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CLINICAL ARTICLE

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Surgery-first in interdisciplinary class II cases

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Abstract

Objectives: To present an interdisciplinary case treated with a surgery-first orthognathic approach, followed by orthodontic and prosthodontic treatment.

Clinical Considerations: After an accurate pre-operative virtual planning, a young patient with skeletal class II, retrognathia, and an anterior open bite was treated with bimaxillary orthognathic surgery without pre-surgical orthodontic decompensation. Orthodontic treatment was carried out post-operatively. The treatment was completed with a prosthodontic phase to improve the final esthetic outcome of the smile.

Conclusions: A surgery-first approach allowed to achieve esthetic and functional results in a reduced treatment duration that remained stable over the course of 1 year. The outcomes were consistent with prior research in terms of advantages brought by following an accurately planned surgery-first protocol. Nevertheless, longer-term follow-up was required to evaluate the treatment stability.

Clinical Significance: An accurately planned surgery-first approach significantly helped in shortening the duration of the treatment, while providing a stable, functional, and esthetic solution to the patient's problems.

KEYWORDS

anterior open bite, class II malocclusion, orthodontics, orthognathic surgery, surgery-first

1 | INTRODUCTION

The surgery-first approach (SFA) consists of performing orthognathic surgery without pre-surgical orthodontic treatment, adjusting the occlusion orthodontically only in the post-operative stage.[1–7] This protocol differs from the conventional sequence of treatments, which generally requires orthodontics prior to and following the surgery.[1–8]

Recently, the concept of surgery-first has gained greater attention, being justified by the numerous advantages over the conventional orthognathic approach.[1–3] In surgery-first, overall treatment time can be decreased compared to the conventional approach, partly due to the elimination of the pre-surgical orthodontic phase.[1–10] This reduction is also attributed to a more efficient postoperative orthodontic treatment, since osteotomies performed during orthognathic surgery induce the regional acceleratory phenomenon (RAP) and the systemic acceleratory phenomenon (SAP).[1–3,9–11] Furthermore, since the skeletal bases are surgically placed in a correct position, the soft tissue forces that might interfere with the orthodontic movement of teeth

Abbreviations: BMI, body mass index; BSSO, bilateral sagittal split osteotomy; CBCT, cone beam computed tomography; CTG, connective tissue graft; FP3, fixed prosthesis 3; MMA, maxillomandibular advancement; PAS, posterior airway space; RAP, regional acceleratory phenomenon; RDI, respiratory disturbance index; SAP, systemic acceleratory phenomenon; SARPE, surgically assisted rapid palatal expansion; SFA, surgery-first approach; SNA, sella-nasion-point A angle; SNB, sella-nasion-point B angle; STO, surgical treatment objective.

are reduced, contributing to the shortening of treatment duration.[2,3,10] The preoperative orthodontic phase in the conventional orthognathic approach has the purpose of decompensating dental arches, aligning and leveling the occlusion.[1,3,7] From a psychological point of view, this is a very difficult phase for most patients,[4,6,8] negatively impacting their quality of life and often resulting in an aggravation of facial esthetics and dental function.[1,2,7] Due to the immediate perceived enhancements in facial appearance and shorter treatment length, a surgery-first approach might reveal higher rates of overall patients satisfaction, increasing their compliance and psychological well-being.[1–6,8–10] The early correction of the skeletal problem could also represent a valuable solution for patients that suffer from sleep-disordered breathing, achieving immediate airway enlargement.[1–3,12]

It is crucial to carefully select patients that are eligible for the surgery-first approach. The recent technological advances in 3D imaging and simulation software provide a more accurate determination of the surgical and orthodontic movements[1,3,7,13–15] and reduce the preoperative treatment planning time.[13]

Anterior open bite, which can be defined as the absence of overbite of incisors in centric relation, could be a difficult problem to manage. Patients with this type of malocclusion that undergo pre-surgical orthodontics have been shown to present high percentages of relapse after surgery. One of the factors that could be linked to this is the pre-surgical orthodontic preparation, which changes the arch width, form and curve of Spee. This instability is predominantly dental rather than skeletal, and it can be reduced by minimizing orthodontic movements before surgery.[16] By operating with a well-planned surgery-first approach, which does not require any presurgical orthodontics, this issue could be overcome.

This case report demonstrates the successful treatment with a surgery-first approach of a patient that presented skeletal class II malocclusion, anterior open bite, and retrognathia. The aforesaid severe dentoskeletal discrepancies require an interdisciplinary approach between orthodontics and maxillofacial surgery to restore function and esthetics. In addition, dental whitening and prosthodontic treatment were carried out to complete the case, enhancing the final esthetic outcome.

The objective of this article is to provide a description of the case and of its resolution, evaluating the outcomes of the treatment in terms of total duration, stability, and improved esthetics and function. This case report supports the conviction that a surgery-first approach, when carried out with meticulous treatment planning and following the strict parameters for case selection, is an efficient and highly satisfactory alternative to the conventional orthodontics-first method.

2 | CASE DESCRIPTION

2.1 | Anamnesis and diagnosis

A 29-year-old female presented with the main concerns of anterior open bite and impaired facial esthetics due to the lack of chin projection. The patient presented no medical history of relevance. In regard to the dental history, the patient previously suffered trauma in a traffic accident that caused the avulsion of both upper central incisors and the loss of vitality of the upper lateral incisors and canines. To replace the upper central incisors, two implants (TicareÆ inhex std 3.75 × 10 mm) were placed 2 years earlier. In a second phase, a connective tissue graft (CTG) was performed to increase the vestibular volume of the tissue, but ultimately a screw-retained metal-ceramic FP3 (fixed prosthesis 3) was used to replace the papillae, as well as composite veneers on the laterals for esthetic reasons.

On clinical examination, the patient presented a thin periodontal biotype, open bite of 7 mm, Angle class II subdivision right, lower midline deviation to the right of 1.5 mm, occlusal pre-contacts at first premolars on both sides, and mild lower anterior crowding. The facial examination revealed maxillomandibular retrusion, lack of jawline and neck definition, lack of chin projection, and lip incompetence.

Complementary tests performed included extraoral and intraoral photographs (Figures 1 and 2), OPG (Figure 3) and CBCT scan, 3D intraoral scan (Figure 4), and lateral teleradiography. Cephalometric analysis (Figure 5) revealed a skeletal class II relationship, mandibular and maxillary retrusion, a steep mandibular plane angle with clockwise rotation, increased lower facial height indicating mandible and

FIGURE 1 Initial extraoral photographs.

FIGURE 2 Initial intraoral photographs.

FIGURE 3 Initial orthopantomography.

maxillary divergence, a reduced interincisal angle, lower incisor protrusion, and lip protrusion.

2.2 | Virtual treatment planning

A surgery-first approach was chosen for the resolution of this case, mainly because of the patient's esthetic motivation and breathing problems, which would be solved immediately with this protocol. Furthermore, the patient's predicted postoperative occlusion was stable, ensuring the attainability of operating with surgery-first. The features that made this patient an adequate candidate for surgery-first were the mild curve of Spee, slightly proclined lower incisors, mild crowding of anterior inferior teeth, minimal asymmetry of the dental midlines, and moderate transverse discrepancy. The treatment plan started by establishing the surgical treatment objective (STO) (Figure 6) and

FIGURE 4 Initial intraoral scan.

by importing and merging the preoperative CBCT of the patient's face and the intraoral scanning of the upper and lower arches using Dolphin! 3D Orthognathic Surgery Planning Software, Version 11.95 (Figure 7). A virtual orthodontic setup was performed with the software program Nemotec SL, Avenida Juan Caramuel n.1°, 28919, Leganés, Madrid, Spain (Figure 8). The surgical plan (Figure 9, Table 1) included maxillomandibular advancement with counterclockwise rotation to manage the concurrent occlusal, facial and breathing issues. Segmentation of the maxilla was also necessary to address her transverse discrepancy and surgically level her curve of Spee. In addition, an optional genioplasty would have contributed to the improvement of the chin projection and jawline definition, but it was ultimately rejected by the patient. Virtual surgical planning allowed the design and manufacturing of two CAD/CAM surgical splints with a 3D printer: one intermediate to first reposition the mandible, and a final one for maxillary placement. Orthodontic treatment was planned to begin 1 month after orthognathic surgery. During this time, the final surgical splint had to be kept in place to provide stability to the occlusion after maxillary segmentation. The treatment plan included the use of intermaxillary elastics with skeletal anchorage provided by the two upper central incisors implants. Finally, prosthodontic treatment foresaw the placement of a new zirconia implant-supported FP3 for the replacement of the central incisors and gingiva, two lithium desilicated veneers on the lateral incisors, and two composite veneers on the canines.

2.3 | Orthognathic surgery

Surgery was scheduled 4 months after the first visit. One week before the surgery, bonding of the brackets (3M™ Clarity™ Advanced

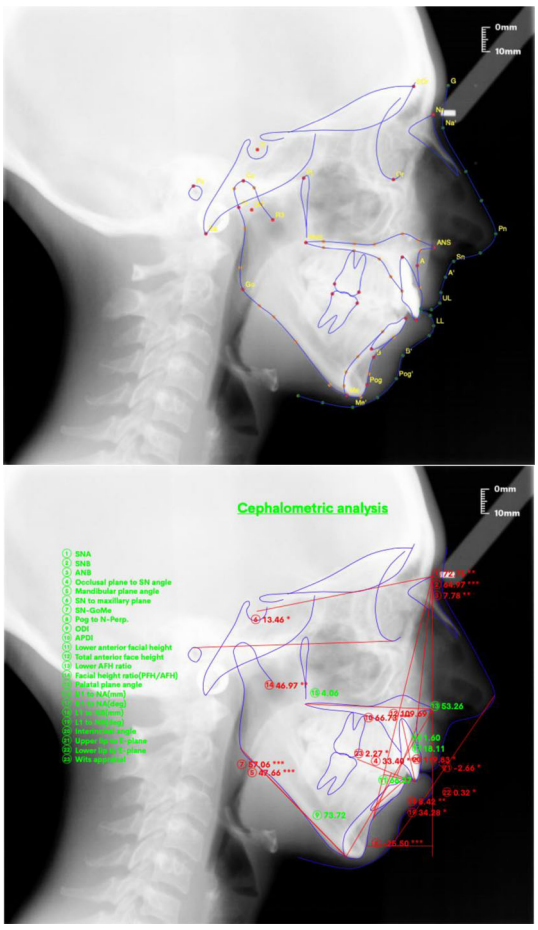

FIGURE 5 Initial cephalometric tracings.

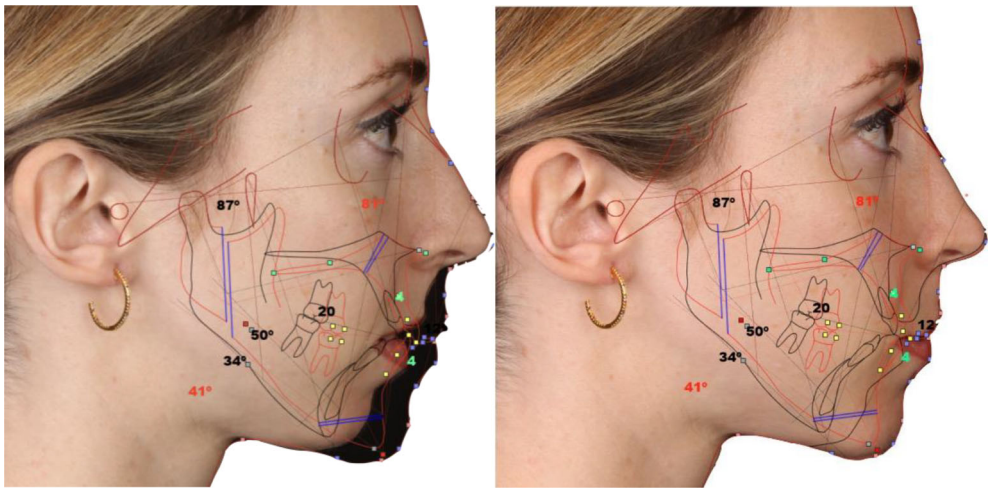

FIGURE 6 Two-dimensional treatment planning. Pre-orthodontics STO (surgical treatment objective).

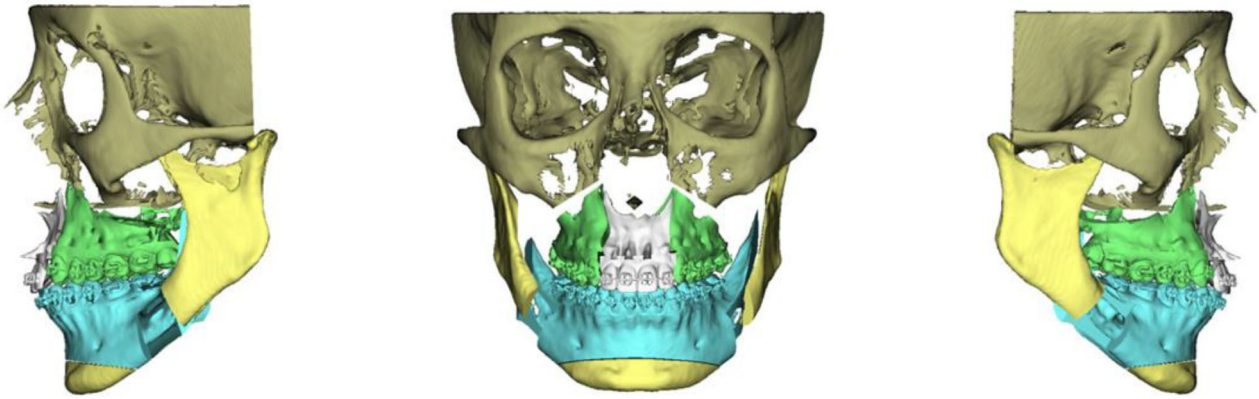

FIGURE 7 Three-dimensional virtual surgical plan.

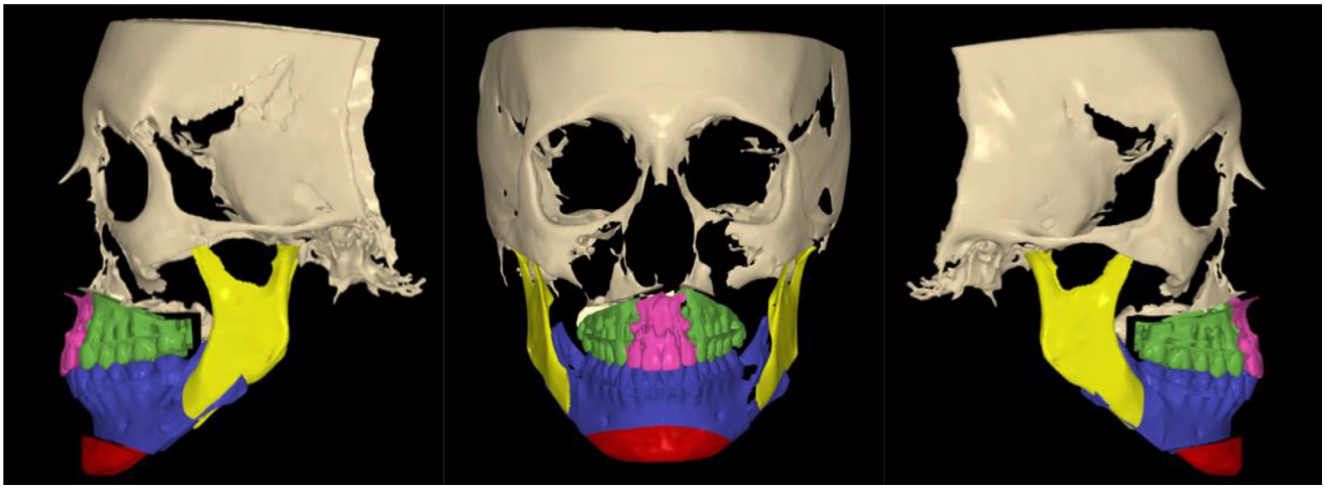

FIGURE 8 Three-dimensional planning. Occlusion setup.

Ceramic Brackets) was carried out (Figure 10). Inactive burned 0.014 NiTi upper and lower archwires were placed. The surgery was performed under general anesthesia, following a mandible-first approach with the execution of bilateral sagittal split osteotomy (BSSO) (Figure 11) to advance the mandible, followed by a segmental LeFort I to reposition the maxilla with the use of an intermendiate splint (Figures 12 and 13). The final splint was left in place for 1 month.

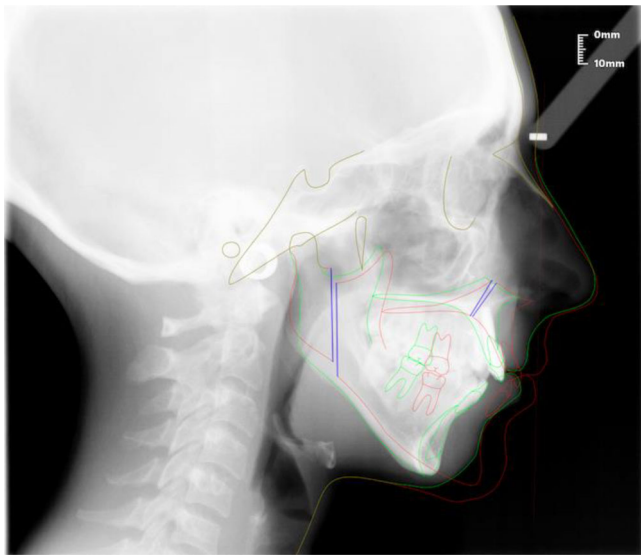

FIGURE 9 Surgery prescription.

TABLE 1 Surgery prescription.

Maxilla		
	A-P (mm)	**Vert (mm)**
ANS	4.5	0.77
PNS	3.45	6.42
Mx1 tip	5.50	1.50
Molar MB cusp tip	8.57	3.57
Mandible		
	A-P (mm)	**Vert (mm)**
Md1 tip	7.97	−1.08
Molar MB cusp tip	7.92	4.79
B point	11.92	1.49
Pogonion	15.06	1.88
Genioplasty	0	0

Note: A positive value indicates forward in anteroposterior (A-P) and downward in vertical (Vert) directions. A negative value indicates backward and upward directions in surgical repositioning, respectively.

2.4 | Orthodontic treatment

Orthodontic treatment was initiated 1 month post-surgery using vertical intermaxillary elastics worn full time. The patient was instructed to perform exercises for muscle rehabilitation. Due to the biological limitation presented by the patient's thin periodontal biotype, lower proximal stripping was performed to reduce lower incisors proclination. The initial archwires were replaced with 0.016 NiTi wires. Two triangle elastics were placed on the hooks from upper canine to lower canine and lower first premolar. One anterior box elastic was attached from upper lateral incisors to lower lateral incisors with some Kobayashi hooks added to the upper anterior teeth. After 2 months, the archwires were replaced with rectangular 0.016 × 0.022 NiTi wires. Two lateral box elastics were placed from canine to first premolar of upper and lower arches. In addition, a power chain was inserted in the lower arch. The archwires were changed after 2 months with 0.017 × 0.025 NiTi wires. Class III elastics were placed on the left side to center the dental midline and achieve adequate dental contacts, establishing an Angle class I canine relationship. A continuous metallic ligature was also inserted in the lower arch. Two months later, A 0.016 NiTi burned (passive) archwire was placed to achieve final intercuspation. Because of the accelerated dental movements during the first postoperative months, appointments were scheduled every 1–2 weeks. The orthodontic treatment was completed in a total of 6 months. After the brackets were debonded (Figures 14-16), retainers were installed. A braided stainless steel wire was used as a fixed retainer, bonded to the lower anterior teeth from canine to canine. In the upper arch, retention was achieved utilizing a vacuum-formed retainer for nighttime wear.

2.5 | Prosthodontic treatment

After orthognathic-orthodontic treatment, a new smile design was continued from canine to canine to restore the dominance of the central incisors. To improve the final esthetic outcome, the patient was

FIGURE 10 Pre-surgical bonding.

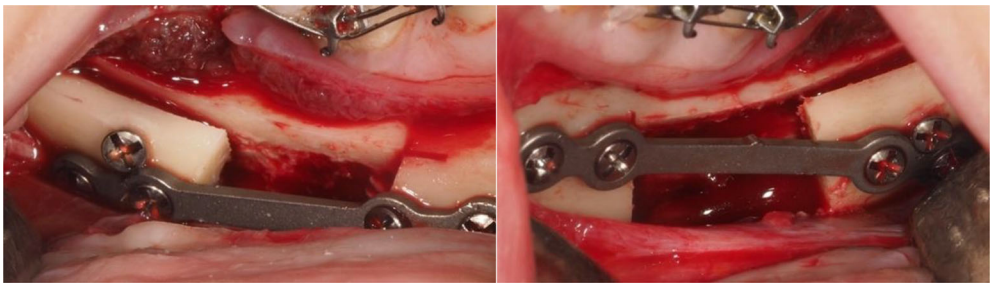

FIGURE 11 Bimaxillary orthognathic surgery. BSSO.

FIGURE 12 Bimaxillary orthognathic surgery. Intermediate splint.

given an at-home whitening product containing carbamide peroxide 16%, applied in thermoplastic splints for 3 weeks, to perform external bleaching of the upper and lower arches. Prosthodontic treatment began with the placement of a new milled acrylic provisional FP3 to replace the central incisors and missing gingiva, and continued with new layered lithium disilicate veneers (E.max press LTA1. Ivoclar Vivadent) for the laterals, according to the previous mock-up (Figure 17). With the veneers cemented for 1 month, a new zirconia (Zr Prime. Ivoclar Vivadent) FP3 was installed on customized screw-retained titanium abutments. Finally, two composite veneers (Filtek supreme body A1. 3M ESPE) were placed on both canines to complete the design and restore the harmony of the smile (Figures 18 and 19).

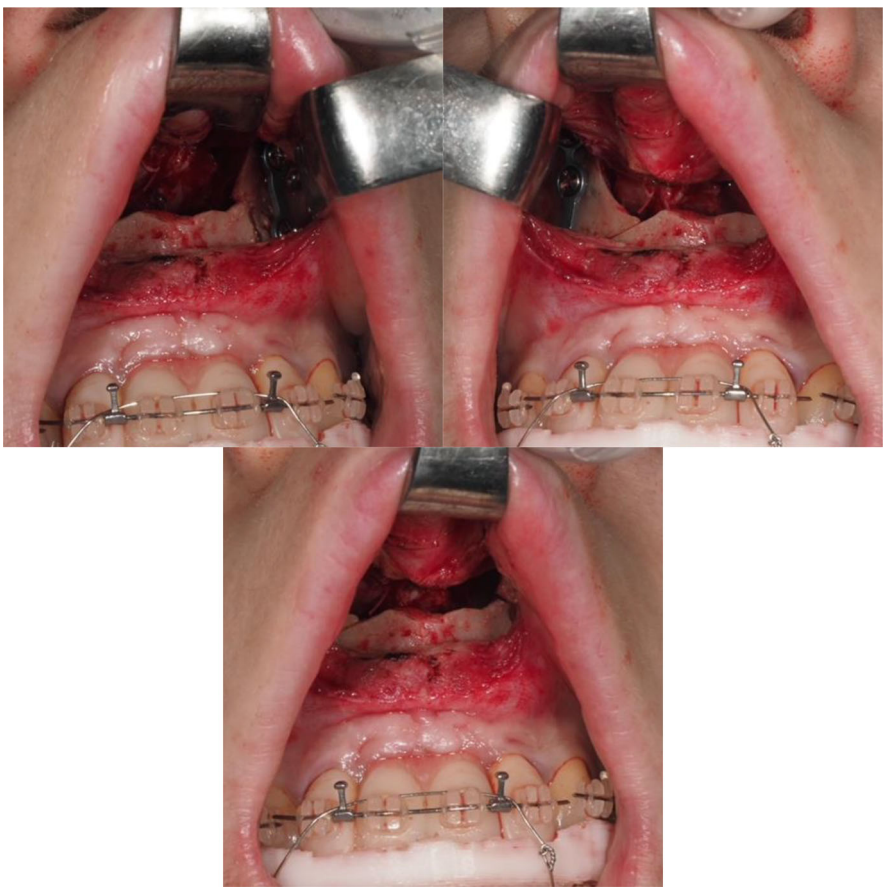

FIGURE 13 Bimaxillary orthognathic surgery. Segmental LeFort I.

FIGURE 14 Results after orthognathic-orthodontic treatment. Extraoral photographs.

2.6 | Treatment results and limitations

The results were satisfactory from the facial and dental point of view, and the patient was extremely pleased. The overall treatment lasted 9 months. On post-surgical cephalometry (Figure 20), an immediate enlargement of the upper airway volume was observed. A decrease in facial convexity and retrognathism were obtained with counterclockwise rotation of the occlusal plane and soft tissue Pogonion advancement, obtaining a harmonic profile (Figures 20 and 21). Results are summarized in Table 2. A canine and molar class I, adequate overjet, and alignment of the teeth were achieved. The lower anterior teeth suffered a slight gingival recession, and a connective tissue graft was

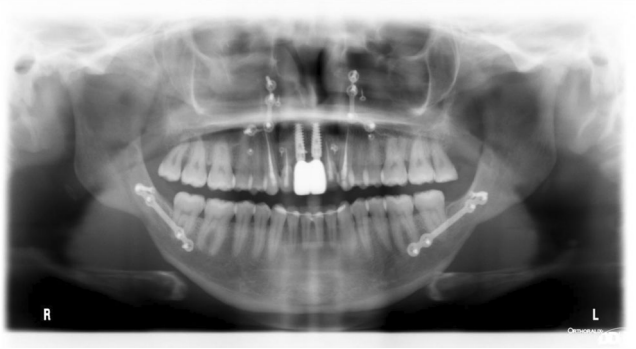

FIGURE 16 Final orthopantomography.

FIGURE 15 Results after orthognathic-orthodontic treatment. Intraoral photographs.

FIGURE 17 Prosthetic phase. Provisional FP3 on 11 and 21. Mock-up on 12 and 22.

FIGURE 18 Photographs of the smile after prosthodontic treatment.

FIGURE 19 Intraoral photographs after prosthodontic treatment.

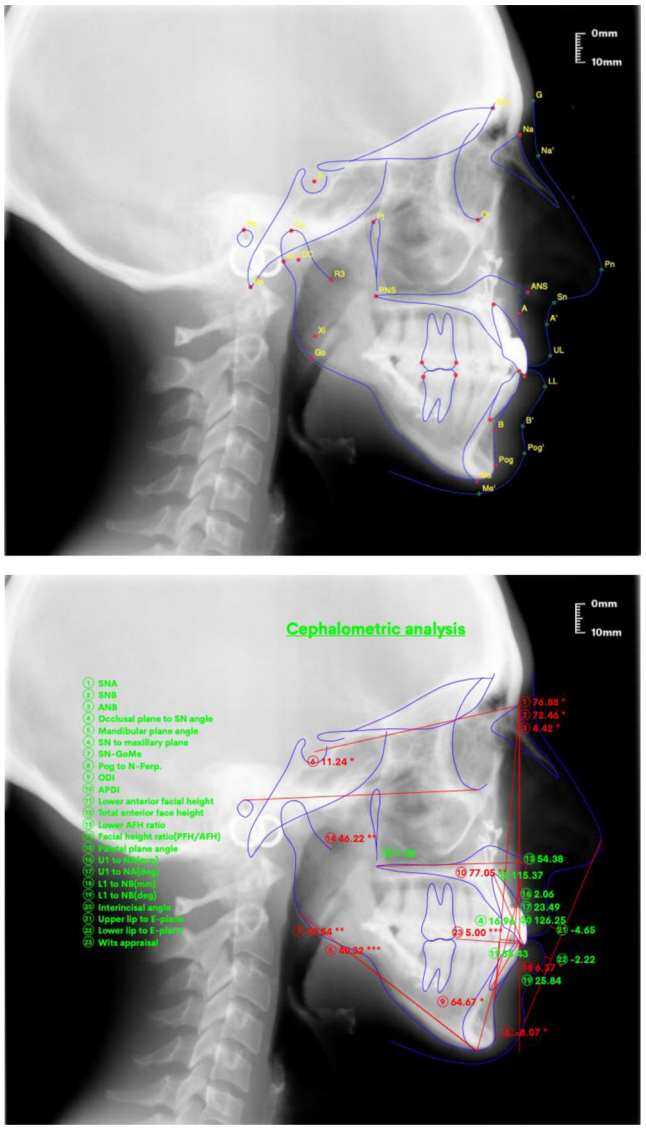

FIGURE 20 Final cephalometric tracings.

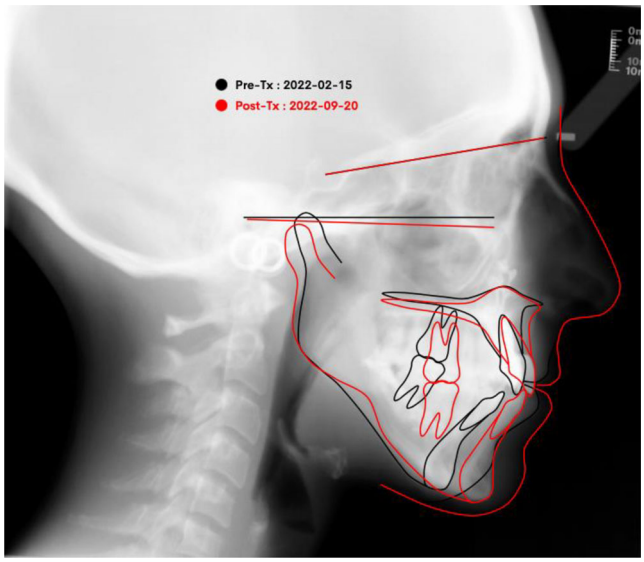

FIGURE 21 Superimposition of pre-treatment and post-treatment cephalometries.

planned for the future. The stability of the occlusion was very high since most of the changes were made before and with surgery, with no short-term relapse encountered clinically after 1 year (Figures 22–24) in terms of overbite values and preservation of anterior guidance. From the orthodontics perspective, the main limitation of the case was the inability to achieve mesiodistal tooth displacement in the upper arch due to the presence of the anterior prosthesis and failure to achieve more overbite, due to the final prosthesis size. From the evaluation of the prosthodontic outcome, the use of biocompatible materials and the fit achieved ensured good behavior of the tissue over time. The major constraint from the periodontal point of view was the achievement of papillae between implants and between implants and lateral incisors.

3 | DISCUSSION

This case exhibits the interdisciplinary treatment of a skeletal class II, anterior open bite malocclusion. For the resolution of this case, the fields of orthodontics, maxillofacial surgery, and prosthodontics were involved. A surgery-first approach was chosen to determine the sequence of treatments, which entailed the immediate surgical correction of the skeletal discrepancy. Subsequently, orthodontic treatment was performed to achieve a balanced occlusion.

The patient's main concern was esthetic, which is reported to be the leading motivation in patients treated with a surgery-first approach.[2] Orthognathic surgery candidates generally suffer from severe facial deformities and, especially those driven by esthetic reasons, could commonly have developed psychosocial problems. A study examined the psychological conditions of individuals treated with surgery-first versus the ones of those treated orthodontically first. This investigation showed a general prevalence of psychological disorders in orthognathic surgery candidates. The last preoperative appointment revealed a difference between the two groups, with the surgery-first group unexpectedly performing worse in terms of physical pain, vitality, social functioning, and mental health. Postoperatively, several psychosocial parameters of surgery-first patients were enhanced compared to the surgery-late cohort.[8] By adopting a surgery-first protocol, the patient perceived a high level of satisfaction immediately after surgery, due to the early improvement of the facial profile appearance and closure of the open bite. As a result, she cooperated well in the post-operative orthodontic phase. These findings are confirmed by another study, which demonstrates that patients treated with a surgery-first approach are more content in the post-surgical period compared to those treated with a traditional protocol. They also present more satisfaction with the overall treatment duration, nonetheless reporting orthodontics to be the most enduring phase.[5] A study investigated how the higher quality of life found in surgery-first patients varies according to demographic factors (age, gender, and dentofacial type), before and after surgery. Females, patients requiring bimaxillary protrusion, and those over 22 years old exhibited worse quality of life.[6] Another investigation included

TABLE 2 Summary of cephalometric analysis.

	Standard	Pre-treatment	Post-treatment
Skeletal			
SNA	81.08° ± 3.70°	72.75°	76.88°
SNB	79.17° ± 3.80°	64.97°	72.46°
ANB	2.46° ± 1.80°	7.78°	4.42°
Occlusal plane to SN angle	14° ± 4°	33.40°	16.96°
Mandibular plane angle	21.9° ± 5°	47.66°	40.32°
SN to maxillary plane	8° ± 3°	13.46°	11.24°
SN-GoMe	34.29° ± 6.40°	57.06°	50.54°
Pog to N-perp.	−1.8 mm ± 4.5 mm	−25.50 mm	−8.07 mm
Wits appraisal	−0.3 mm ± 1.7 mm	2.27 mm	5.00 mm
Overbite depth indicator (ODI)	74.5° ± 6°	73.72°	64.67°
Anteroposterior dysplasia indicator (APDI)	85.74° ± 4°	66.73°	77.05°
Lower anterior facial height	66.7 mm ± 4.1 mm	66.37 mm	65.43 mm
Total anterior facial height	119 mm ± 5 mm	109.69 mm	115.37 mm
Lower AFH ratio	55% ± 2%	53.26%	54.38%
Facial height ratio (AFH/PFH)	65.3% ± 8.8%	46.97%	46.22%
Palatal plane angle	0° ± 5°	4.06°	1.02
Dental			
U1 to NA (mm)	4 mm ± 3 mm	1.60 mm	2.06 mm
U1 to NA (°)	22° ± 5°	18.11	23.49°
L1 to NB (mm)	4 mm ± 2 mm	8.42 mm	6.37 mm
L1 to NB (°)	25° ± 5°	34.28°	25.84°
Interincisal angle	130° ± 5.8°	119.83°	126.25°
Soft tissues			
Upper lip to E-plane	−4.7 mm ± 2 mm	−2.66 mm	−4.65 mm
Lower lip to E-plane	−2 mm ± 2 mm	0.32 mm	−2.22 mm

patients with similar demographic characteristics divided into surgery-first and orthodontics-first groups, and it did not report any significant differences between the two cohorts in terms of postoperative quality of life. In this case, more dissatisfaction was observed among patients treated with the traditional approach only before surgery, particularly with regard to the social element.[4] The research on the changes in the psychosocial state of patients treated with surgery-first appears to be heterogeneous. Different evaluation methods and timings were utilized, therefore requiring standardization and longer follow-up to address the outcomes.

The additional advantage of using a surgery-first approach for the resolution of this case, and in general considered one of the main benefits of this approach, is the reduction of the total duration of the treatment. In this case, the post-surgical orthodontic treatment lasted 6 months, which is slightly less than the average 9–15 months described in previous studies.[1,10] Orthodontic treatment was initiated 1 month after orthognathic surgery, partly taking advantage of the RAP and SAP which appear to be increased in the first 2 months after surgery.[1,3] The skeletal anchorage provided by the implants is an additional factor that might have shortened the treatment duration. One study analyzes the factors that play a role in the treatment duration, revealing that dental crowding, increased arch length discrepancy, anterior open bite, and requirement for orthodontic extractions implied a significant extension of treatment. In the virtual occlusion setup, a molar class I, adequate overbite, correct dental midline position, and an increased number of contact points (at least four bilateral posterior contacts) positively influenced the duration of treatment.[9]

The recent advances in digital dentistry allow the anticipation of the final occlusion three-dimensionally, using CBCT and intraoral digital scanning. Several articles provide guidelines and measure the accuracy of the pre-operative setup. The objective of the setup is to plan the tooth movements that will be carried out after surgery in order to achieve an ideal occlusion. It is fundamental to accurately predict the surgical and orthodontic movements for the treatment success, since any minor inaccuracy could impair the final outcome. Previous research concluded that the accuracy of the surgical and occlusion setup is satisfactory and should be implemented in the digital flow of surgery-first planning.[7,13,14] In the resolution of this case, the virtual planning work-up started by merging the preoperative

FIGURE 22 Extraoral photographs at the 12 months follow-up.

CBCT scan of the patient's head and face and the intraoral scanning of the arches, using Dolphin! 3D Orthognathic Surgery Planning Software, Version 11.95. A 3D virtual orthodontic setup (Nemotec SL, Avenida Juan Caramuel n.1°, 28919, Leganés, Madrid, Spain) was created to predict the final occlusion. Finally, the surgical movements were established.

The patient met the inclusion criteria indicated in literature for this approach. She did not present any asymmetries that would require SARPE, severe crowding, periodontal and TMJ acute symptoms, and a class I occlusion with virtual orthodontic setup was achieved.[1,3] A large number of existing studies focus on class III cases, but it is indicated for class II first division malocclusions as well. The rationale behind this could be the added benefit that this approach offers in particular to class III patients, by eliminating the pre-surgical decompensation phase that could exacerbate the patients' deformity.[3]

In terms of stability, the patient did not present overbite relapse after 1 year. Despite the controversy regarding three-dimensional stability when operating with a surgery-first approach, the literature evaluation shows no differences between the surgery-first and surgery-late approaches. Post-surgical relapse is more prevalent when a setback movement is performed, affecting mainly the mandible, and is directly proportional to the amount of displacement required.[3] However, the lack of homogeneity among studies and the need for extended follow-up prevent the assessment of the actual long-term post-treatment stability.[3,15]

FIGURE 23 Photographs of the smile at the 12 months follow-up.

FIGURE 24 Intraoral photographs at the 12 months follow-up.

4 | CONCLUSIONS

AB case treated with a surgery-first approach was presented. A description of each part of the interdisciplinary treatment, involving orthognathic surgery, orthodontics and prosthodontics, was provided. For the presented case, using a surgery-first approach significantly reduced treatment duration, obtaining satisfactory results in both function and esthetics. Furthermore, the results were stable over the course of 1 year, demonstrating the success of the surgery-first protocol, nevertheless requiring a long-term follow-up due to the high rates of relapse encountered with open bite malocclusions.

AUTHOR CONTRIBUTIONS

All of the authors contributed to the writing of the manuscript, as well as the reading and approval of the final manuscript. The experts that worked on this case are Dr. Raúl Ferrando Cascales, Dr. Álvaro Ferrando, and Dr. Federico Hernández Alfaro. Francesca Casolari conducted the literature research and Dr. Mayra Lucero Berdugo provided technical support throughout the writing process.

CONFLICT OF INTEREST STATEMENT

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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