The Use of 2.4-mm Locking Plate System in Treating Comminuted Mandibular Fracture by Firearm

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Abstract

Maxillofacial trauma caused by firearms has considerably increased, in which the mandibular body is the site of highest incidence of firearm projectiles. In these cases, the use of titanium plates and screws allows the early restoration of form and function of the mandible with stable and predictable results. Recently, conventional plates have been extensively used to treat comminuted mandibular fractures. Nevertheless, the conventional system presents several limitations such as screw compression against the bone interface and the necessity of precise fit of plate to the bone. To overcome such drawbacks, the locking plates have emerged. The present clinical case reported the operative treatment of mandibular fracture caused by firearm projectiles with the use of locking plate. The indications, advantages, and disadvantages of this system are presented.

Keywords

- mandibular fracture
- firearm
- fixation
- plates

Most of the maxillofacial injuries were caused by car accidents; however, owing to the introduction of severe traffic laws such as seat belt and speed limit, and the increase of urban violence, the injuries by firearm projectiles have steadily increased (around 200%) in the past few years, and 61% of the injuries affect the head sites.^{1–3}

Mandibular body presents the highest incidence of fractures caused by firearm projectiles.^{4,5} Both closed reduction with Erich bar and maxillomandibular block are the conventional treatment options of this injury.⁶ However, the use of open treatment and stable internal fixation with titanium plates and screws has increased⁷ and promotes an early restoration of mandibular form and function as well as provides stable and predictable outcomes.

The open treatment of mandibular fractures consists of using 1.3-, 1.5-, and 2.0-mm miniplate systems in fractures and tension bands. Fixation systems with reconstruction plates (2.4 and 2.7 mm) promote stable internal fixation of

comminuted mandibular fractures caused by firearm projectiles. Nowadays, both conventional and locking plates are the most common systems to treat comminuted mandibular fractures.^{8,9}

The conventional system stability is based on the compression of the screw head inserted into the plate against the bone interface. Invariably, the adjacent bone is resorbed and, in ideal conditions, the system remains stable until the fracture heals. However, improper bone bed conditions associated with nonprecise fit of plate fixation can result in occlusal discrepancies, instability of the fractured segments, and postoperative infection.^{8,10–12}

To overcome such drawbacks, the use of locking plates has been proposed. The locking plate system was introduced 3 decades ago, and it has an optimal principle of load distribution on the plate/screw interface and provides great rigidity of the system, good stability of fracture segments, and low incidence of screw loosening. Additionally, no precise fit of

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the plate to the bone is necessary, which reduces the surgical time.¹³

The present clinical case reported the operative treatment of mandibular fracture caused by firearm projectiles with surgical reduction and fixation with locking plate. The indications, advantages, and disadvantages of this system are presented.

Case Report

A 40-year-old man was referred to the emergency room of the Policlin Hospital, Sao Jose dos Campos, São Paulo, due to a firearm projectile injury in his face that occurred 40 minutes before. Patient was initially evaluated by the Traumatology Surgery team. Patient was afebrile, active, conscious, hydrated, ruddy, acyanotic, anicteric, eupneic with airway clear, and hemodynamically stable with normal vital signs. The Oral and Maxillofacial Surgery and Traumatology team was requested to evaluate the patient. The extraoral examination showed severe swelling, bruises on the right hemiface, and lacerated injuries resulting from projectile entrance hole in the ipsilateral zygoma body region. The intraoral examination revealed severe swelling and bruising in the mouth vestibule and floor of the right mandibular body and angle, tissue laceration, and bleeding corresponding to the lower upper path of the projectile without exit hole, characterizing as an open fracture of the mandible. Imaging examinations showed the comminuted fracture of

the right mandibular body and the projectile position, placed in the ipsilateral submandibular region. After laboratory tests, antibiotic therapy, and tetanus prophylaxis, the surgical treatment was performed to reduce and fix the mandibular comminuted fracture (►Fig. 1).

Under general anesthesia via nasotracheal intubation, we performed a saline washing, conservative debridement of lacerated and blunt intraoral wound, and the projectile fragments and unviable soft tissues were removed. Finally, tissues were sutured with 4-0 polyglactin 910. A submandibular extraoral approach was used to expose the fractured segments, followed by occlusal pattern restoration with upper complete denture and lower removable partial denture. Afterward, a comminuted fracture reduction was performed while keeping the perimeter of the mandibular arch. The fractured segments were fixed with plates and screws of the 2.4-mm locking plate system. The flap was replaced and sutured in layers with 4-0 polyglactin 910, skin was sutured with 5-0 nylon, and antibiotic therapy was administrated during the following 10 days (►Fig. 2).

At 7 days postsurgery, the facial contour and occlusion of the patient had been recovered. Radiograph examination revealed proper positioning of plate and screws with correct basal realignment (►Fig. 3). At 6 months postsurgery, total bone and soft tissue healings and no signs of mobility and/or infection in the right mandibular body were noted. Additionally, occlusal maintenance, neurotmesis, and no motor deficit with mild submandibular scar were presented (►Fig. 4).

Figure 1 Preoperative: (A) extraoral clinical aspect; (B) intraoral clinical aspect; (C) radiographs of the patient with a comminuted right mandibular body fracture.

Figure 2 Transoperative: (A) extraoral approach of the mandible was used to expose the fracture sites; (B) occlusal pattern restoration; (C) comminuted fracture reduction was performed while keeping the perimeter of the mandibular arch and fixing fracture segments by using plates and screws of the 2.4-mm locking plate system; (D) flap was replaced and sutured in layers.

Figure 3 At 7 days postsurgery, the facial contour and occlusion of the patient were recovered. Radiograph examination revealed proper plate and screws placement with correct basal realignment.

Figure 4 At 6 months postsurgery, total bone and soft tissue healings were noted and no signs of mobility and/or infection in the right mandibular body and occlusal maintenance were observed.

Discussion

With the great number of urban violence, the firearm projectile injuries have drastically increased² in which the mandibular body is the most common site of the head and neck region.¹ Several factors such as shape, size, composition, and speed of the firearm projectiles as well as the distance from the shooting, movement, and penetration angle affect both the pathophysiology and magnitude of the trauma.^{14,15}

The injuries caused by firearm projectiles can be classified as follow: penetrating, piercing, and avulsion.¹⁶ In the present case the injury was penetrating as the projectile remained lodged inside of injured tissues, which is characteristic of low-speed projectiles.

According to Henriksson,¹⁷ the treatment of firearm projectiles is based on four distinct phases: (1) Posttraumatic—patient is admitted to the hospital with vital functions checked and maintained; (2) primary—after the stabilization of the patient's condition, patient is subjected to image examinations to investigate the projectile placement, and to decontaminate the wound; (3) postoperative—prevention and treatment of local and systemic complications; and (4) reconstruction—reconstruction of soft tissue and bone. In the current clinical report, a definitive treatment was opted in the first intervention. Conservative tissue debridement was performed to remove dental and projectile fragments that could cause postoperative complications (e.g., bone dehiscence and

kidnappings). In addition, nonviable tissues were analyzed based on their color, texture, and vascular support. Then, reduction and fixation of the fractured fragments were conducted, which minimizes the need of secondary surgical procedure for mandibular reconstruction.

In this case, the fixture should provide a bridge on the comminuted area and should support the masticatory forces transmitted to the affected area.¹⁸ The 2.4-mm locking plate systems are used to fix complex or comminuted mandibular fractures and mandibular reconstruction with continuity loss.¹⁹ The plates act as an internal fixation and provide great stability to the fractures. The bone tissue stresses are absorbed by the plate system which reduces the mobility of the fractured segments and secondary displacement. The passive fit between plate and bone provides adequate bone healing, even in critical situations,⁸ which minimizes complications and sequelae.

The locking plate system presents some advantages when compared with the 2.0- and 2.4-mm conventional systems. In the latter, the stability is achieved when the screw head compresses the plate to the bone, which may cause further adjacent bone resorption and consequently screw loosening and treatment failure. On the other hand, in the locking plate system, no precise fit is required on the plate/bone interface as the forces are shared between the threaded portion of the ring plate and screw. Therefore, no bone compression is observed, which favors the bone blood supply, preventing cortical bone resorption and minimizing the infection risk.^{8,12,20,21}

In the present clinical report, the comminuted pattern of fractured bone hinders the precise fit between the plates and screws of the conventional fixation system, and compromises the system stability and the quality of the treatment. For this reason, 2.4-mm locking plates were used according to their indication and biomechanical principles.

In 1999, Gutwald et al²² were the first authors who compared the biomechanical behavior of locking plates in the mandible. A total of 16 mandibles of cadavers with simulated angle fractures were used. Mandibles were reconstructed with either 2.0-mm Compact locking plate (Mathys, Bettlach, Switzerland) or 2.0-mm conventional plate. Cranial, caudal, and torsion forces were applied on the mandibles. The locking plates provided greater stability to the fracture bone. Haug et al observed that the precise fit between the bone and the plate was only crucial to the conventional plates when compared with the locking plate system.²³ Herein, several variables may limit the accuracy of the locking plate as it was performed in a human. However, as observed on the postoperative period, the plate remained stable with no screw loosening even after masticatory loading, and absence of clinical signs of infection and inflammatory process were noted.

However, the cost of the locking system is considered an important disadvantage. Furthermore, the surgeon needs additional instruments such as milling guide to install the screw perpendicularly to the plate.^{13,24} Common complications such as infections and fractures of the plate and screw can occur.

The complication rate (i.e., absence of bone repair, infection, and occlusal change) is similar for both conventional and 2.0- and 2.4-mm locking plates.^{8,13,21} No technical difficulty was observed in using locking plate systems by the inexperienced surgeons.

In conclusion, the locking plate system presents several advantages and the most important is the great stability of the fractured segments due to its higher load transmission. Additionally, it provides absence of pressure on the plate/bone interface and does not affect the vascular supply and bone healing on the fractured area. Finally, there is no need of large inclinations of the plate to fit it to the bone segment.

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