Orthodontic Decompensation and Virtual Surgical Planning-Assisted Bimaxillary Correction of Severe Skeletal Class III Malocclusion: A Case Report

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Abstract
Background: Severe skeletal Class III malocclusion in adults commonly requires combined orthodontic and orthognathic treatment. Presurgical dental decompensation permits accurate correction of the underlying skeletal discrepancy, while virtual surgical planning facilitates controlled three-dimensional repositioning of the jaws.
Case presentation: A 24-year-old woman presented with a forwardly positioned lower jaw and irregular teeth. Examination revealed a concave facial profile, increased lower facial height, reverse overjet, maxillary constriction, crowding, and bilateral Class III canine relationships. Cephalometric analysis showed mandibular prognathism, with an SNA angle of 80°, SNB angle of 87°, ANB angle of −7°, and Wits appraisal of −7 mm. Presurgical orthodontics was undertaken using a 0.022-inch MBT appliance. The mandibular incisors were decompensated from an incisor mandibular plane angle of 74° to 90°. Virtual planning incorporated 4-mm maxillary advancement, 2° leftward maxillary yaw rotation, and 5-mm mandibular setback. Bimaxillary surgery was performed using a Le Fort I osteotomy and bilateral sagittal split osteotomy. Postoperative analysis showed an SNA angle of 83°, SNB angle of 80°, ANB angle of 3°, and Wits appraisal of 0 mm. Healing was uneventful, with satisfactory facial, skeletal, and occlusal correction.
Conclusion: Coordinated orthodontic decompensation and three-dimensional bimaxillary repositioning produced effective correction of the severe skeletal Class III discrepancy. Virtual planning was particularly useful for distributing the sagittal correction and addressing the associated midline discrepancy.
Keywords: Computer-aided design; Mandibular prognathism; Orthodontic decompensation; Surgical splints; Treatment planning
How to cite this article: SameP. Narkhede, Karthick D. Shetty, Sushma U. Tambe, Ankita H. Sanil, Nitin D. Gadhiya, Mukul N. Padhye, Manali H. Patil, Adwait B. Thatte. Orthodontic Decompensation and Virtual Surgical Planning-Assisted Bimaxillary Correction of Severe Skeletal Class III Malocclusion: A Case Report. Int J Drug Deliv Technol. 2026;16(79s):1125-1130. DOI: 10.25258/ijddt.16.79s.187

.Introduction

Skeletal Class III malocclusion represents a complex dentofacial deformity resulting from maxillary deficiency, mandibular excess, or a combination of both. Affected individuals may present with reverse overjet, anterior or posterior crossbite, facial concavity, functional difficulty, and dissatisfaction with facial appearance. These problems can adversely influence oral health-related quality of life, particularly in patients with severe skeletal discrepancies requiring surgical correction [1].

Dentoalveolar compensation commonly develops in response to the underlying skeletal discrepancy. In skeletal Class III patients, the maxillary incisors may be proclined and the mandibular incisors retroclined, thereby reducing the apparent severity of the reverse overjet. Presurgical orthodontic treatment aims to eliminate these compensations, coordinate the arches, and position the teeth over their supporting basal bone. Although decompensation may temporarily worsen the facial profile and sagittal dental relationship, it permits a more complete skeletal correction during orthognathic surgery [2].

Conventional planning using cephalometric prediction tracing, mounted dental casts, and model surgery remains clinically useful. However, these methods have limitations when yaw, roll, occlusal cant, and facial asymmetry require correction. Three-dimensional virtual surgical planning allows detailed visualization of the craniofacial skeleton, simulation of segmental movements, evaluation of intermediate and final jaw positions, and fabrication of surgical splints [3]. Clinical studies have demonstrated acceptable agreement between virtually planned and surgically achieved jaw positions [4]. This report describes the orthodontic-surgical management of severe skeletal Class III malocclusion using presurgical orthodontic decompensation, virtual planning, Le Fort I maxillary advancement, and bilateral sagittal split mandibular setback.

Case Presentation

Patient information and clinical examination

A 24-year-old woman reported to the Department of Orthodontics and Dentofacial Orthopedics with the chief complaint of a forwardly positioned lower jaw and irregularly positioned teeth. She was systemically healthy, with no condition contraindicating comprehensive orthodontic treatment or orthognathic surgery.

Extraoral examination revealed a concave facial profile, prominent lower jaw, and increased lower facial height. The prominence of the chin and lower lip contributed to an unbalanced sagittal relationship. Frontal evaluation indicated a dental midline discrepancy requiring transverse correction during surgical planning.

Intraoral examination showed an Angle Class III malocclusion with bilateral Class III canine relationships and reverse overjet. The maxillary arch was constricted and showed anterior crowding. Rotations were present in relation to teeth 12 and 24. Tooth 14 was absent. The mandibular arch showed anterior crowding and marked retroclination of the mandibular incisors, representing dentoalveolar compensation for the skeletal discrepancy. Pretreatment extraoral and intraoral findings and lateral cephalogram are presented in Figure 1.

Figure 1: Pre-operative photographs of a) lateral facial profile, b) occlusal relation, and c) lateral cephalogram

Radiographic and cephalometric assessment

The panoramic radiograph did not demonstrate any finding that prevented orthodontic-surgical treatment. The pretreatment lateral cephalogram confirmed a severe skeletal Class III relationship predominantly resulting from mandibular prognathism. The SNA angle was 80°, whereas the SNB angle was 87°, producing an ANB angle of −7°. The Wits appraisal was −7 mm.

The mandibular incisors were markedly retroclined, with a lower incisor-NB relationship of 2 mm/8°, incisor mandibular plane angle (IMPA) of 74°, and lower incisor-A-Pogonion distance of −5 mm. The interincisal angle was increased to 157°, further demonstrating dental compensation. The nasolabial angle was 101°. The combined clinical and cephalometric findings supported a diagnosis of severe skeletal Class III dentofacial deformity associated with mandibular prognathism, maxillary transverse constriction, dentoalveolar compensation, reverse overjet, and crowding in both dental arches.

Treatment objectives and planning

The treatment objectives were to:

- Correct the skeletal Class III discrepancy
- Reduce mandibular prognathism and improve the facial profile
- Establish a positive overjet and overbite
- Correct maxillary and mandibular crowding
- Decompensate the mandibular incisors
- Coordinate the maxillary and mandibular arches
- Correct dental rotations and midline discrepancy
- Obtain bilateral Class I canine relationships
- Establish a stable functional occlusion

Orthodontic camouflage was considered unsuitable because of the magnitude of the skeletal discrepancy, concave profile, reverse overjet, and existing mandibular incisor compensation. A combined orthodontic-orthognathic approach was therefore selected. The proposed treatment, anticipated changes in facial appearance, surgical risks, and need for postoperative orthodontic finishing were explained to the patient. Written informed consent was obtained.

Presurgical orthodontic treatment

Fixed orthodontic treatment was initiated using a preadjusted edgewise appliance with a 0.022-inch MBT prescription. Tooth 24 was extracted to complement the pre-existing absence of tooth 14 and facilitate alignment and arch coordination. A transpalatal arch was used for anchorage, and the maxillary and mandibular second molars were banded.

Sequential archwires were used for leveling and alignment of both arches. Dental rotations were corrected, and the extraction space was closed using active tiebacks. Particular attention was directed toward proclination of the compensated mandibular incisors and coordination of the transverse arch relationship.

At the completion of presurgical orthodontics, the mandibular incisor-NB relationship had increased from 2 mm/8° to 4 mm/28°, while the IMPA increased from 74° to 90°. The interincisal angle decreased from 157° to 137.5°. These changes demonstrated effective mandibular incisor decompensation. Consequently, the skeletal discrepancy became more apparent, with the ANB angle remained −7° and the Wits appraisal from −7 to −8 mm. The maxillary and mandibular arches were sufficiently aligned and coordinated for surgical correction. The extraoral and intraoral profiles at this stage are depicted in Figure 2.

Figure 2: Intraoperative photographs of a) lateral facial profile, b) occlusal relation, and c) lateral cephalogram

Conventional and virtual surgical planning

Initial surgical prediction tracing suggested the requirement for substantial mandibular setback. Conventional model surgery was subsequently performed to evaluate occlusal compatibility and the anticipated maxillomandibular movements. Surgical splints were fabricated to transfer the intermediate and final jaw positions.

Three-dimensional virtual surgical planning was then undertaken using the craniofacial and dental records. The simulation allowed the sagittal correction to be distributed between the maxilla and mandible while simultaneously addressing the dental midline discrepancy. The final plan consisted of:

- Maxillary advancement of 4 mm
- Maxillary yaw rotation of 2° toward the left
- Mandibular setback of 5 mm
- Establishment of a coordinated final occlusion

The intermediate and final skeletal positions were assessed in the frontal, lateral, and inferior views. Soft-tissue simulation was also used to evaluate the anticipated changes in the facial profile. The virtual plan and surgical splints were verified before surgery.

Surgical procedure

Bimaxillary orthognathic surgery was performed under general anesthesia. A Le Fort I osteotomy was completed through an intraoral approach, followed by controlled downfracture and mobilization of the maxilla. Bilateral sagittal split osteotomies were performed to permit posterior repositioning of the mandibular tooth-bearing segment.

The maxilla was advanced by 4 mm and rotated by 2° toward the left to improve the maxillary midline relationship. Its position was transferred using the intermediate surgical splint. The maxilla was stabilized using rigid internal fixation with titanium miniplates and screws.

The mandible was subsequently repositioned posteriorly by 5 mm. The final occlusal relationship was established with the definitive surgical splint. The proximal segments were positioned appropriately, and the mandible was stabilized using rigid internal fixation. The condylar position, dental midlines, transverse relationship, and occlusion were verified before closure. The operative sites were irrigated, hemostasis was achieved, and the intraoral incisions were closed.

The intraoperative course was uneventful. No unfavorable osteotomy split, excessive hemorrhage, infection, or other surgical complication occurred. The surgical procedures are demonstrated in Figure 3.

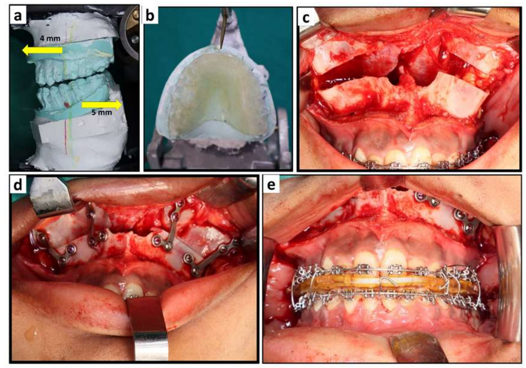

Figure 3: a) Advancement of maxilla by 4 mm and mandibular setback by 5 mm in the model; b) fabrication of splint; c) Le Fort I osteotomy; d) stabilization by titanium miniplates and screws; e) Stabilization of mandible by rigid internal fixation

Postsurgical orthodontics and outcome

Postoperative healing proceeded without complication. Guiding elastics and routine postoperative instructions were provided. Orthodontic finishing and settling were undertaken after adequate healing to refine intercuspation, coordinate the dental midlines, and establish stable overjet and overbite.

At the completion of treatment, the patient demonstrated an improved facial profile, correction of mandibular prominence, and a balanced maxillomandibular relationship. A positive overjet and overbite were established, and bilateral Class I canine relationships were achieved. The maxillary and mandibular dental midlines showed satisfactory coordination. No persistent neurosensory disturbance was present, and the occlusion remained stable during subsequent clinical reviews.

Postoperative cephalometric evaluation demonstrated an SNA angle of 83° and an SNB angle of 80°. The ANB angle improved from −7° pretreatment and presurgically to 3° postoperatively. The Wits appraisal improved from −7 to 0 mm. The angle of convexity changed from −7° to +1°, confirming correction of the concave skeletal profile.

The postoperative upper incisor-NA and lower incisor-NB relationships were 4 mm/18° and 4 mm/24°, respectively. The IMPA remained stable at 90°, demonstrating maintenance of the achieved mandibular incisor decompensation. The lower incisor-A-Pogonion relationship improved from −5 to 1 mm, and the postoperative interincisal angle was 139°. The nasolabial angle remained within an acceptable range at 100°. The principal cephalometric changes are summarized in Table 1 and depicted through a 3D Diagram in Figure 4. The post-operative clinical profile photographs are shown in Figure 5.

Table 1. Cephalometric changes during treatment

Variable	**Pretreatment**	**Presurgical**	**Postoperative**
SNA	80°	80°	83°
SNB	87°	87°	80°
ANB	−7°	−7°	3°
Wits appraisal	−7 mm	−8 mm	0 mm
FMPA	24°	28°	32°
GoGn-SN	24°	29°	28°
Y-axis	59°	59°	61°
Facial angle	91°	90°	83°
Angle of convexity	−7°	−7°	+1°
A-B plane angle	+5°	−2°	−6°
Upper incisor-NA	5 mm/20°	3 mm/18°	4 mm/18°
Lower incisor-NB	2 mm/8°	4 mm/28°	4 mm/24°
IMPA	74°	90°	90°
Interincisal angle	157°	137.5°	139°
Occlusal plane angle	11°	14°	14°
Nasolabial angle	101°	108°	100°
Anterior facial height, N-Me	110 mm	114 mm	113 mm
Posterior facial height, S-Go	77 mm	76 mm	76 mm
Jarabak ratio	70%	66.62%	67.25%

Abbreviations: FMPA, Frankfort mandibular plane angle; IMPA, incisor mandibular plane angle; N-Me, nasion to menton; S-Go, sella to gonion.

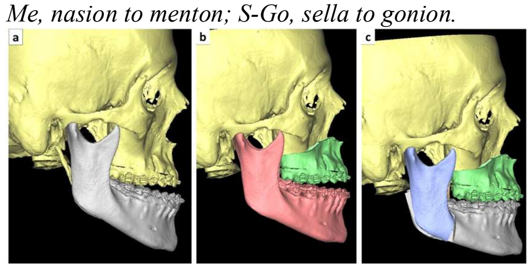

Figure 4: 3D reconstruction of a) pre-operative, b) intra-operative, and c) post-operative lateral facial profile

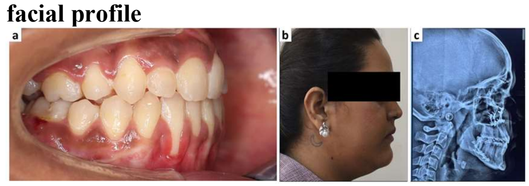

Figure 5: Post-operative profile photographs of the patient - a) intraoral and b) extraoral

Discussion

The present case demonstrates the correction of a severe skeletal Class III dentofacial deformity through coordinated orthodontic decompensation and bimaxillary surgery. The pretreatment SNA angle was within the normal range, whereas the SNB angle was markedly increased. Thus, mandibular prognathism was the principal contributor to the sagittal discrepancy. Nevertheless, isolated mandibular setback would have required a comparatively larger posterior movement and would not have addressed the maxillary midline discrepancy. Distributing the correction between 4-mm maxillary advancement and 5-mm mandibular setback allowed improvement of the sagittal relationship without relying excessively on movement of either jaw.

Presurgical orthodontic decompensation was an essential component of treatment. The mandibular incisors initially showed marked lingual compensation, with an IMPA of 74° and lower incisor-NB inclination of only 8°. Proclination to an IMPA of 90° exposed the actual skeletal discrepancy and created a dental relationship compatible with complete surgical correction. Similar investigations have shown that the amount of mandibular incisor decompensation can influence the magnitude of skeletal correction and the long-term dental relationship [2]. Three-dimensional studies have also demonstrated that mandibular incisor proclination during decompensation is associated with remodeling of the symphyseal region [5].

Therefore, decompensation must be performed within the anatomical limits of the alveolar housing. The worsening of the ANB angle from −5° to −7° during the orthodontic phase should not be interpreted as treatment deterioration. Orthodontic removal of dentoalveolar compensation often makes the reverse overjet and facial discrepancy appear more severe immediately before surgery. This temporary change is intentional because it prevents residual dental compensation from restricting the surgical movements. The maintenance of an IMPA of 90° postoperatively indicates that the surgical correction was not obtained through renewed mandibular incisor compensation.

Bimaxillary surgery was selected to obtain balanced skeletal and soft-tissue correction. Long-term evaluation of Class III patients treated using Le Fort I advancement and BSSO setback has shown generally satisfactory skeletal and occlusal stability, although relapse may be influenced by the magnitude and direction of movement [6]. In the present case, the movements were moderate and distributed between the jaws. This reduced the need for an excessive mandibular setback and allowed independent correction of the maxillary midline. The postoperative improvement from an ANB angle of −7° to 3° and Wits appraisal of −7 to 0 mm confirmed effective normalization of the maxillomandibular relationship.

Virtual planning was valuable because the required correction was not limited to anteroposterior movement. The 2° maxillary yaw rotation allowed controlled correction of the midline discrepancy, which is difficult to evaluate completely using two-dimensional prediction tracing alone. Prospective evaluation of computer-assisted surgical simulation has demonstrated clinically acceptable transfer of planned jaw positions using computer-generated splints [3]. Zhang et al. reported mean linear and angular differences of 0.81 mm and 0.95°, respectively, between planned and postoperative positions during two-jaw surgery [4]. Virtual model surgery has also shown maxillary positioning accuracy comparable to conventional articulator-based model surgery while avoiding several laboratory transfer steps [7].

Conventional model surgery was retained as an additional method of confirming dental intercuspation and splint design. This combined approach was suitable because the conventional models provided direct assessment of the planned occlusion, whereas virtual planning offered better visualization of the skeletal asymmetry and yaw correction. Nevertheless, the accuracy of the final result still depends on precise osteotomy execution, stable condylar positioning, correct use of surgical splints, and rigid fixation. Differences between planned and achieved Le Fort I movements may occur even with careful planning, emphasizing the need for intraoperative verification of the maxillary position [8].

The postoperative vertical measurements demonstrated a controlled increase in FMPA, while the GoGn-SN angle and anterior facial height remained relatively stable. The resulting skeletal changes improved facial convexity from −7° to +1°. Soft-tissue response following bimaxillary surgery is influenced by the direction and magnitude of movement, preoperative tissue thickness, and changes in facial height [9]. Moderate maxillary advancement combined with mandibular setback generally produces a more convex profile by increasing midfacial support and reducing lower facial prominence [10]. In this patient, the postoperative nasolabial angle remained acceptable at 100°, suggesting that maxillary advancement improved skeletal support without producing excessive alteration of the upper lip relationship.

Surgical orthodontic treatment can also improve patient-centered outcomes. Prospective studies have demonstrated improvement in condition-specific quality of life following correction of skeletal Class III deformity, despite temporary deterioration during the decompensation phase [11]. The patient in the present report was satisfied with the improvement in facial appearance and occlusion. Healing was uneventful, and no persistent sensory disturbance was observed. This is clinically relevant because altered sensation involving the inferior alveolar nerve remains a recognized complication of BSSO [12].

The principal limitation of this report is that it represents the outcome of a single patient. Furthermore, direct three-dimensional superimposition of the planned and achieved skeletal positions was not performed. Thus, the numerical accuracy with which the virtual movements were transferred could not be quantified. Nevertheless, the postoperative clinical and cephalometric findings demonstrated correction of the skeletal discrepancy, maintenance of incisor decompensation, and satisfactory occlusal and facial outcomes.

Conclusion

Presurgical orthodontic decompensation followed by Le Fort I advancement and BSSO setback effectively corrected the severe skeletal Class III discrepancy in this patient. Virtual planning facilitated distribution of the sagittal movement and controlled maxillary yaw correction, resulting in a balanced skeletal relationship, improved facial profile, and stable functional occlusion.

Conflict of Interest

The authors declare no conflict of interest.

Funding

No external funding was received.

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