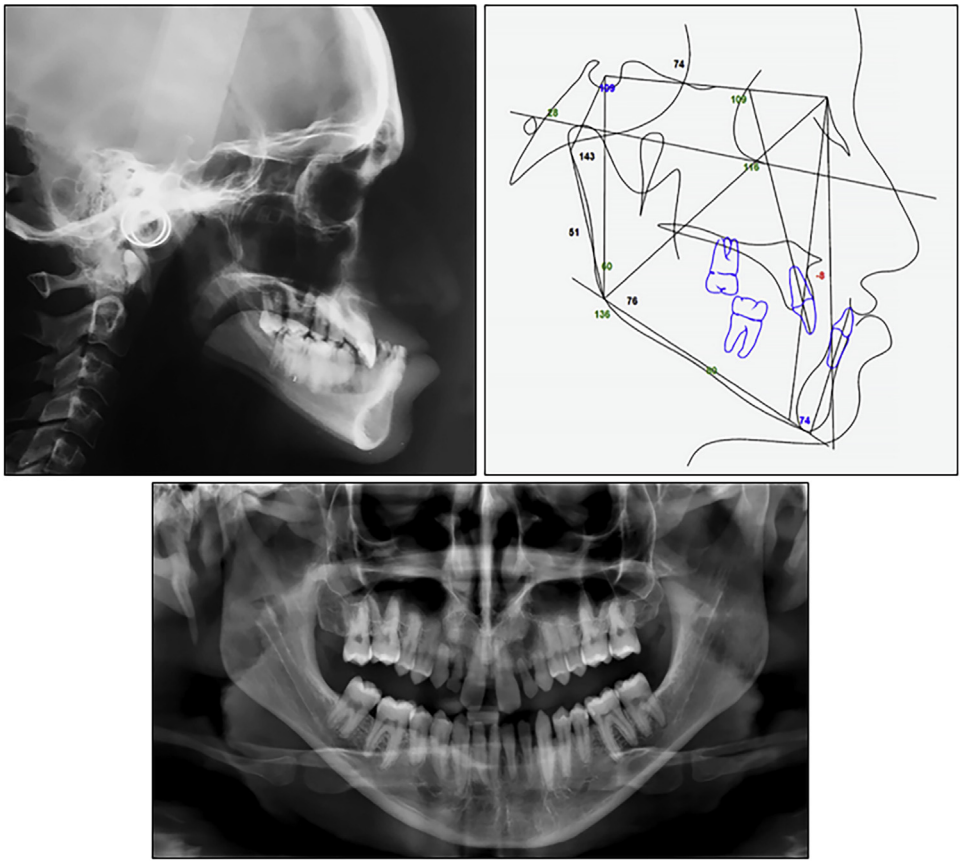

Fig 3. Pretreatment lateral radiograph, lateral radiograph tracing, and panoramic radiograph.

Table I. Cephalometric measurements

Measurement	*Pretreatment*	*Posttreatment*
Skeletal		
Sella angle (SN-Ar, °)	109.1	111.4
Articular angle (°)	142.8	147.2
Gonial/Jaw angle (Ar-Go-Me, °)	136	139.7
Upper gonial angle (Ar-Go-Na, °)	60.4	60.2
Lower gonial angle (Na-Go-Me, °)	75.6	79.5
Sum of angles (Jarabak, °)	387.9	398.3
Anterior cranial base (SN, mm)	74.3	74.4
Posterior cranial base (S-Ar, mm)	27.6	26.8
Ramus height (Ar-Go, mm)	50.7	42.2
Corpus length (Go-Me, mm)	80.5	72.1
P-A face height (S-Go/N-Me, %)	66.6	58.9
Jarabak anterior ratio (×1000)	82.8	91.1
SNA (°)	88.8	85.6
SNB (°)	96.5	82.5
ANB (°)	−7.7	3.2
Anterior face height (NaMe, mm)	112	112.7
Posterior face height (SGo, mm)	74.6	66.4
Dental		
IMPA (L1-MP, °)	74	80.7
U1-SN (°)	109.5	102.8
U1-FH (°)	115.6	109

The condyles appeared to have a good shape, and the patient did not present any symptoms of temporomandibular joint dysfunction (Fig 3).

The cephalometric analysis showed a severe skeletal Class III relationship with an ANB angle of −7.7°, an increased mandible corpus length, an increased gonial angle, and a normodivergent vertical pattern with posterior/anterior face height rate of 66.6%. The mandibular incisors were retroinclined with an IMPA of 74°, and the maxillary incisors were proclined with an angle related to FH of 116° (Fig 3). The complete cephalometric analysis is reported in Table I.

TREATMENT OBJECTIVES

The treatment objectives were to obtain a dental and skeletal Class I relationship, align and level both maxillary and mandibular dental arches, resolve anterior and posterior crossbite relationship, resolve skeletal asymmetry, manage maxillary spaces for the rehabilitation of the maxillary lateral incisor and canine, and close mandibular diastemas without losing incisor torque. All of these objectives were pursued to improve the balance of soft and hard tissue of the middle and lower thirds of the face and increase smile display of the patient.

TREATMENT ALTERNATIVES

To correct the skeletal malocclusion, different treatment options were considered. A mandibular setback alone would not have been ideal for facial esthetics and would not have fulfilled the patient's expectations. As a result, to obtain an adequate facial balance, a mandibular setback was combined with maxillary advancement. Furthermore, posterior crossbite due to maxillary deficiency inevitably required double-jaw surgery. A surgery-first approach was discarded by the authors because the extrusion of the upper right second molar would have caused great instability of the occlusion.

Both vestibular and lingual appliances were considered for the orthodontic preparation. Lingual brackets (Win Lingual System) were preferred to the vestibular ones for the complete customization and the high torque control of the incisors owing to the ribbon archwire configuration. In the mandibular dental arch, the space closure treatment option was considered as was the torque increase of the mandibular incisors. Torque control provided by the customized lingual appliance and the ribbon archwire was considered to be the best alternative to obtain both of these results. Another advantage of a customized lingual appliance is the opportunity to create temporary dental elements already at the set-up phase, 3D print them, and apply them to the archwire during therapy. This procedure was very helpful for 2 reasons: First, it provided an esthetic solution for the patient and did not leave an open wide space during the treatment; and second, it permitted easy management of space closure of adjacent teeth.

In the maxillary dental arch, 2 options were considered: space closing or space opening for maxillary lateral incisors and canines. Space closure can be a valid alternative when it is necessary to close the space of 1 tooth; in this case, however, the amount of space to close exceeded 10 mm per side and it would have made the management of the anchorage and treatment duration particularly challenging.

For the final prosthetic rehabilitation, the number of implants per side was discussed. The oral surgeon and the prosthodontist preferred to have only 1 implant per side in the canine position and a cantilevered rehabilitation of both elements. This solution provides a better periodontal outcome, in particular when considering the interdental papilla that is hard to manage between 2 adjacent implants.

TREATMENT PROGRESS

Indirect bonding procedure was performed following the clinical protocol of Win Lingual System (Fig 4, *A*).

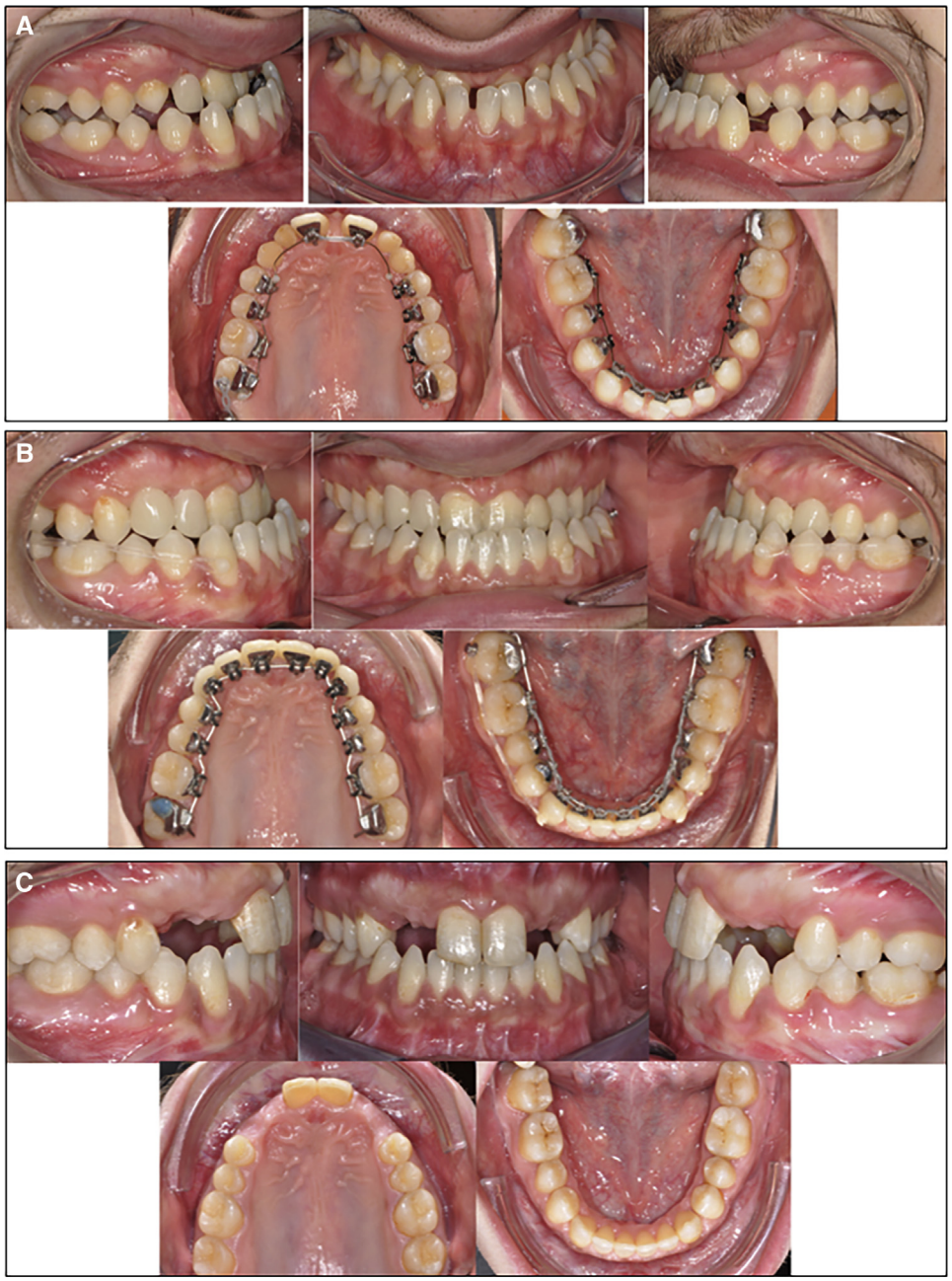

Fig 4. Progress intraoral photographs: **A,** bonding; **B,** before surgery treatment; **C,** after surgery treatment.

Extraction of the maxillary deciduous lateral incisors and canines was performed later during therapy to avoid any dental movement that could have affected the precision of the indirect bonding tray. The archwire sequences were: 0.14 NiTi, 0.16 × 0.22 NiTi, 0.18 × 0.25 NiTi, 0.16 × 0.24 SS with 13° of extra torque, and 0.18 × 0.25 TMA in the maxillary dental arch and 0.14 NiTi, 0.16 × 0.22 NiTi, 0.18 × 0.25 NiTi, 0.18 × 0.25 SS reduced in the posterior straight segments and 0.18-x 0.25 TMA in the mandibular dental arch.

In the maxillary dental arch a miniscrew was placed in the right tuber maxillae from the first phase of therapy to help the second molar intrusion movement. The diastema closure between upper central incisors was started from the beginning with the use of a light elastic chain.

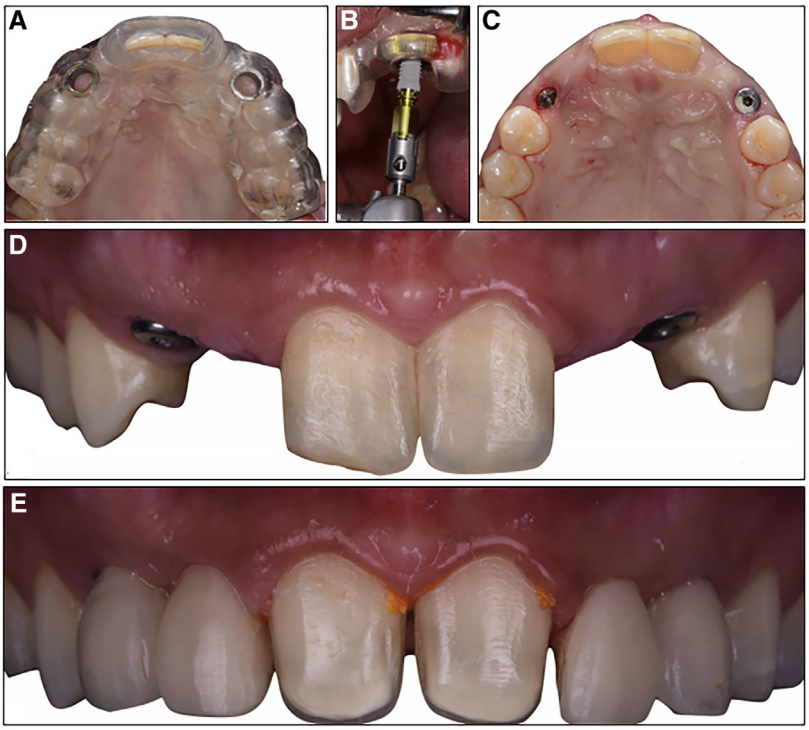

Fig 5. A-D, Implant position. **E,** Maxillary right and left central incisors preparation.

Deciduous lateral incisors and canines were extracted when the 0.16 × 0.22 NiTi archwire was applied, because the temporary crowns planned in the set-up need a rectangular archwire for their stabilization (Fig 4, *B*).

In the mandibular dental arch space, closure was started with the use of light elastic chains on round and rectangular NiTi archwires and proceeded with the use of double-cable powerchain mechanics on rectangular SS archwires. Metal and composite buttons were applied to help the maxillofacial surgeon during the surgical phase.

The surgeon planned maxillary advancement with the use of a modified Le Fort II osteotomy, a mandibular setback with a bilateral sagittal split osteotomy, and a genioplasty (Fig 4, *C*). Titanium plates were used for the final fixation. Genioplasty was planned to change the anatomy of the symphysis and improve the final esthetic result.

After healing time, cone-beam computed tomography (CBCT) was performed with a radiolucent splint to plan the computer-guided implant surgery. Implants were placed in the canine site with the use of flapless guided surgery (Fig 5, *A-D*). After 3 months, cantilevered temporary bridges were delivered. Cantilever bridges were preferred to obtain a better outcome of the interdental papilla between the canine and the lateral incisor. After the gingival condition phase, final prosthetic rehabilitation consisted in 2 veneers for the central incisors and 2 zirconia-ceramic cantilevered bridges for the canine and lateral incisor (Fig 5, *E*).

TREATMENT RESULTS

After 36 months of active treatment, the patient showed an Angle Class I molar and canine relationship, skeletal asymmetry and midline corrections, and a full correction of the overbite and overjet. Maxillary and mandibular dental arches presented ideal alignment and leveling. All spaces in the mandibular dental arch were closed, and in the maxillary dental arch all closed spaces and frontal teeth in the maxillary arch presented an ideal proportion thanks to the correct management during treatment and prosthetic rehabilitation. Posterior crossbite was completely resolved, thanks to surgical maxillary advancement and good arch coordination during orthodontic treatment (Figs 6 and 7).

The whole facial esthetics was significantly improved. The mandibular protrusion and maxillary deficiency were completely solved by means of orthognathic surgery. The patient had a good and natural display of his teeth at rest and while smiling, lips were competent, and he was totally satisfied with the treatment result. Stable occlusion was achieved with no premature contacts and appropriate incisor and canine guidance.

Fig 6. Posttreatment photographs.

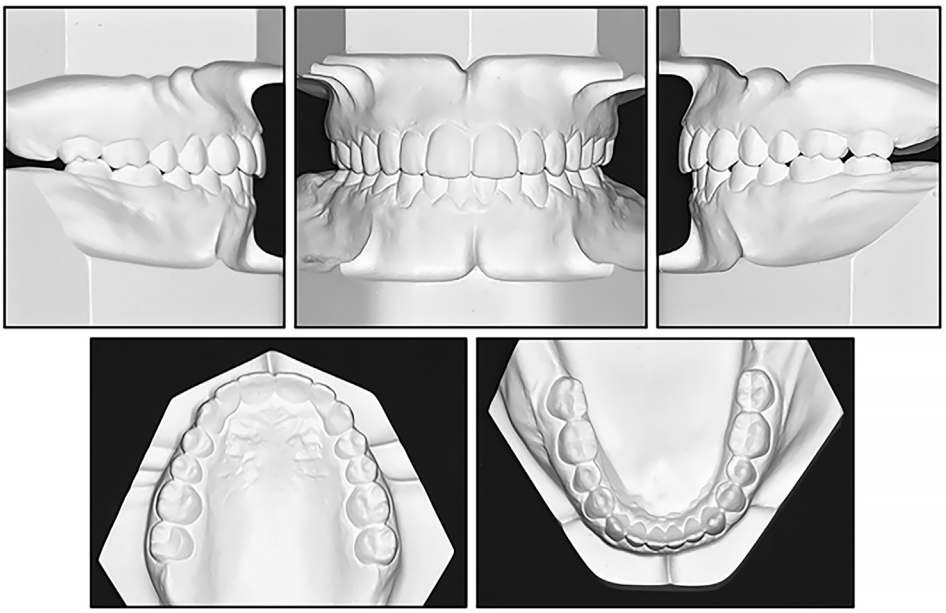

Fig 7. Posttreatment dental casts.

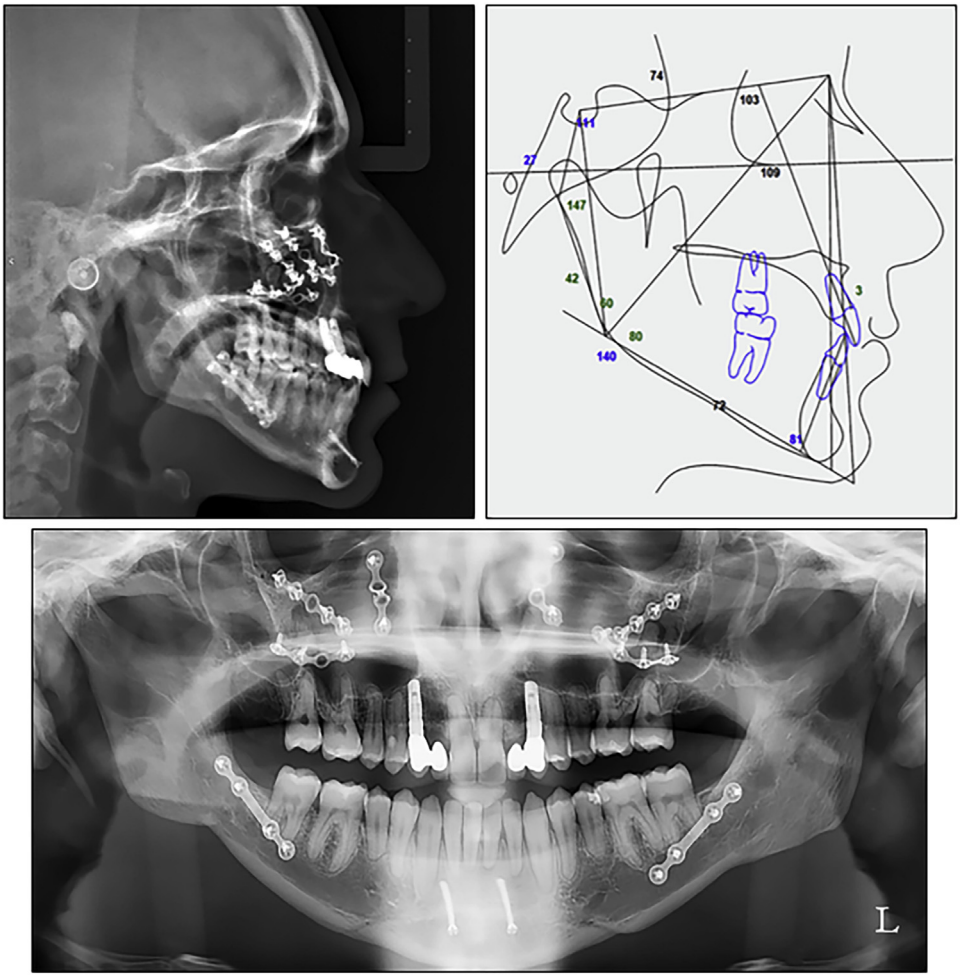

Fig 8. Posttreatment lateral radiograph, lateral radiograph tracing, and panoramic radiograph.

The final panoramic radiograph confirmed an adequate root inclination and parallelism in the anterior and the posterior regions, an adequate distance between implants and the adjacent teeth, healthy tissue around dental implants, and no sign of marginal bone loss (Fig 8).

The lateral radiograph and cephalometric analysis showed a good balance of the skeletal pattern, a good profile of the soft tissue, and proper inclinations of the maxillary and mandibular incisors in relation to the maxilla and mandible (Fig 8; Table I).

The tracing superimposition showed the maxillary advancement with posterior impaction, the mandibular setback, the maxillary incisors retroinclination, and the optimal torque control of the mandibular incisors (Fig 9).

Upper and lower Essix splints were given to the patient for use nightly. After 1 year, the Essix splint use was reduced to 3-4 nights a week.

After 2 years of follow-up, the gingival levels were satisfactory (Fig 10). Particular attention was given to the interdental papilla between maxillary canine and lateral incisor, which looked natural and filled the site. The choice of a single implant supporting a cantilevered bridge, instead of a 2-implant rehabilitation, associated with an accurate management of the temporary bridge, were essential to attaining this result. The patient maintained ideal oral hygiene, with no sign of marginal inflammation and absolute stability of the periodontal and perimplant soft and hard tissue. The patient did not show any temporomandibular problems during treatment, retention, and postretention periods.

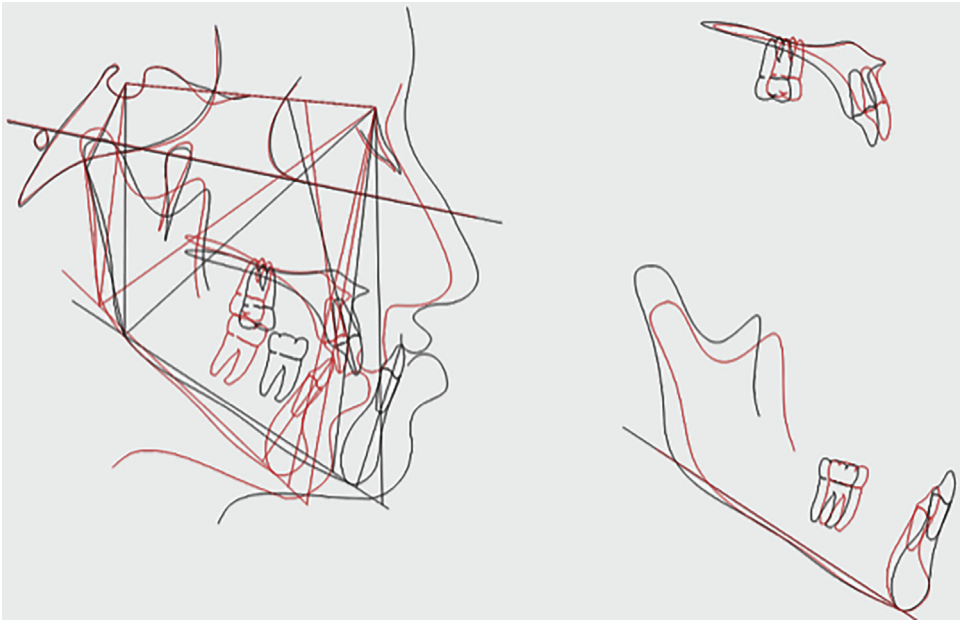

Fig 9. Superimposed tracings.

Fig 10. Intraoral photographs 2 years after treatment was completed.

Maximum opening was in the normal range, and no mandibular shift during opening movements was evident.

DISCUSSION

This case report concerns the orthodontic and surgical treatment of a severe Class III malocclusion in an adult patient. At the time being, the treatment plan for these patients is influenced by facial esthetics analysis, degree of anteroposterior and vertical skeletal malocclusion, dental crowding, and upper and lower incisor inclinations.[1,2] Severe skeletal malocclusion is often associated with dental compensation, which has to be solved during the orthodontic phase before the orthognatic surgery.[19] During the orthodontic phase the facial characteristics of the patient tend to worsen owing to the loss of the dental compensation. Based on cephalometric measurements, facial appearance,

and severity of anterior and posterior crossbite of the patient, the surgical option was the only acceptable treatment choice.[20]

The treatment plan was even more complex because the patient also presented missing maxillary canine and lateral incisors bilaterally, requiring an accurate management of spaces between central incisors and first premolars.[3] Moreover, in the mandibular dental arch the patient presented different spaces to close and at the same time the necessity to gain torque of the lower incisors. The precise control of all of these movements was necessary to achieve a proper orthodontic preparation, an essential parameter for the outcome of the orthognatic surgery.[4-6,19] Customized lingual appliances include brackets and archwires that are manufactured during the set-up of treatment, allowing complete control of the mechanics and final position of the teeth, particularly the upper and lower incisors.[21] In addition to the esthetic benefit of using a lingual appliance, temporary crowns with lingual brackets were manufactured and applied after deciduous teeth extraction. This solution allowed leaving the patient with no open spaces throughout the duration of treatment, especially as they exceeded 10 mm. Furthermore, it gave a clear idea of teeth dimensions and enabled a more precise management of space closure and incisor positions.

For the final restoration, the surgeon and the prosthodontist decided to proceed with one implant per side in the canine site and a cantilevered bridge. Flapless guided implant surgery was used to plan the insertion site on the CBCT of the patient, to set the implant position in the 3 dimensions and the distance from the first bicuspid. Particularly in the esthetic zone, the simulation of an interdental papilla is a critical factor for the final esthetic result.[22] The cantilevered bridge requires periodontal management and tissue condition with a temporary bridge of a pontic shape. Only after the formation of an interdental papilla is it possible to proceed with the definitive ceramic bridge. Owing to the high esthetics demand from the patient, 2 ceramic veneers were planned for the 2 central incisors to obtain an ideal proportion of the frontal.

CONCLUSIONS

A customized lingual appliance is a reliable and efficient system to manage the anchorage and level the curve of Spee, owing to the ribbon system, in difficult malocclusions. Set-up prescription and customized archwires are particularly indicated for orthodontic preparation of orthognathic patients.

In case of multiple agenesis, a multidisciplinary approach among the orthodontist, implant surgeon, and prosthodontist, is necessary to achieve the best esthetic outcome of both the hard and the soft tissues.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajodo.2019.05.004.

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