CASE REPORT

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Staged reconstruction of panfacial trauma involving a comminuted mandibular fracture: a case report

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Abstract (J Korean Assoc Oral Maxillofac Surg 2026;52:200-207)

Comminuted mandibular fractures (CMFs) associated with panfacial trauma are challenging because restoration of skeletal continuity does not necessarily re-establish functional occlusion or facial form. We report a staged multidisciplinary rehabilitation in a 34-year-old man who sustained severe craniofacial injuries in an industrial explosion, including a CMF, multiple midfacial fractures, and extensive anterior maxillary destruction. Initial treatment consisted of hemorrhage control, top-down open reduction and internal fixation, and simultaneous orbital floor reconstruction. Because severe mandibular comminution and fragment interference prevented safe restoration of the mandibular arch and occlusion, stable skeletal fixation was prioritized and the potential need for delayed correction was recognized intraoperatively. After osseous union, persistent mandibular arch discrepancy and malocclusion were reassessed, and definitive corrective surgery was planned using right sagittal split ramus osteotomy and anterior mandibular vertical osteotomy. Subsequent rehabilitation included rhinoplasty, anterior maxillary reconstruction with an autogenous mandibular body block bone graft, implant placement, and prosthetic treatment. The staged approach achieved clinically acceptable occlusion, satisfactory masticatory function, and improved facial symmetry. This case suggests that delayed corrective surgery after skeletal healing can provide a practical pathway when immediate occlusal restoration is unsafe during primary fixation.

Key words: Mandibular fractures, Facial injuries, Internal fracture fixation, Orthognathic surgical procedures, Dental implants

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I. Introduction

The mandible is the most frequently fractured bone of the facial skeleton because of its prominent position and structural characteristics[1]. Comminuted mandibular fractures (CMFs), which typically result from high-energy trauma, are particularly difficult to manage because fragmentation, vascular compromise, loss of occlusal stability, and disruption of mandibular continuity complicate anatomical and functional reconstruction[2].

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Open reduction and internal fixation (ORIF) is the standard treatment for CMFs[3,4], but stable fixation and osseous union do not necessarily restore mandibular arch form, condylar position, or functional occlusion[4]. These limitations are amplified in panfacial trauma, especially when reliable skeletal and dental reference points are lost and extensive alveolar defects coexist[5,6].

In such cases, reconstruction may need to extend beyond primary fixation to include delayed correction of residual skeletal deformity, alveolar reconstruction, and dental rehabilitation. Multidisciplinary coordination is also essential when orbital, otologic, nasal, and soft-tissue injuries must be treated in parallel[7-9]. Nevertheless, reports describing how these procedures can be integrated into a coherent, staged treatment pathway remain limited.

Herein, we present a severe CMF associated with panfacial trauma in which the reconstructive plan evolved according to intraoperative findings and residual functional needs. Primary ORIF restored skeletal continuity but could not safely re-establish the mandibular arch or occlusion; secondary

mandibular corrective surgery was therefore performed after fracture healing, followed by alveolar, prosthetic, and aesthetic rehabilitation.

II. Case Report

A 34-year-old man presented to the emergency department of a regional trauma center on July 19, 2021, after an industrial explosion. He had no significant medical history. His Glasgow Coma Scale score was 15 (E4V5M6), and he reported severe facial pain, profuse bleeding, and dyspnea.

A penetrating wound extended approximately 7 cm from the submental region toward the left side. A heavy metal plate had struck the patient's face, producing Le Fort I, II, and III fractures, a severe CMF involving the condylar region, extensive destruction of the anterior maxillary alveolar process, and complete loss of the anterior maxillary dentition.(Fig. 1)

Immediate management focused on hemorrhage control. Endovascular embolization was performed for the bilateral internal maxillary arteries, the left facial artery, and a traumatic arteriovenous fistula between the left middle meningeal artery and vein using gelatin sponge particles (EG-Gel, 1,000-1,400 μm; Engain Co.).

On July 26, 2021, one week after injury, ORIF was performed for the panfacial fractures. Because of extensive mandibular comminution and loss of continuity, a load-bearing reconstruction plate was applied along the inferior border for bridging fixation, while less comminuted segments were stabilized with miniplates.(Fig. 2)

Le Fort II and III fractures were addressed. A top-down reduction sequence was used. The Le Fort II and III fractures were approached through lateral eyebrow and infraorbital incisions, and the frontozygomatic sutures and infraorbital rims were fixed first. The Le Fort I fracture was then reduced through an intraoral approach.

This sequence was selected because the severely comminuted mandible could not serve as a reliable reference for mandibular height, transverse arch form, or occlusion. In contrast, the upper midface retained more reproducible anatomical landmarks; the reconstructed maxilla was therefore used to guide mandibular reduction and occlusal alignment.

Postoperative intermaxillary fixation was not maintained because of maxillary instability and airway concerns, which further limited immediate occlusal stabilization.

Bilateral orbital floor fractures had been confirmed preoperatively in consultation with the ophthalmology department and were reconstructed during the same operation.

The pre-existing facial wound was used to access the mandible and minimize additional soft-tissue injury. Viable fragments were preserved, and excessive periosteal stripping was avoided. A fragment containing the two mandibular central incisors was retained for possible later orthodontic or surgical repositioning.

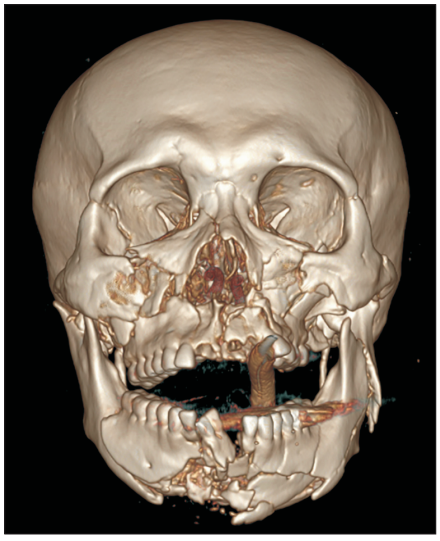


Fig. 1. Preoperative three-dimensional facial computed tomography reconstruction showing panfacial fractures, severe comminution of the mandible, and extensive destruction of the anterior maxillary alveolar region.
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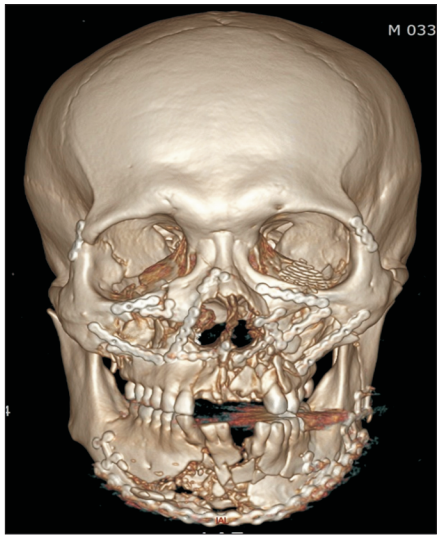


Fig. 2. Postoperative three-dimensional computed tomography reconstruction after open reduction and internal fixation of the panfacial fractures. Mandibular continuity was restored using a load-bearing reconstruction plate along the inferior border, with additional miniplate fixation of the less comminuted segments.
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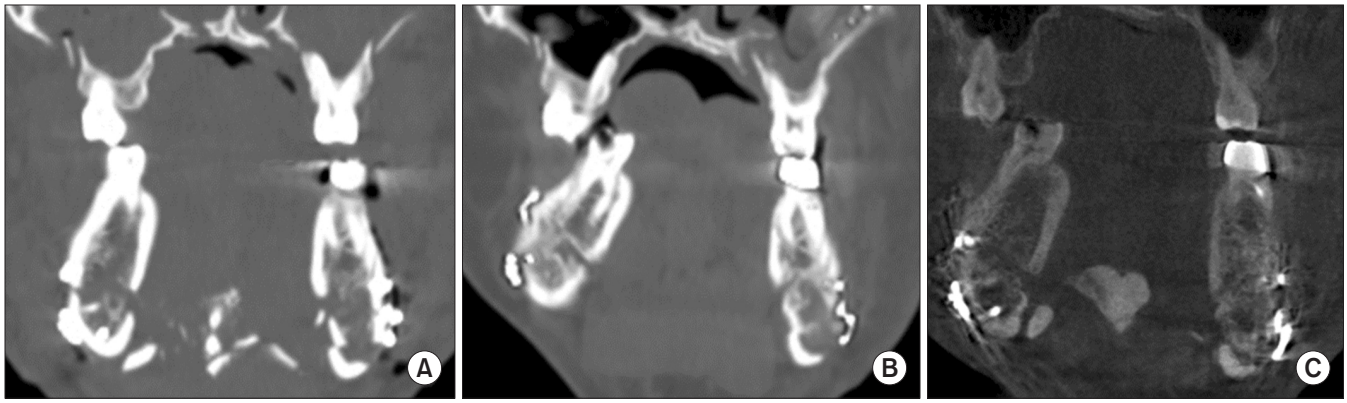


Fig. 3. Serial coronal computed tomography images showing persistence of the right-sided mandibular arch discrepancy after primary open reduction and internal fixation. A. Immediate postoperative image showing residual transverse malalignment of the right mandibular posterior segment. B. Follow-up image obtained approximately 3 months after primary fixation, demonstrating progressive osseous healing with persistent lingual displacement of the right mandibular posterior segment. C. Preoperative image obtained before secondary mandibular corrective surgery, showing continued right-sided malocclusion despite osseous union.
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Interference among the comminuted fragments prevented complete restoration of the mandibular arch. Although continuity and gross alignment were achieved, separation remained in the right premolar region, with lingual displacement of the right mandibular posterior segment. Further manipulation was considered likely to compromise fragment vascularity and fixation stability; therefore, stable skeletal reconstruction was prioritized, and definitive correction of the residual deformity was deferred until osseous union.

The potential need for secondary corrective surgery was recognized intraoperatively; however, the definitive decision to proceed with corrective surgery and the specific osteotomy design were deferred until fracture healing and reassessment of the residual deformity.

During healing, right external auditory canal stenosis was diagnosed and treated by the otolaryngology department with canaloplasty on October 13, 2021.

Immediate postoperative computed tomography (CT) confirmed restoration of mandibular continuity and stable fixation of the major segments. The right-sided transverse discrepancy identified during primary surgery nevertheless persisted. Clinically, incomplete contact remained in the right premolar region, and the right mandibular posterior dentition was positioned lingually relative to the maxillary dentition, whereas the left posterior occlusion remained comparatively stable. Serial imaging demonstrated progressive osseous union without correction of the arch discrepancy and without infection, hardware failure, nonunion, or secondary displacement.(Fig. 3) The right-sided lingualized occlusal relationship persisted throughout follow-up, supporting union in the residual malaligned position rather than postoperative deterioration of an initially satisfactory reduction.

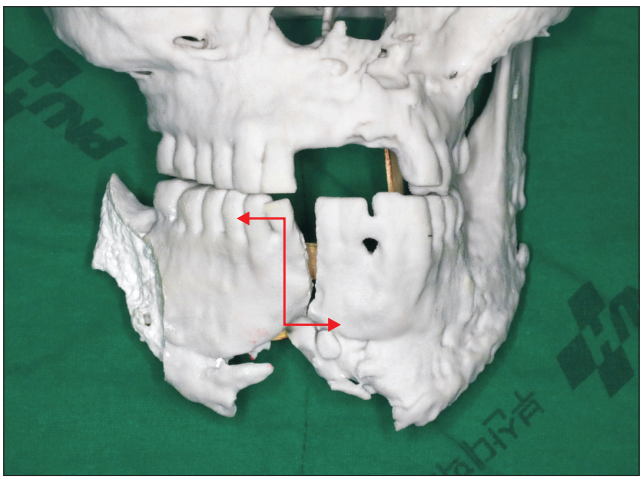


Fig. 4. Patient-specific rapid prototyping model used for planning secondary mandibular corrective surgery. The residual transverse mandibular arch discrepancy and the proposed osteotomy sites for right sagittal split ramus osteotomy and anterior mandibular vertical osteotomy were evaluated on the model.
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After sufficient osseous union had been confirmed, the persistent mandibular arch discrepancy and malocclusion were reassessed. The objective of secondary corrective surgery was to improve the residual transverse mandibular arch discrepancy and the associated right-sided malocclusion while maintaining the skeletal stability achieved after fracture healing. Based on this post-healing assessment, the definitive decision to proceed with corrective surgery was made. A patient-specific rapid prototyping model was fabricated to evaluate the

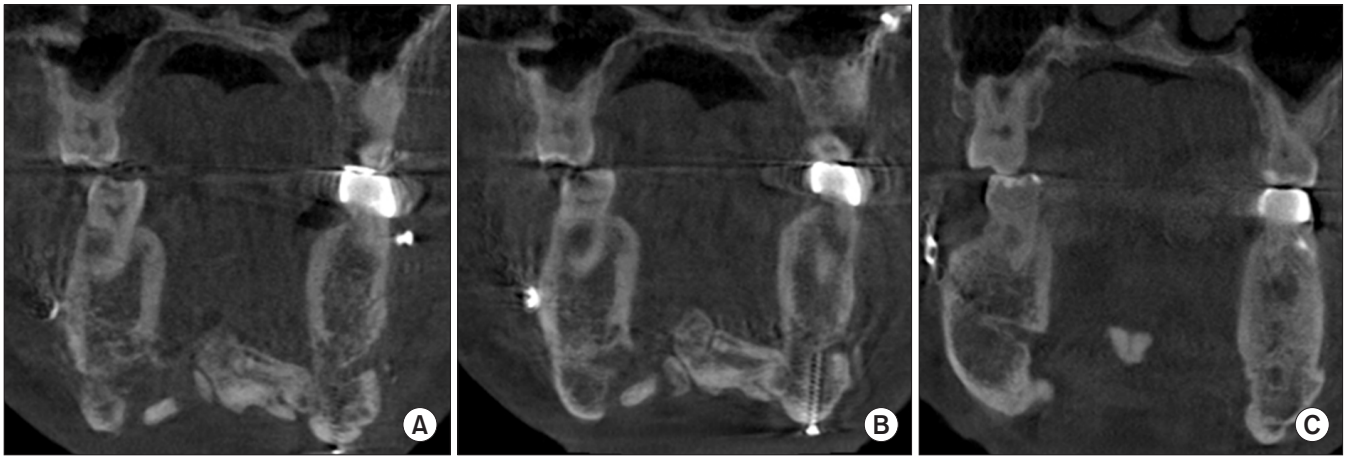


Fig. 5. Serial coronal computed tomography images after secondary mandibular corrective surgery. A. Early postoperative image obtained approximately 2 weeks after surgery, showing improved transverse alignment of the right mandibular posterior segment. B. Follow-up image obtained 8 months after surgery, demonstrating maintenance of the corrected mandibular position and progressive osseous healing. C. Image obtained 2 years and 3 months after surgery, showing long-term skeletal stability without secondary displacement. A mildly lingualized right posterior occlusal relationship remained.
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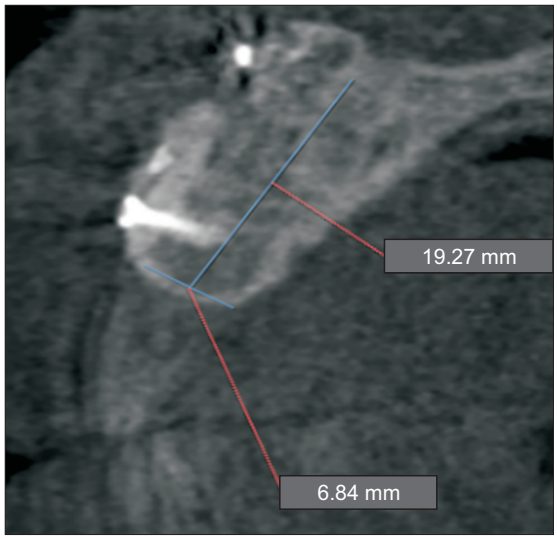


Fig. 6. Cross-sectional dental computed tomography image of the augmented alveolar ridge at the maxillary right central incisor site. The reconstructed ridge measured approximately 19.27 mm in vertical height and 6.84 mm in horizontal width at the planned implant site.
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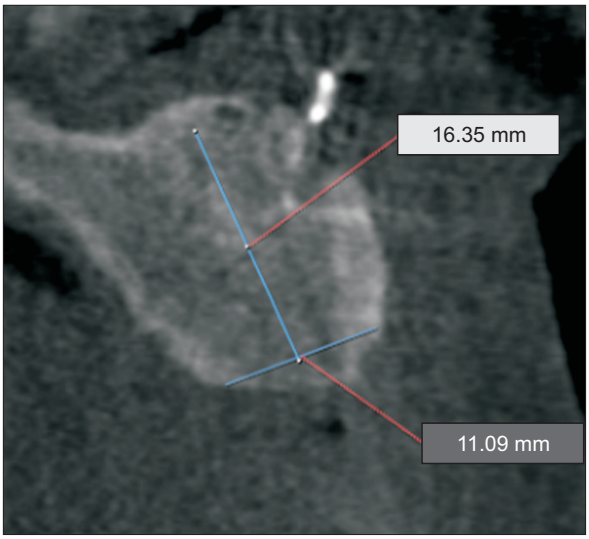


Fig. 7. Cross-sectional dental computed tomography image of the augmented alveolar ridge at the maxillary left lateral incisor site. The reconstructed ridge measured approximately 16.35 mm in vertical height and 11.09 mm in horizontal width at the planned implant site.
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healed mandibular configuration and plan the required segmental movements. The planned procedure consisted of right sagittal split ramus osteotomy (SSRO) combined with anterior mandibular vertical osteotomy.(Fig. 4) Surgery was performed on February 28, 2022, approximately seven months after primary ORIF. The reconstruction plate was removed, followed by right SSRO and anterior mandibular vertical osteotomy. Intraoperatively, osseous interference between the posterior segments limited the intended transverse repositioning; therefore, an additional posterior bending osteotomy was performed to obtain adequate alignment.

Postoperative clinical assessment demonstrated substantial reduction of the right premolar separation and improvement in the transverse relationship of the right posterior dentition. Serial CT confirmed maintenance of the corrected mandibular position without secondary displacement or loss of

skeletal correction.(Fig. 5) Although mild lingualization of the right posterior mandibular dentition remained and ideal intercuspation was not achieved, the occlusion was clinically stable, masticatory function was satisfactory, and the patient reported no functional discomfort.

After occlusal correction, aesthetic rehabilitation was undertaken in collaboration with the plastic surgery department. Corrective rhinoplasty was performed on April 27, 2022, using an open approach with tip refinement and augmentation of the depressed nasal dorsum with a dermofat graft.

Dental rehabilitation began after skeletal and occlusal stabilization. On December 5, 2022, the anterior maxillary alveolar defect was reconstructed with an autogenous mandibular body block bone graft. Post-augmentation dental CT demonstrated sufficient vertical and horizontal bone dimensions at the planned implant sites in the maxillary right central incisor and left lateral incisor regions.(Fig. 6, 7). After graft healing, implants were placed at sites #11 and #22 on June 20, 2023, and the mandibular anterior region was restored with a six-unit tooth-supported fixed prosthesis extending from #33 to #43.

Final panoramic radiography confirmed implant-supported restoration of the anterior maxilla and fixed prosthetic rehabilitation of the anterior mandible.(Fig. 8) The patient achieved satisfactory masticatory function without functional discomfort.

After intraoral rehabilitation, final aesthetic refinement was performed on November 14, 2023, in collaboration with the plastic surgery department. Facial contour irregularities were corrected using autologous microfat grafting with the Coleman technique, and tracheostomy-site scar contracture was treated by surgical scar revision.

The complete multidisciplinary treatment sequence is summarized in Fig. 9. Primary ORIF and orbital reconstruction were performed in July 2021, followed by canaloplasty in October 2021, secondary mandibular corrective surgery in February 2022, and corrective rhinoplasty in April 2022. Anterior maxillary bone augmentation and subsequent implant and prosthetic rehabilitation were completed between December 2022 and October 2023, and final facial soft-tissue refinement was performed in November 2023.



Fig. 8. Final panoramic radiograph after dental rehabilitation, showing implant-supported prosthetic restoration in the anterior maxillary region and a six-unit tooth-supported fixed prosthesis in the anterior mandibular region.
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III. Discussion

Severe CMFs associated with panfacial trauma require more than restoration of skeletal continuity. The principal challenge is to achieve stable fixation while preserving frag-

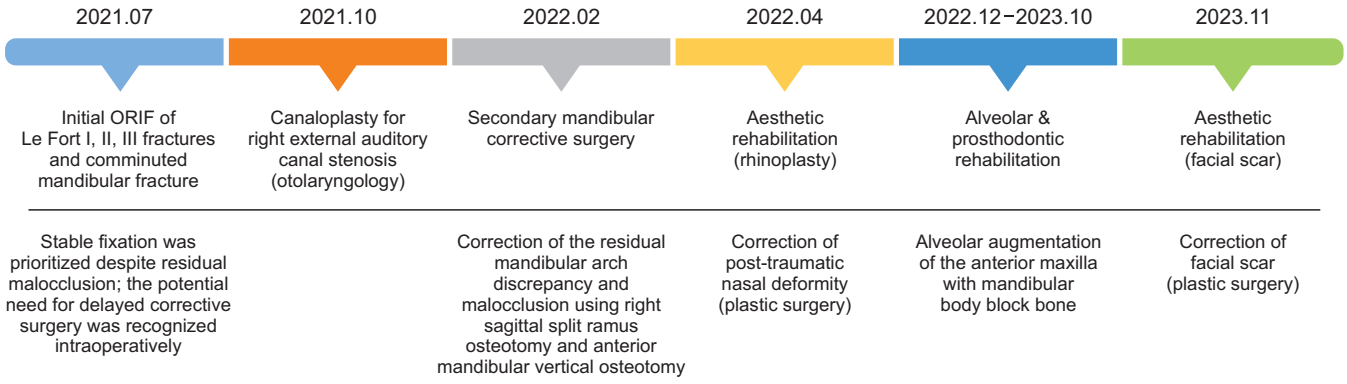


Fig. 9. Timeline of multidisciplinary staged reconstruction. Following the initial injury and hemorrhage control on July 19, 2021, primary open reduction and internal fixation (ORIF) with orbital reconstruction was performed on July 26, 2021. Canaloplasty was performed in October 2021, followed by secondary mandibular corrective surgery in February 2022, approximately seven months after primary fixation. Subsequent procedures included corrective rhinoplasty in April 2022, anterior maxillary bone augmentation in December 2022, implant placement in June 2023, and final facial soft-tissue refinement in November 2023.
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ment viability and, ultimately, recovering mandibular arch form, functional occlusion, and facial symmetry[2-6]. This case illustrates the limits of primary ORIF when comminution, loss of anatomical landmarks, and associated midfacial injury make complete functional reconstruction unsafe during the acute operation.

Selection of the fixation sequence is central to panfacial reconstruction. Top-down, bottom-up, and outside-in strategies each depend on the availability of a reliable anatomical reference[8,10]. A bottom-up approach is advantageous when the mandible can be anatomically reconstructed and used to restore lower facial height, condylar position, and occlusion; however, a severely comminuted or malpositioned mandible may transmit positional error to the maxilla and midface. A top-down sequence uses the cranial and upper midfacial skeleton to re-establish facial height, projection, and central facial alignment before mandibular reduction, although residual occlusal discrepancies may become apparent only during the final stage of reconstruction. The outside-in approach begins with restoration of the lateral facial frame, including the zygomatic arches and lateral buttresses, and may facilitate early recovery of facial width and projection. Its limitation is that it provides less direct control over the central midface and occlusion when these structures are extensively disrupted.

In the present case, the top-down sequence was chosen because the mandible could not provide a reproducible reference for height, transverse arch form, or occlusion, whereas the upper midface retained comparatively stable landmarks. Simultaneous orbital reconstruction also favored early stabilization of the upper facial skeleton. Thus, the sequence was selected according to the most reliable remaining anatomy rather than by uniform adherence to a single reconstructive algorithm[8,10].

In addition, the need for simultaneous orbital floor reconstruction favored early stabilization of the upper facial skeleton, whereas maxillary instability and airway concerns limited postoperative intermaxillary fixation. The extensive submental soft-tissue wound and the need to preserve the vascularity of the comminuted mandibular fragments further discouraged prolonged manipulation of the mandible during the acute operation.

The residual malocclusion should be understood in the context of the priorities of acute fracture management. Interference among the comminuted fragments prevented restoration of the original mandibular arch, and further manipulation would have increased the risk of devascularization and fixation instability. Stable load-bearing fixation and preservation of viable fragments were therefore prioritized over immediate ideal intercuspation[2,4,6]. Importantly, serial imaging showed progressive union without hardware failure, infection, nonunion, or secondary displacement. The residual deformity therefore reflected persistence of the malalignment recognized during primary surgery rather than deterioration of an initially ideal reduction. Although the final osseous relationship may radiographically be described as union in a malaligned position, it did not represent progressive malunion caused by postoperative loss of fixation or loss of a previously satisfactory occlusion.

This distinction determined the timing and role of secondary surgery. The potential need for delayed correction was recognized during primary ORIF; however, the definitive decision to proceed with secondary surgery and the osteotomy design were established only after fracture healing and reassessment of the persistent residual deformity. The objective of the secondary procedure was not to revise failed fracture fixation, but to correct the residual transverse mandibular arch discrepancy and improve the associated malocclusion after stable osseous union had been achieved. Right SSRO combined with anterior mandibular vertical osteotomy permitted controlled three-dimensional repositioning of the healed segments after biological and mechanical stability had been achieved. Previous reports in this journal have similarly described surgical correction of post-traumatic malocclusion after maxillofacial fracture healing[9,11]. For selected patients with persistent post-traumatic malocclusion, this approach may avoid excessive acute manipulation while providing a predictable opportunity for later functional correction.

An additional advantage of delaying corrective osteotomy was that treatment planning could be based on the consolidated skeletal configuration rather than on unstable, mobile fracture fragments. The rapid prototyping model allowed the residual transverse discrepancy, anticipated sites of osseous interference, and required segmental movements to be assessed before surgery. In this setting, model-based planning did not replace intraoperative judgment, as an additional posterior bending osteotomy remained necessary, but it provided a practical framework for translating a complex post-traumatic deformity into a controlled corrective procedure. This experience suggests that three-dimensional planning may be particularly useful when conventional dental landmarks are absent or distorted and when previous fixation hardware further limits surgical access.

The outcome also requires measured interpretation. Secondary correction substantially improved the transverse arch

relationship and right posterior contact, but did not produce ideal intercuspation. A mildly lingualized posterior relationship remained; nevertheless, the occlusion was stable, masticatory function was satisfactory, and the patient had no functional discomfort. The result is therefore best described as clinically acceptable functional rehabilitation rather than complete occlusal normalization.

Rehabilitation extended beyond the mandibular deformity. Reconstruction of the anterior maxillary alveolar defect with an autogenous mandibular body block bone graft provided sufficient bone for implant placement and definitive prosthetic treatment. Ophthalmologic, otolaryngologic, plastic surgical, and prosthodontic interventions addressed orbital injury, external auditory canal stenosis, nasal deformity, facial contour irregularities, scarring, and dental loss. Their integration into a staged pathway allowed each procedure to be timed according to healing and the patient's evolving functional and aesthetic needs[7,9].

The sequence of alveolar and prosthetic reconstruction was also clinically important. Definitive implant rehabilitation was deferred until skeletal alignment and occlusal relationships had stabilized, because premature reconstruction of the anterior maxilla could have constrained subsequent mandibular repositioning or produced a prosthesis based on an unstable maxillomandibular relationship. After secondary correction, reconstruction with an autogenous mandibular body block bone graft restored the deficient implant bed and permitted prosthetic rehabilitation to proceed on a more stable functional foundation. Thus, the order of treatment was not merely chronological; each stage reduced uncertainty for the next and protected the gains achieved during the preceding phase.

The principal value of this case lies in showing how a reconstructive strategy can evolve without becoming fragmented. The entire sequence was not predetermined before the initial trauma operation; rather, primary stabilization, secondary mandibular correction, alveolar reconstruction, dental rehabilitation, and soft-tissue refinement were linked by repeated assessment of residual deficits. Successful osseous union after ORIF should therefore not be regarded as the endpoint of treatment when mandibular malalignment or functional occlusal disturbance persists.

In conclusion, severe CMFs associated with panfacial trauma may require staged reconstruction when safe anatomical and occlusal restoration cannot be achieved during primary fixation. Selection of the initial fixation sequence should be based on the most reliable remaining anatomical reference, and secondary corrective surgery should be considered after skeletal healing when residual malocclusion remains clinically significant. A coordinated multidisciplinary pathway can achieve stable, clinically acceptable function and improved facial form even when complete normalization is not feasible.

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Authors' Contributions

J.Y.A. conceived the study, collected the data, and drafted the manuscript. J.U.K. and J.C.B. contributed to study design and data interpretation. S.Y.S. and Y.J.L. assisted in data collection and critically reviewed the manuscript. N.R.C. supervised the overall study, contributed to study design and interpretation, and critically revised the manuscript. All authors have read and approved the final version of the manuscript.

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Ethics Approval and Consent to Participate

This study was approved by the Institutional Review Board (IRB) of Pusan National University Hospital (IRB No. 2606-004-163). Written informed consent for the publication of clinical information and images was obtained from the patient.

Consent for Publishing Photographs

Written informed consent was obtained from the patient for publication of this article and accompanying images.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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