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CASE REPORT

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Management of gunshot-induced fractures in the maxillofacial region: case report and literature review

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ABSTRACT

The management of fractures in the maxillofacial region caused by firearms represents a challenge that requires immediate multidisciplinary intervention. Treatment is conditioned by the severity of the injury and the structures involved. In this study, three cases of patients admitted to the maxillofacial surgery service due to ballistic trauma with extensive soft-tissue injuries and hard-tissue damage are described. All patients showed favorable clinical evolution following treatment. Additionally, a literature review was conducted to design a management algorithm for fractures caused by firearms based on established protocols.

Keywords: gunshot wounds; multiple fractures; firearms; penetrating head injuries; case report.

INTRODUCTION

The mechanism by which a projectile causes tissue damage results from the transfer of kinetic energy upon contact between the bullet and the body, with the tissues dissipating that energy and thereby sustaining damage. These wounds may be classified as penetrating, perforating, and avulsive. Penetrating wounds are caused by low-velocity projectiles (<300 m/s) and lack an exit wound. Perforating wounds are characterized by the presence of an exit wound, which is larger than the entry wound and presents stellate margins. Avulsive wounds are essentially perforating injuries characterized by tissue loss and destruction, regardless of the wound type. The extent of injury is proportional to the amount of kinetic energy transferred from the projectile to the tissues and, therefore, depends on the velocity at which the projectile penetrates. Accordingly, firearms may also be classified as low-velocity, reaching up to 300 m/s; medium-velocity, between 330 and 660 m/s; and high-velocity, above 660 m/s (1,2).

Initial patient management upon admission to the emergency department should focus on securing the airway and ensuring hemodynamic stability, followed by a systematic assessment to categorize injuries and affected structures. Subsequently, repair of soft and hard tissue damage is performed, followed by definitive tissue treatment involving reconstruction and rehabilitation in order to restore both function and esthetics (2,3).

This study aims to describe the management of gunshot-induced fractures in the maxillofacial region in three patients who provided informed consent for the use of their clinical information and publication of their photographs. In addition, a brief literature review is included, and a management algorithm based on currently established protocols is proposed.

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CASE PRESENTATIONS

The following section presents three cases of patients who sustained gunshot-induced fractures.

Case 1

A 43-year-old male patient was admitted to the emergency department after sustaining a gunshot injury to the maxillofacial region. Physical examination and computed tomography (CT) revealed a comminuted fracture involving the right and left mandibular body, including the symphysis, with soft tissue injury (lower lip, buccal mucosa, and tongue), without tissue loss. The projectile followed a horizontal trajectory, with an entry wound at the left labial commissure and no exit wound; the projectile was located within the right submandibular space (Figure 1).

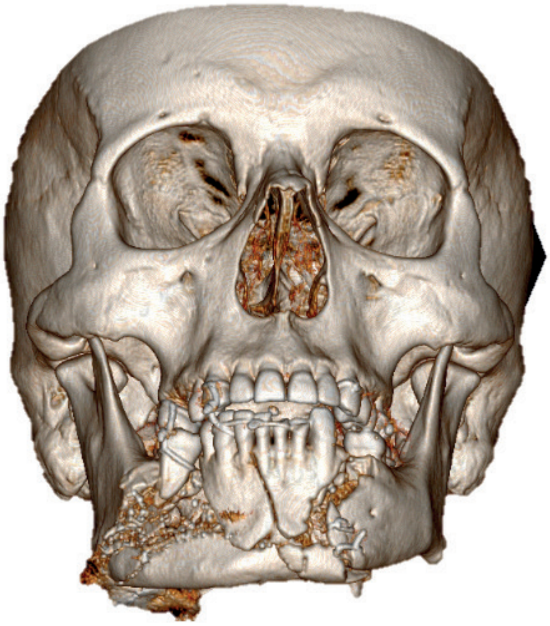

Figure 1. Preoperative 3D reconstruction.

After patient stabilization and following the Advanced Trauma Life Support (ATLS) protocol, management of the soft tissues and mandibular fractures was undertaken. In the first surgical stage, damage and hemorrhage control were performed, along with surgical irrigation and debridement. Bone fragments and projectile splinters embedded in the mucosa were removed, followed by simplification and occlusal stabilization using interdental wiring (Figure 2). During the second surgical stage, open reduction and internal fixation (ORIF) of the mandibular fractures was performed. In the operating room, under balanced general anesthesia and nasotracheal intubation, a bilateral submandibular surgical approach was performed. Anatomical reduction of the fractures was achieved, and compromised bone fragments were removed. Fixation was then accomplished using a reconstruction plate and screws, both from the 2.4 system (Figure 3). This osteosynthesis material was selected because reconstruction plates provide absolute mandibular stability, which is essential in this type of unstable fracture that tends to displace despite reduction. Furthermore, reconstruction plates withstand all functional forces at the fracture site and provide absolute stability (4).

A follow-up tomography scan was obtained six months later (Figure 4). This new study made it possible to assess the feasibility of bone graft placement for subsequent implant-supported rehabilitation.

Figure 2. Ernst interdental wiring + intermaxillary fixation.

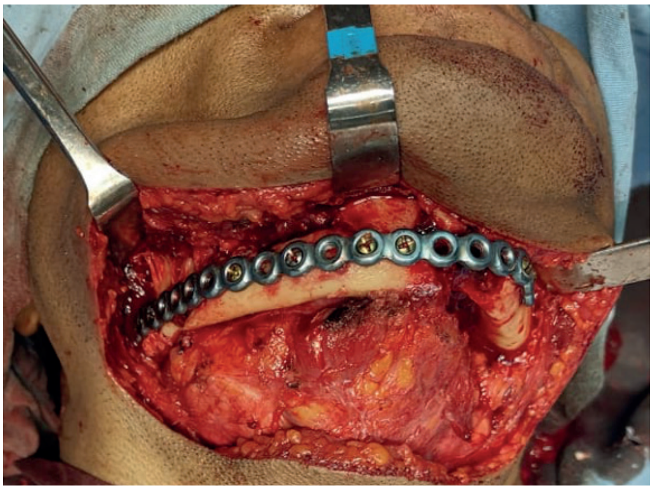

Figure 3. ORIF with reconstruction plate.

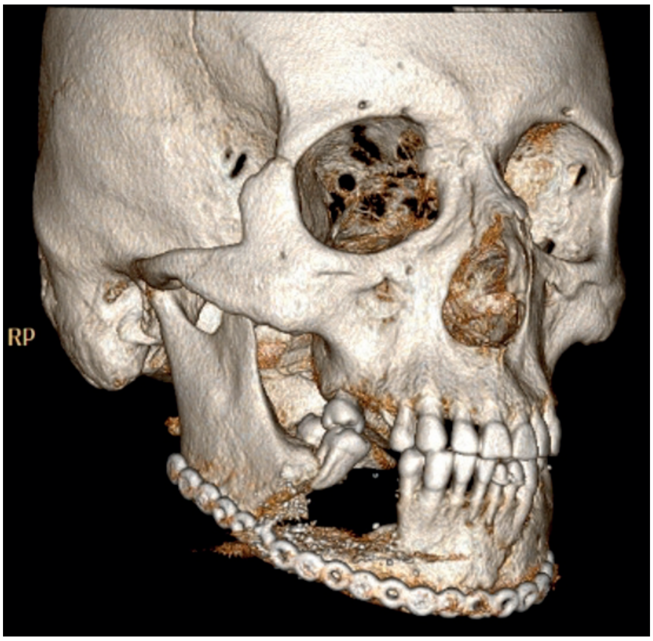

Figure 4. Six-month postoperative 3D reconstruction.

Figure 5. Initial 3D reconstruction from a non-contrast cranial CT scan.

Case 2

A 43-year-old male patient presented with a diagnosis of frontoorbital and zygomatic complex fracture associated with injury to the left eyeball and meningeal damage caused by a gunshot projectile (Figure 5). The patient was evaluated by the ophthalmology department due to projectile-induced damage, and enucleation of the eyeball was indicated.

During the first surgical stage, performed by the neurosurgery department, decompressive craniotomy and management of meningeal injuries were carried out. During the second stage, ORIF of the frontozygomatic fractures and the roof of the left orbit was performed using 1.5 system plates and titanium mesh (Figure 6). During the third surgical stage, a polymethyl methacrylate (PMMA) frontoparietal prosthesis was placed, and the ophthalmology department inserted an ocular prosthesis (Figure 7).

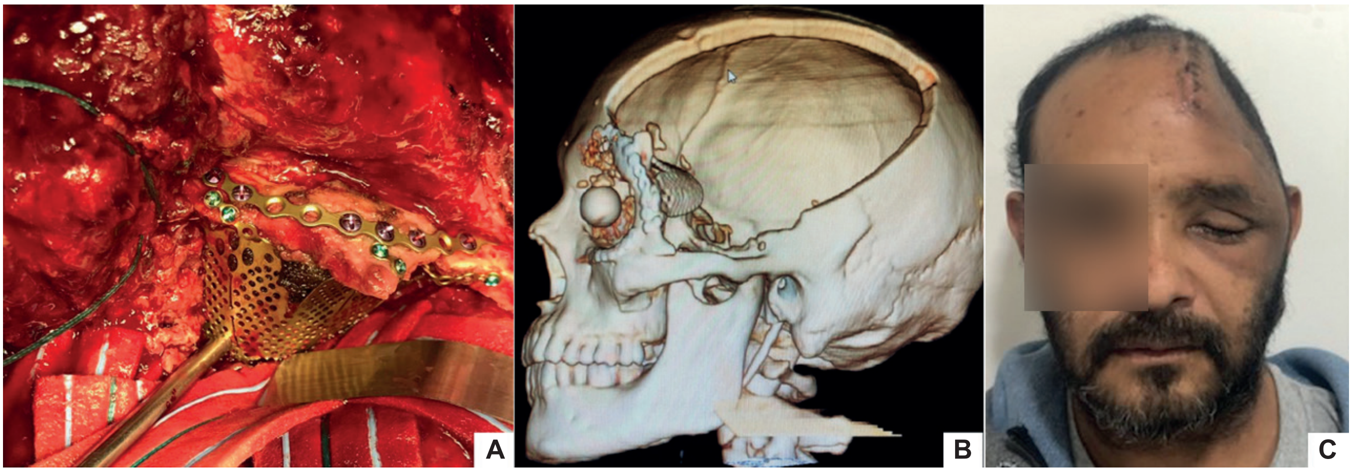

Figure 6. A) Intraoperative photograph showing placement of titanium mesh and osteosynthesis material at the left supraorbital rim. B) 3D reconstruction following the second surgical procedure. C) Clinical photograph following the second surgical procedure.

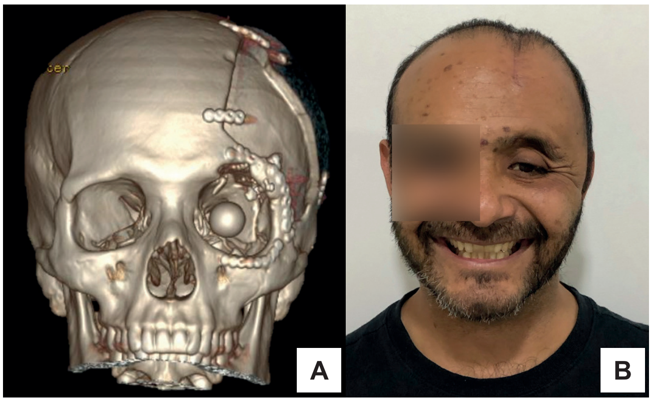

Figure 7. A) 3D reconstruction after placement of the frontoparietal prosthesis and ocular prosthesis. B) Six-month postoperative clinical photograph.

Case 3

A 38-year-old male patient was admitted to the emergency department due to a fracture involving the right mandibular region resulting from a gunshot wound. Once stable, physical examination and imaging studies were performed. These revealed a comminuted fracture involving the left mandibular ramus and coronoid process, a fracture of the zygomaticomaxillary buttress and the left maxillary alveolar ridge, as well as a fracture of the left infraorbital rim (Figure 8). The projectile followed a posteroanterior trajectory, with an entry wound located 1 cm below the right earlobe and an exit wound at the level of the upper lip, resulting in a laceration at that site.

Under balanced general anesthesia and nasotracheal intubation, it was decided to place a mandibular reconstruction plate for the fractures in that region and to perform open reduction and internal fixation (ORIF) of the maxillary and zygomatic fractures. Erich arch bars were placed to simplify the maxillary dentoalveolar ridge fracture. Since the maxillary fractures were simple and nondisplaced, 2.0 system osteosynthesis plates were used for ORIF of these fractures. Conversely, since the mandibular fractures were comminuted, a reconstruction plate and screws, both from the 2.4 system, were placed, prioritizing continuity of the mandibular condylar segment and its position within the glenoid fossa (Figure 9). A follow-up computed tomography (CT) scan was obtained six months after surgery (Figure 10).

DISCUSSION

Initial evaluation

Initial management of ballistic trauma is based on Advanced Trauma Life Support (ATLS) protocols once the patient arrives at the hospital. The CABC sequence (circulation, airway, breathing, disability/neurologic assessment) is followed, while damage control in the maxillofacial region is simultaneously assessed and managed. Airway compromise is a frequent consequence of ballistic trauma, either due to direct injury to airway structures or indirect mechanisms such as hemorrhage, muscular detachment, or anterior mandibular fractures.

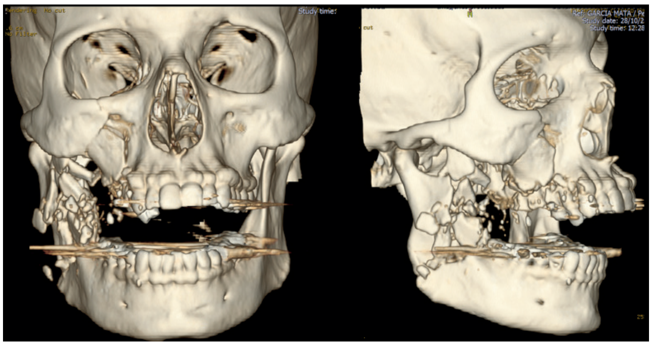

Figure 8. Initial 3D reconstruction.

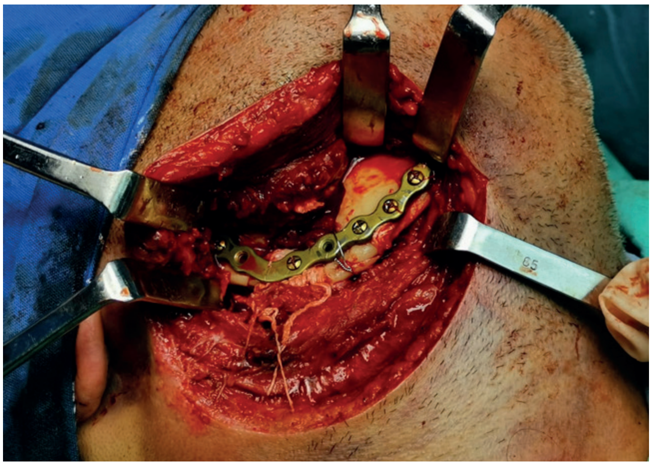

Figure 9. Mandibular reconstruction plate.

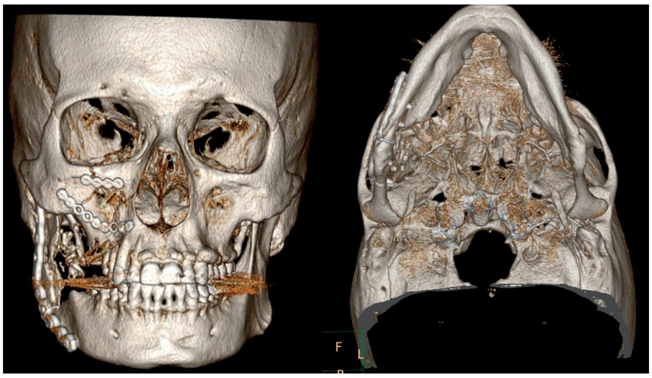

Figure 10. Postoperative 3D reconstruction.

Manual repositioning of the mandible and tongue base is an essential measure to maintain integrity and prevent collapse of the posterior airway. This airway may be secured through nasotracheal or orotracheal intubation; however, edema or hemorrhage may occasionally preclude these approaches, thereby necessitating a tracheostomy (1,3).

Hemorrhage secondary to injuries caused by high-velocity projectiles is particularly difficult to control through external pressure because it frequently involves bony structures and highly vulnerable anatomical tissues, such as the globe, brain, and airway. In cases of open trauma, the bleeding source may be directly identified and controlled through ligation. Nevertheless, when hemorrhage persists or cannot be controlled in this manner, alternative therapeutic approaches should be considered, including external carotid artery ligation and selective embolization (3). Once stable, the patient should be evaluated by multiple specialties.

Neurosurgery

Neurological alterations in patients with ballistic trauma may involve changes in alertness, cognition, and behavior. During the assessment, it is essential to distinguish among memory impairment, disorientation, altered consciousness, and psychiatric manifestations. A rapid yet accurate assessment of the level of consciousness should be performed in all polytraumatized patients.

The Glasgow Coma Scale enables the identification of conditions requiring immediate neurosurgical intervention, including intracranial hemorrhage and cerebral edema, among others. According to the New Orleans Criteria, cranial computed tomography (CT) is indicated in trauma patients presenting with any of the following findings: headache, vomiting, being older than 60, alcohol or drug intoxication, persistent amnesia, visible trauma above the clavicles, or seizures (1,3,4).

Ophthalmology

Many patients with ballistic trauma sustain ocular injuries, making visual assessment mandatory. This evaluation includes examination of visual acuity, direct and consensual pupillary reflexes, pupil shape and size, visual fields, color vision, diplopia, ocular movements, ocular adnexa, and eyeball position (4).

Cardiothoracic Surgery

In patients with multiple gunshot wounds, it is essential to rule out pneumothorax, hemothorax, cardiac tamponade, and other thoracic conditions (4).

General surgery

Abdominal assessment constitutes an integral component of trauma management. ATLS protocols should be followed, and the patient's hemodynamic stability and potential organ involvement should be evaluated (3,4).

Orthopedics

Orthopedic evaluation is essential in patients presenting with fractures involving the upper extremities, pelvis, or lower limbs. Open fractures constitute a true surgical emergency and should be treated within the first six hours. Similarly, debridement must be performed according to the Gustilo-Anderson classification guidelines, ensuring complete removal of necrotic soft tissue. Recommended mechanical debridement consists of irrigation with 3 L of saline solution for type I fractures, 6 L for type II fractures, and 10 L for type III fractures, according to this classification (4–6).

Diagnosis

Once the patient is hemodynamically stable, attention should be directed toward imaging studies in order to determine definitive management. Depending on the severity of the trauma, different diagnostic modalities may be requested, including radiographs, computed tomography (CT) scans, and angiography. To accurately evaluate the severity and extent of osseous tissue injuries or fractures, thin-slice CT scans of 0.5 mm and three-dimensional reconstructions are required (4,5).

Definitive treatment

Definitive treatment of maxillofacial ballistic trauma aims to restore both function and facial esthetics through a series of organized and progressive interventions. First of all, debridement is performed, consisting of copious irrigation of the wound with 4–6 L of saline solution combined with bacitracin. During this process, all necrotic tissue is removed, and muscle viability is assessed according to the classic criteria of color, consistency, contractility, and bleeding (6).

Subsequently, infection prevention becomes an essential component of management due to the high septic potential associated with projectile injuries. Broad-spectrum antibiotics are recommended for 10–14 days, with second- and third-generation cephalosporins being the most appropriate agents in this context (4,7).

Once the initial cleaning and stabilization phase has been controlled, reconstruction of the soft tissues is performed, followed by fracture stabilization and reconstruction of bone tissue. These stages aim to restore anatomical architecture and provide adequate support for subsequent reconstructive phases.

Definitive reconstruction should be performed as soon as the patient's clinical condition permits in order to preserve soft tissue volume and minimize scar formation. This phase includes fundamental principles such as wide exposure of the fracture site, rigid internal fixation, appropriate bony coverage with viable soft tissue, use of free bone grafts to restore the midface with nasal or oral mucosal coverage when necessary, and appropriate selection of the reconstructive flap (4,8).

Complete rehabilitation may require placement of dental implants and use of maxillofacial prostheses, contributing to recovery of stomatognathic system function and optimization of the overall esthetic outcome.

Complications

Potential complications following reconstructive treatment may be classified as functional or esthetic. Functional complications include infection, rejection of grafts, flaps, or osteosynthesis materials, as well as disturbances in mastication, vision, speech, and swallowing. Esthetic complications include poor nasal projection or contour, traumatic telecanthus, facial asymmetry, and unsatisfactory facial contour (4,8).

Algorithm

Based on the information obtained from the literature, the following algorithm for managing maxillofacial fractures caused by ballistic trauma was developed. Figure 11 presents the protocol to be followed in the initial service, namely the emergency department. Figure 12 illustrates the treatment provided by the oral and maxillofacial surgery service, classifying potentially affected structures and their corresponding management. Figure 13 outlines the management of comminuted facial skeletal fractures and the treatment required for these injuries.

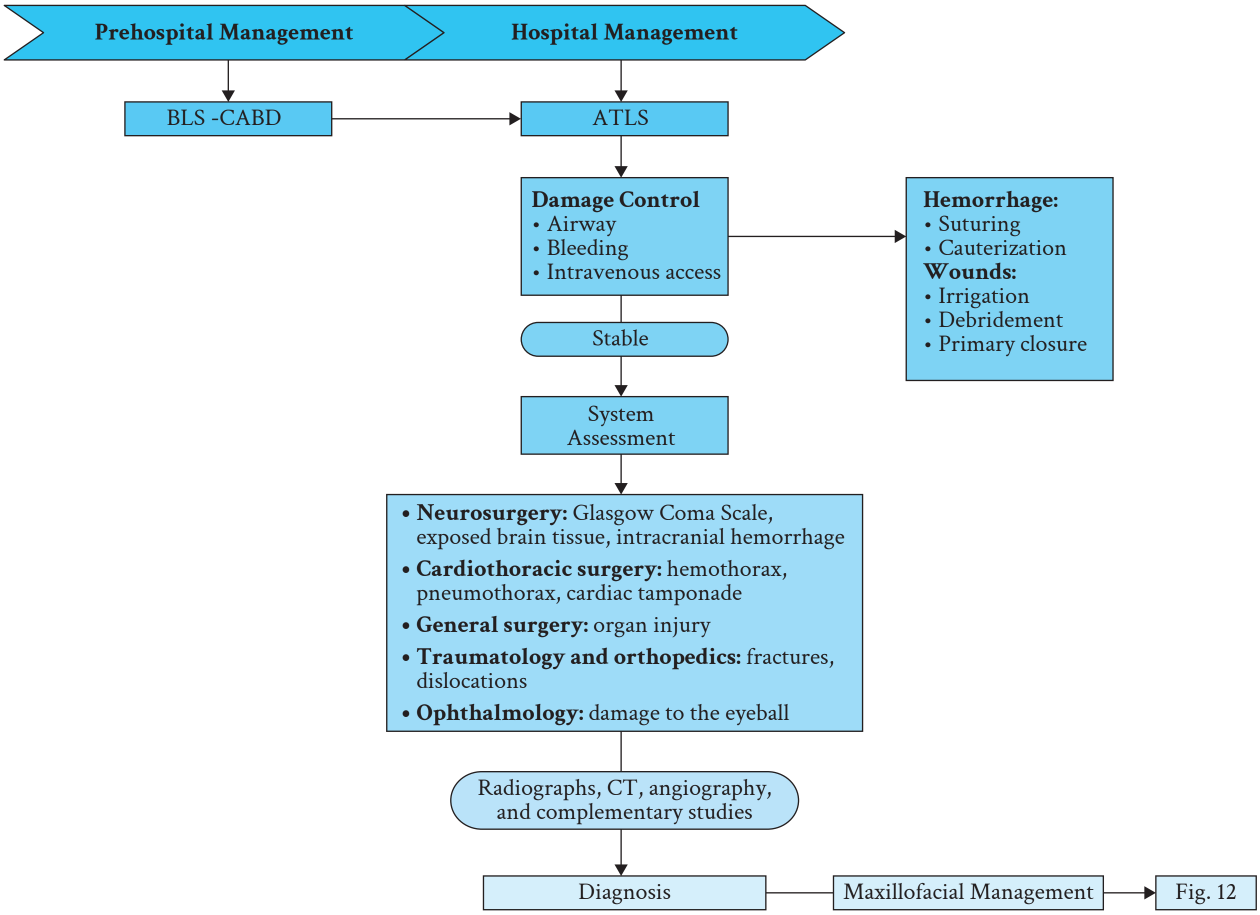

Figure 11. Initial service protocol. BLS: basic life support; CABD: circulation, airway, breathing, disability/neurologic assessment.

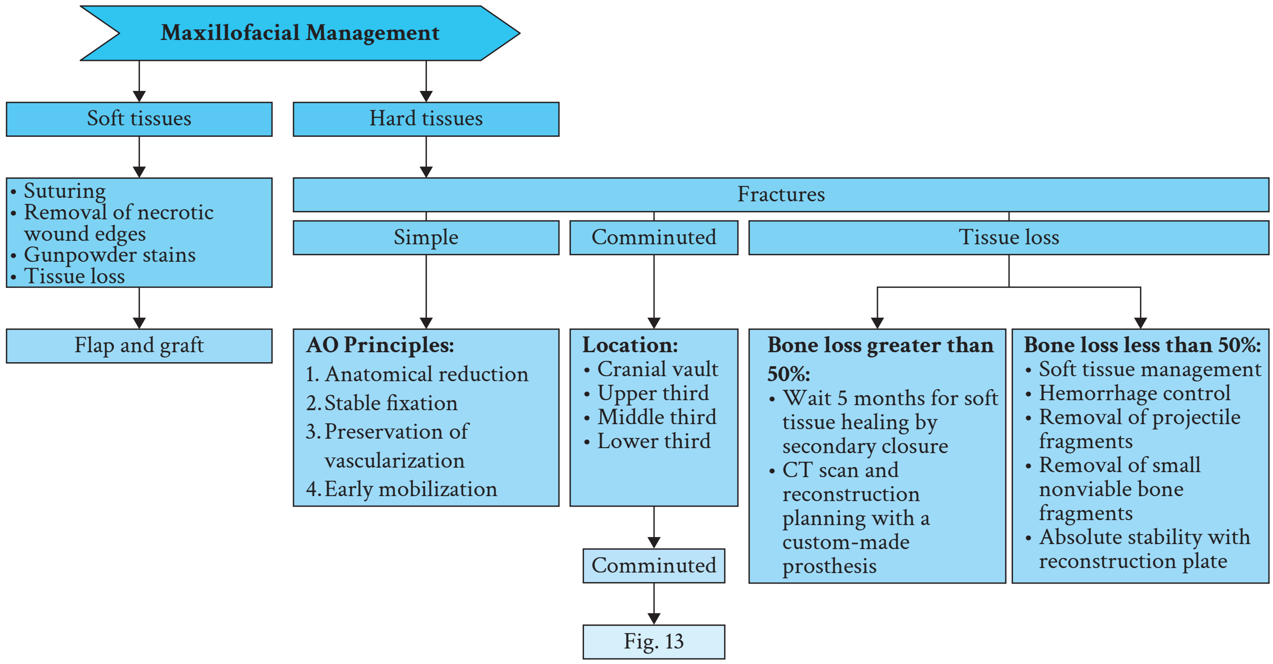

Figure 12. Treatment provided by the oral and maxillofacial surgery service.

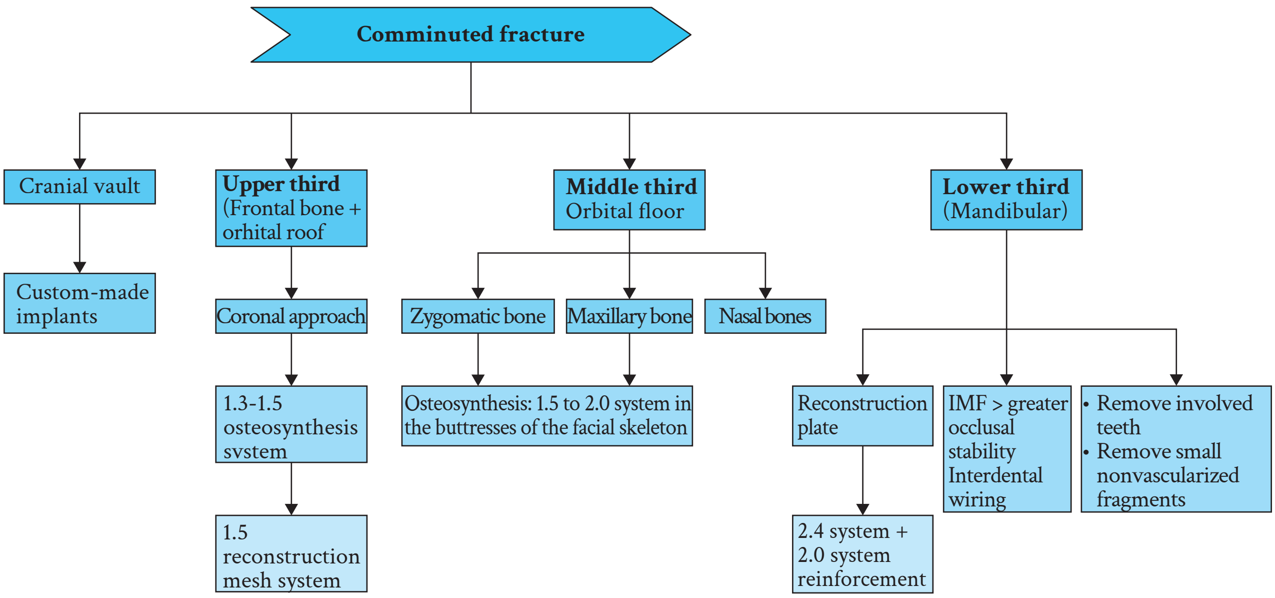

Figure 13. Management of comminuted fractures of the facial skeleton.

Study limitations

This study presents limitations that should be considered when interpreting its results. First, the descriptive case-based nature of the work limits generalizability to broader populations, since anatomical characteristics, projectile trajectory, and injury severity vary widely among patients. In addition, the absence of a comparison group precludes causal conclusions or evaluation of the superiority of one reconstructive method over another.

Another important limitation lies in the variability inherent to multidisciplinary management of ballistic trauma. Although clinical decisions are based on standardized protocols, they may differ among institutions and surgical teams, introducing heterogeneity into the described approaches. Similarly, follow-up periods were limited in some cases, restricting long-term assessment of functional and esthetic outcomes as well as potential late complications.

Finally, the availability of specialized resources, such as imaging studies, specific osteosynthesis materials, or reconstructive equipment, may not be uniform across all hospitals, potentially affecting the reproducibility of the treatments described.

CONCLUSIONS

Management of ballistic trauma in the maxillofacial region requires an organized approach grounded in life-support principles, in which hemodynamic stabilization and airway management constitute the initial priorities. Once the patient has been stabilized, definitive treatment depends on the severity of injuries and projectile trajectory, which guide identification of compromised structures and the extent of damage.

Since this type of trauma involves multiple systems and tissues, management must necessarily be interdisciplinary, integrating different specialties to establish a comprehensive treatment plan aimed at restoring both function and facial esthetics. Within this framework, maxillomandibular fixation screws and interdental wiring may be used as temporary measures to provide support or simplify occlusion in comminuted fractures. However, they do not replace definitive treatment, but rather facilitate its implementation and optimize reconstructive results.

Overall, comprehensive evaluation, careful planning, and multidisciplinary collaboration constitute the fundamental pillars for achieving satisfactory functional and esthetic results in patients with maxillofacial ballistic trauma.

The presentation of these cases, complemented by the literature review and proposed algorithm, underscores the need for standardized diagnostic and therapeutic strategies in the management of firearm-related maxillofacial trauma to improve predictability, safety, and clinical results in this patient population.

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The authors declare no conflict of interest.

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Informed consent:
The patients provided informed consent for the use of their information and publication of their photographs.

Authorship contribution:
ASGT: conceptualization, methodology, research, writing of the original draft. **JGC:** visualization, supervision, writing - review & editing.

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