

## Caso clínico

# Therapeutic management of a severe maxillofacial defect after landmine fragmentation

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## ARTICLE INFORMATION

### Article history:

Received: 6 de marzo de 2025

Accepted: 7 de marzo 2025

### Keywords:

Firearms, facial trauma, reconstruction, computer-assisted surgical planning, titanium mesh.

## A B S T R A C T

Reconstruction of severe maxillofacial defects caused by shrapnel represents a complex challenge in the maxillofacial area. We report the case of a 42-year-old military patient who suffered extensive soft tissue and bone defects following an injury from fragmentation of an antipersonnel mine in the Ukrainian war. He presented a shrapnel wound with massive soft tissue damage in the midface region and fractures with multiple fragments in the maxilla and orbital walls, including loss of soft tissue, bone and eyeball. A two-stage surgical approach was performed. In the initial prehospital phase, surgical debridement with cavity cleaning and removal of foreign bodies and nonviable tissue was performed. In a second phase after evacuation to the Military Medical Clinic, a 3D model was created, and a custom-made titanium mesh was made to reconstruct the periorbital and maxillary area. Subsequently, residual correction of a skin defect was required using a frontal pedicle flap. The result at 6 months was satisfactory. This case demonstrates the importance of a multidisciplinary and stepwise approach to optimize functional and aesthetic outcomes in complex maxillofacial reconstructions in the military setting.

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<http://dx.doi.org/10.20986/recom.2025.1616/2025>

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## Manejo terapéutico de un defecto maxilofacial severo tras fragmentación de una mina terrestre

### R E S U M E N

#### Palabras clave:

Armas de fuego, traumatismos faciales, reconstrucción, planificación quirúrgica asistida por ordenador, malla de titanio.

La reconstrucción de defectos maxilofaciales severos causados por metralla representa un desafío complejo en el territorio maxilofacial. Se reporta el caso de un paciente militar de 42 años que sufrió defectos extensos de tejidos blandos y óseos tras una herida por fragmentación de una mina antipersona terrestre en la guerra de Ucrania. Presentó una herida por metralla con daños masivos en los tejidos blandos de la región centrofacial y fracturas con múltiples fragmentos en el maxilar y en las paredes orbitarias, incluyendo la pérdida de tejidos blandos, óseos y del globo ocular. Se realizó un enfoque quirúrgico en dos etapas. En la fase inicial prehospitalaria se realizó un desbridamiento quirúrgico con limpieza de cavidades y eliminación de cuerpos extraños y del tejido no viable. En una segunda fase tras la evacuación a la Clínica Médica Militar se elaboró un modelo 3D y se confeccionó una malla de titanio a medida para reconstruir el área peri-orbitaria y maxilar. Posteriormente se precisó una corrección residual de un defecto cutáneo mediante un colgajo pediculado frontal. El resultado a los 6 meses fue satisfactorio. Este caso demuestra la importancia de un enfoque multidisciplinario y escalonado para optimizar los resultados funcionales y estéticos en reconstrucciones maxilofaciales complejas en el contexto militar.

### INTRODUCTION

For the third consecutive year, active fighting continues on Ukrainian territory. Every week, hundreds of Ukrainian civilians and military personnel are injured by explosions, missile attacks, bullet impacts and fires. These circumstances result in serious injuries to those on the battlefield. Among the different types of injuries, landmine explosions stand out due to the damage they cause to organs and tissues, the risk of potentially fatal complications, the complexity of immediate treatment, and the high probability of provoking devastating maxillofacial injuries that pose a reconstructive challenge<sup>1,2</sup>.

The frequency of shrapnel wounds in the maxillofacial region ranges between 4.36 % and 5.19 % in recent war conflicts<sup>1-3</sup>, with 23.9 % corresponding to gunshot wounds<sup>3-5</sup>. These serious injuries require a multidisciplinary approach to achieve optimal functional and aesthetic results since they are characterized by the presence of complex fractures and a large loss of soft tissue and bone with a tendency to ischemia and subsequent necrosis. The controversy lies in whether therapeutic management should be performed in a single surgical stage as a primary procedure or in several secondary interventions<sup>6,7</sup>. In the military field, the choice of therapeutic approach depends on the experience and availability of appropriate means on the battlefield, the extent of the injury and the general health of the patient. In the first line of combat, a three-phase approach is generally advocated<sup>8,9</sup>, especially in those complex cases where there is severe involvement of soft tissue and bone that can cause primary reconstruction to fail. The first phase consists of initial debridement, fracture stabilization, and primary closure with simple techniques. The second phase is based on bone

reconstruction with adequate soft tissue coverage. This secondary reconstruction should be performed as soon as possible, once the soft tissues are in good condition. In the third phase, residual deformities are corrected, and the patient is prepared for full oral rehabilitation.

This clinical case presents the results of the management and reconstructive treatment of a patient with extensive soft tissue and bone defects after suffering a shrapnel wound from an antipersonnel landmine fragmentation in the war in Ukraine.

### CASE REPORT

A 42-year-old male military patient sustained severe maxillofacial trauma and extensive craniofacial injury from a landmine fragmentation in July 2024, resulting in massive soft tissue damage to the midface and multiple fractures to the maxilla and left orbit, including loss of soft tissue, bone, and eyeball. In the prehospital phase, initial surgical treatment of the wounds was performed with cleaning of cavities and foreign bodies and debridement and removal of nonviable tissue (Figure 1A). He was subsequently evacuated from the battlefield according to NATO STANAG 2546 - AJMedP-2 standard and transferred to the Odesa Military Medical Clinic, Ukraine (Figure 1B). The diagnosis included an extensive shrapnel wound to the middle third of the face with several multi-fragment fractures to the maxilla and maxillary sinus, nasoorbital complex, orbital walls, zygomatic bone, nasal bones, and frontal sinus. The left eyeball was absent, and there was post-traumatic neuropathy of branches II and III of the facial nerve (Figure 1C).

The day before the intervention, the CT images were sent to a technical laboratory where a 3D model of the facial skeleton was obtained, and a titanium reconstructive mesh was printed (Figures 2A and B). The surgical treatment included the removal of the comminute bone fragments of the maxilla and the revision of the left orbit to complete the enucleation and eliminate the ocular remains, as well as the section and ligation of the optic nerve. Osteosynthesis with miniplates of the right zygomatic fracture was performed and the titanium mesh was placed in the left periorbital area and maxilla (Figure 2C). The immediate postoperative period was uneventful with good primary wound healing. The follow-up CT showed adequate reduction and fixation of the fractures and the mesh with a satisfactory reconstruction of the facial contour (Figure 2D).

On the day of stitch removal, a skin defect was evident in the area of the titanium mesh in the paranasal zone (Figure 3A), which was corrected in a third operation using

a frontal axial flap (Figure 3B). The long-term results were evaluated at 6 months, showing good facial symmetry with restoration of the malar and orbital projection, stable skin coverage, and no exposure of titanium material (Figure 3C). The palpebral function of the right eye was preserved. The patient was satisfied with the aesthetic and functional result obtained.

## DISCUSSION

This case report illustrates the complexity of reconstruction of maxillofacial injuries caused by shrapnel from an antipersonnel landmine in a contemporary war. The step-wise approach allowed the patient to be initially stabilized on the battlefield and then definitive reconstruction to be planned after evacuation to the military medical hospital.

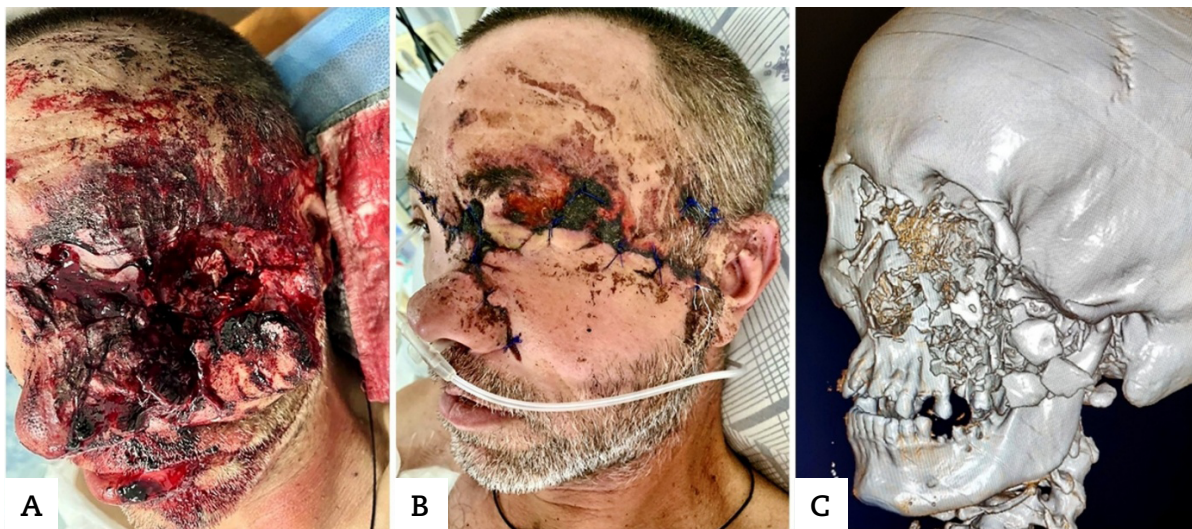


Figure 1. A: mine blast injury with involvement of the left maxilla and orbit. B: view on admission to the military medical center. C: preoperative 3D-CT showing extensive bone destruction.

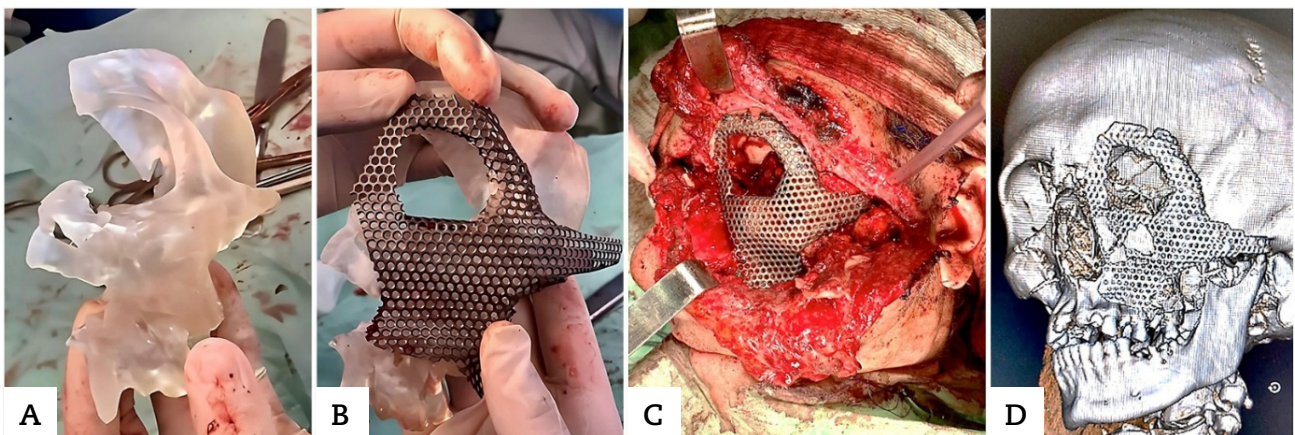


Figure 2. A: 3D model of the bone defect. B: reconstruction with custom-made titanium mesh to replace the bone defects. C: placement of the titanium mesh. D: follow-up 3D-CT results after craniofacial reconstruction.

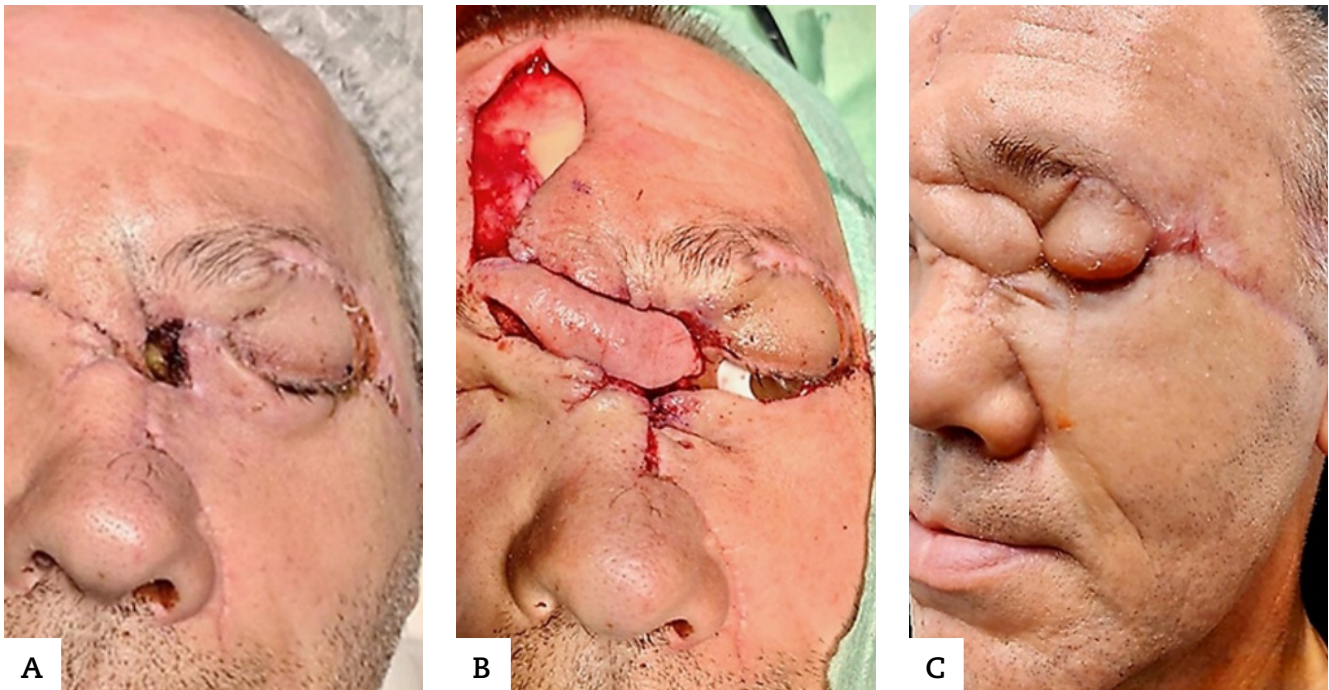


Figure 3. A: treatment outcome showing a post-traumatic residual skin defect in the paranasal area. B: reconstruction with a pedicled forehead flap. C: outcome at 6 months.

This treatment approach aligns with standard recommendations advocating multidisciplinary and stepwise management of complex maxillofacial injuries<sup>8</sup>. In the context of war, the treatment plan depends on the experience and resources available in the combat theatre, the extent of injuries, and the general health of the patient<sup>9</sup>. Although primary reconstructive surgery can optimise outcomes by reducing the time and number of secondary procedures, a stepwise approach is generally recommended on the battlefield, especially in complicated cases where there is severe soft tissue and bone damage that may jeopardize the initial reconstruction.

In the context of military oral and maxillofacial traumatology in Ukraine, advanced technologies such as 3D imaging and computer-assisted surgical planning can be used for complex procedures. In addition, international collaboration has been used to tackle the most difficult cases. Because of the need to perform multiple operations on patients over time, comprehensive treatment includes psychological care and physical rehabilitation techniques, in addition to reconstructive surgery procedures.

Virtual planning using 3D models and preoperative modelling of a custom-made titanium mesh optimized this patient's outcome, allowing for a more accurate reconstruction of the facial contour<sup>10</sup>. For this purpose, non-viable bone fragments were removed from the maxilla and the orbit was revised to eliminate remnants of the eyeball and adjacent structures in order to facilitate reconstruction of the orbital framework. The custom-made titanium mesh was then placed to reconstruct the orbit and maxilla, restoring facial structural support. This has the advantage of being precisely and accurately adapted to the patient's anatomy. It is also

noteworthy that titanium mesh has sufficient three-dimensional stability, avoid donor site morbidity and present a low risk of infection, even in proximity to the sinus cavities, as they are highly biocompatible.

In the postoperative period, a wound dehiscence occurred in the paranasal area, which was reconstructed in a third procedure with a frontal pedicle flap. This flap proved to be a versatile option for defect coverage, useful in areas with traumatized tissue. Its axial pedicle guarantees reliable vascularization to treat early complications, such as residual skin defects.

The experience gained in treating these complex injuries in situations of armed conflict may have broader applications for use in oral and maxillofacial reconstructive surgery in non-war periods and potentially benefit patients with facial defects of various aetiologies. This case demonstrates that even in situations of severe craniofacial destruction, satisfactory reconstructive outcomes can be achieved by accurate secondary surgical planning using advanced virtual planning techniques. In this patient, the multidisciplinary and stepwise approach was essential to comprehensively address the complex injuries. Preoperative planning, including 3D modelling and titanium mesh fabrication, was able to improve the accuracy and quality of the reconstruction.

## ETHICAL CONSIDERATIONS

For the publication of this work, the guiding principles established in the Declaration of Helsinki and publications related to research ethics were complied with. Informed consent was obtained from the patient.

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## CONFLICTS OF INTEREST

None.

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## FUNDING

This research has not received specific support from public sector agencies, the commercial sector or non-profit entities.

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