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INNOVATIVE USE OF A DOUBLE Y-SHAPED MINIPLATE IN COMPLEX MANDIBULAR FRACTURE: A RARE CASE REPORT

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Abstract

Mandibular fractures are common in maxillofacial trauma, particularly affecting the anterior mandible. This study assesses the effectiveness of double 'Y'-shaped miniplates for fixing anterior mandibular fractures. A 24-year-old male with a symphyseal fracture from a motorcycle accident was treated using a double 'Y'-shaped titanium miniplate and six 6mm monocortical screws. Postoperative care included intermaxillary fixation for 7-14 days, antibiotics, and analgesics. The double 'Y'-shaped miniplate provided enhanced stability and load distribution, reducing the risks of malocclusion and non-union. Clinical evaluations over three months post-surgery showed no sensory deficits, highlighting the importance of careful fracture handling and precise hardware application. The double 'Y'-shaped miniplate demonstrated significant advantages over traditional lag screws, including better anatomical fit, reduced surgical time, and fewer postoperative complications. This design's even force distribution across the fracture site promotes successful bone healing and minimizes displacement risk. Despite the promising results, the choice of fixation method should consider individual patient factors and fracture characteristics. Double 'Y'-shaped miniplates offer superior biomechanical stability and clinical outcomes, presenting a viable alternative to traditional methods. Further long-term and comparative studies are necessary to confirm their clinical superiority. This study supports the potential benefits of double 'Y'-shaped miniplates in managing anterior mandibular fractures, advocating for their consideration in clinical practice.

INTRODUCTION

The mandible ranks as the second most frequently fractured bone in the maxillofacial area, owing to its prominent and exposed location. Studies from countries such as Kenya, Nigeria, Egypt, Canada, and India indicate that fractures of the anterior mandible constitute between 23% and 36% of all mandibular fractures. The nasal bone is the most commonly fractured bone in the maxillofacial region due to its central and prominent position on the face (1).Anterior mandibular fractures (AMFs) refer to fractures located in the region delineated by vertical lines immediately behind the canine teeth (parasymphysis) or as linear breaks along the centerline of the mandible (symphysis) (2). Mandibular angle fractures can be treated with wire osteosynthesis,

one miniplate at the superior border (2.0 mm), a single plate on the inferior border (2.3 or 2.7 mm) with an arch bar tension band, two miniplates (1 at the superior and inferior borders), 3-D plates, 3-D strut plates, X-shaped plates, or lag screws (3). Researchers and surgeons worldwide have a strong interest in managing maxillofacial fractures. Mandibular fractures account for 55.9% of facial fractures due to their distinctive morphology (4).The primary causes of anterior mandibular fractures are road traffic accidents and interpersonal violence, which account for 14-19% of cases. The anterior mandible encompasses the symphysis and parasymphysis regions. This part of the mandible has a higher trabecular bone density, providing it with greater elastic modulus and compressive strength compared to other sections of the mandible (5). Fracture care has evolved over time, from maxillary - mandibular fixation (MMF) employing wire osteosynthesis, lag screws, and miniplates to the use of resorbable plates.Two Advancements in research have led to the replacement of cumbersome compression plating techniques with non compression ones. Although the best fixation approach is still contested, open reduction and internal fixation of front mandibular fractures using mini-plates has gained acceptance, following Champy's notion of osteosynthesis. (3,4) Champy's work focused on bending and torsional forces. Recent studies show that the mandible is subjected to three types of forces: bending, torsional, and shear. Using two conventional miniplates requires more ammunition, which increases the risk of harm (6) Fractures involving the symphysis and parasymphysis constitute 47.09% of all mandibular fractures. The prevalence of anterior mandibular fractures relative to other types varies across studies and geographical regions (7).

The discussion persists between "rigid" fixation, utilizing two bone plates, and "non-rigid" yet functionally stable fixation using a single miniplate. In response to the constraints of rigid and semi-rigid fixation methods, 3D miniplates and strut plates have been developed. Studies have indicated challenges with 3D plates in managing mandibular angle fractures. The use of a 3D plate system effectively challenges Champy's traditional concept of osteosynthesis. These plates can be configured as a dual-plate system by connecting two miniplates with crossbars, enhancing their resistance to torsion and bending along the longitudinal axis. This configuration ensures stable compression and tension zones (8). However, applying 3D plates in the symphysis region of the mandible has been problematic due to its pronounced curvature.(9)The anterior mandible undergoes significant rotational and torsional stresses, necessitating osteosynthesis materials (such as miniplates) that can withstand these forces while minimizing their presence.

Biomechanical studies have shown that a double 'Y' shaped miniplate is particularly advantageous in this context. This design offers a larger contact surface area with the bone, effectively distributing forces and achieving outcomes comparable to using two separate miniplates. Its biomechanical performance is noted to be akin to 3D plates, which are designed to optimize stability and strength in challenging surgical scenarios. Thus, utilizing a double 'Y' shaped miniplate in the anterior mandible is supported by its ability to enhance stability against rotational and torsional pressures while economizing on material usage (10). The research aimed to evaluate clinical and radiological outcomes between a double 'Y' shaped miniplate and two 4-hole miniplates in the treatment of anterior mandibular fractures using standard open reduction and internal fixation. The study proposed comparing the ease of placement and time required for applying double 'Y' shaped miniplates versus standard miniplates (11).

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CASE PRESENTATION

A 24-year-old Male patient presented to our clinic after a road traffic accident, exhibiting a mandibular fracture at the symphysis.The patient was asymptomatic until he was involved in a motorcycle collision a day ago. He was hit by another bike, resulting in injuries. The patient sustained a facial laceration and a discontinuity on the lower border of the mandible **(Figure 1)**.

Figure 1: Operative Image of the Patient

Although there was no initial displacement of the teeth, malocclusion was observed following the fracture. Fractures occurring in the midline of the mandible are classified as symphyseal fractures. When teeth are present, the fracture line typically passes between the mandibular central incisors. Cone Beam Computed Tomography of the patient is shown in (**Figure 2).**

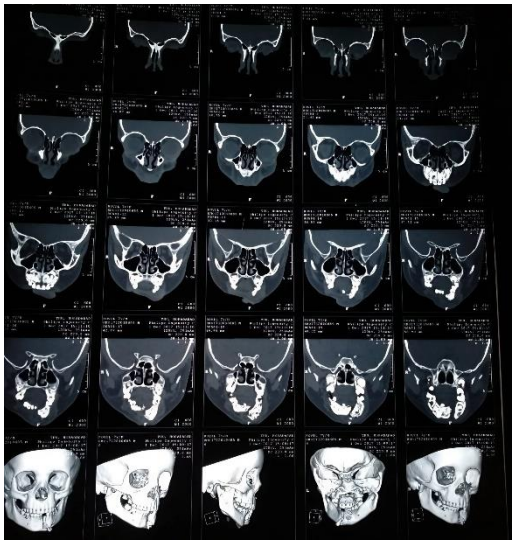

Figure 2 : Cone Beam Computed Tomography of the Patient

Preoperative examination revealed no initial displacement of the teeth; however, malocclusion was noted subsequent to the fracture, characteristic of symphyseal fractures **(Figure 3**).

ISSN 1462 2815

Figure 3: Pre Operative Orthopantogram of the Patient

Instruments used in the treatment of mandibular fracture included arch bars, dental and interdental wiring, metallic and nonmetallic splints for intermaxillary fixation; Langenbeck and Howarth retractors; periosteal elevators; a double Y-shaped titanium miniplate with 2 x 6 mm mono-cortical titanium screws **(Figure 4)** ; an examination kit; local anesthetic delivery systems; periotomes and luxators; elevators; dental extraction forceps; mouth props; retractors; scalpel handle and blade; dissecting forceps (toothed) ; hinged forceps; tissue clamps; and angled surgical scissors. Erich Arch bars are fixed to the teeth to achieve intermaxillary fixation.

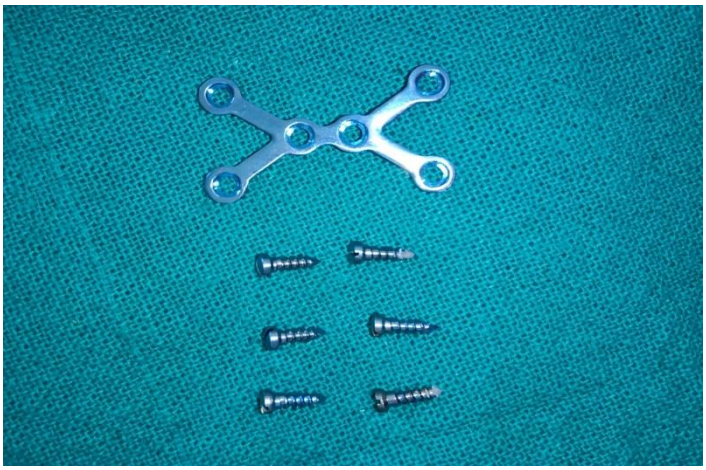

Figure 4: Photograph depicting the fixation of a symphysis fracture using a 2mm double 'Y' shaped titanium mini plate secured with 2 x 6mm monocortical titanium screws

Upon administration of local anesthesia, the surgical team meticulously prepared and decontaminated the site of the mandibular fracture. An incision was carefully made to expose the fractured mandible, followed by the delicate elevation of periosteum using specialized instruments. The fracture fragments were manually reduced to restore anatomical alignment and ensure proper occlusion. A Y-shaped titanium miniplate, selected for its optimal fit, was contoured to match the mandibular anatomy and positioned over the fracture. Using precise drilling techniques, pilot holes were created mono cortically through the plate's designated holes. Subsequently, Six 6mm

ISSN 1462 2815

monocortical titanium screws were carefully inserted and sequentially tightened to securely fixate the plate to the mandible. The stability of the fixation was verified through gentle manipulation of the mandible, confirming no movement at the fracture site and ensuring correct occlusion alignment **(Figure 5)**

Figure 5: Six 6mm monocortical titanium screws were inserted and tightened to secure the plate to the mandible.

Following the successful fixation of the Y-shaped titanium miniplate and screws, the surgical team proceeded to meticulously close the surgical site. First, the area was thoroughly irrigated with sterile saline solution to remove any debris and reduce the risk of infection. Careful attention was paid to ensuring the irrigation reached all areas around the incision site. Subsequently, the incision was closed using 3-0 silk sutures, meticulously placed to minimize tension on the wound edges and promote optimal healing **(Figure 6)**. Each suture was carefully tied to approximate the tissue layers accurately without causing undue stress on the skin. This meticulous closure technique aimed to achieve a cosmetically pleasing result while maintaining the integrity of the surgical site. Finally, a sterile dressing was applied to protect the wound and promote a clean, healing environment.

Figure 6: Incision was closed using 3-0 silk sutures

After closure, the surgical site was covered with a sterile dressing to protect it from external contaminants and promote healing. The patient was prescribed antibiotics to prevent infection and analgesics for pain management as needed. Detailed instructions were provided to the patient regarding postoperative care, emphasizing

the importance of maintaining a soft diet to avoid stress on the healing tissues of the mandible. Additionally, the patient was advised to avoid trauma to the surgical area and to follow up regularly for monitoring and further guidance. These measures aimed to optimize recovery and ensure successful outcomes following the mandibular fracture repair. Post-reduction, proper occlusion was successfully achieved. Post operative Orthopantogram of the Patient is shown in **Figure 7**

Figure 7: Post Operative Orthopantogram of the Patient

DISCUSSION

The double 'Y'-shaped mini plates are particularly effective in treating symphysis fractures due to their unique design, which offers enhanced stability and improved load distribution across the fracture site (12). This design reduces the risk of plate failure and ensures a more robust fixation compared to conventional plates. The anatomically congruent shape of these plates provides a precise and secure fit to the mandibular bone, minimizing complications such as malocclusion and non-union (13). Additionally, these plates require fewer screws and less overall hardware, reducing the risk of irritation and infection post-surgery. The ease of application further simplifies the surgical procedure, allowing for better alignment and fixation of the fractured segments, leading to better patient outcomes and quicker recovery times.

Postoperative maintenance of the arch bar with IMF was implemented for 7-14 days, varying based on the presence of additional fractures. Pain levels before and after surgery were evaluated using a visual analogue scale. Assessments for edema, occlusal discrepancy, maximum interincisal mouth opening, wound infection, and dehiscence were conducted preoperatively and up to 3 months postoperatively. Neurosensory deficits were monitored through mechanosensory tests for the mental nerve and inferior alveolar nerve, both before and after surgery, for a duration of 3 months. Clinical evaluations and treatment outcome comparisons were performed on all patients on the 1st day post-surgery, then at 1 week, 1 month, and 3 months postoperatively. Symphysis fractures are common and difficult to treat, largely because there is no universal standard protocol for their management (14).Various types of plates have been designed, each claiming to provide better stability and fewer complications than others.Surgeons have widely used various shapes of titanium mini plates for fixation in the mandibular angular region (15). The current study shows the use of double Y-shaped miniplates in the fixation of anterior mandibular fractures. There were no postoperative sensory nerve issues detected following fracture fixation.

This outcome was achieved through gentle handling of the fracture, meticulous dissection of the mental nerve, and careful placement of screws near the nerve. These results are consistent with the findings of Agarwal et al. (16), who also reported no nerve deficits after surgery and highlighted the crucial role of skill and patience when applying hardware in anterior mandibular fractures.

CONCLUSION

The use of double 'Y'-shaped mini plates offers several advantages over traditional lag screws in terms of biomechanical stability and clinical efficacy.

Firstly, the double 'Y'-shaped mini plates are designed to distribute forces more evenly across the fractured mandibular segments. This distribution helps in achieving greater stability of the fracture fixation, which is crucial for promoting successful bone healing and reducing the risk of displacement postoperatively. In contrast, lag screws provide compression at the fracture site but may not offer the same level of stability across the entire fractured area.

Secondly, the anatomical design of the double 'Y'-shaped plates conforms better to the curvature of the mandible, allowing for a more precise fit and minimizing the risk of malocclusion or hardware-related complications. This anatomical adaptation is particularly advantageous in maintaining occlusal stability and ensuring proper alignment during the healing process.

Moreover, double 'Y'-shaped mini plates often require fewer screws compared to lag screws, which can reduce surgical time and potential complications associated with multiple hardware placements. This aspect is beneficial in minimizing surgical trauma and improving patient comfort and recovery outcomes.

Clinically, studies and prospective clinical trials have shown favorable outcomes with the use of double 'Y'-shaped mini plates in terms of reduced postoperative complications, such as infection and hardware prominence, compared to lag screws. Additionally, these plates have demonstrated comparable or superior outcomes in terms of bone healing, functional recovery (including mouth opening and occlusal function), and patient satisfaction.

However, it is important to note that the choice between double 'Y'-shaped mini plates and lag screws should be based on individual patient factors, fracture characteristics, and surgeon preference. While double 'Y'-shaped mini plates offer significant advantages, including enhanced stability, anatomical fit, and reduced hardware volume, further long-term studies and comparative trials are necessary to fully elucidate their superiority over lag screws in specific clinical scenarios.

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