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IMPROVING THE EFFECTIVENESS OF SURGICAL TREATMENT OF MANDIBULAR FRACTURES USING BIODEGRADABLE MINI-PLATES

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Abstract

Mandibular fractures are among the most common injuries of the maxillofacial region and often require surgical intervention to restore anatomical integrity and functional activity of the lower jaw. Traditional titanium fixation systems provide reliable stabilization; however, they are associated with several disadvantages, including the need for secondary surgery for plate removal, stress shielding, and possible allergic or inflammatory reactions. The development of biodegradable mini-plates has opened new perspectives in maxillofacial surgery by reducing postoperative complications and eliminating the necessity for repeated surgical procedures.

The aim of this study was to evaluate the clinical effectiveness of biodegradable mini-plates in the surgical treatment of mandibular fractures. The article analyzes the biomechanical properties, clinical outcomes, postoperative complications, and rehabilitation potential associated with biodegradable fixation systems. Clinical observations demonstrated satisfactory bone healing, reduced postoperative discomfort, favorable tissue compatibility, and decreased risk of long-term complications.

The use of biodegradable mini-plates contributes to improved functional and aesthetic outcomes, shortens rehabilitation time, and enhances patient quality of life. The findings suggest that biodegradable osteosynthesis systems represent a promising alternative to conventional metallic fixation devices in the management of mandibular fractures.

Keywords: mandibular fractures, biodegradable mini-plates, osteosynthesis, maxillofacial surgery, bone healing, biodegradable fixation systems, rehabilitation, surgical treatme

Introduction

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Mandibular fractures account for a significant proportion of maxillofacial injuries due to the anatomical prominence and functional mobility of the mandible. These fractures commonly result from road traffic accidents, sports injuries, falls, interpersonal violence, and occupational trauma. Improper or delayed treatment may lead to serious complications, including malocclusion, temporomandibular joint dysfunction, infection, facial asymmetry, and impaired mastication and speech.

The primary goals of mandibular fracture treatment are anatomical reduction, stable fixation, restoration of occlusion, preservation of mandibular function, and prevention of postoperative complications. Over recent decades, rigid internal fixation using titanium mini-plates has become the gold standard for the management of mandibular fractures. Titanium systems provide excellent mechanical stability and predictable healing outcomes. Nevertheless, metallic fixation devices are associated with several disadvantages, such as palpability, thermal sensitivity, interference with imaging techniques, stress shielding, and the frequent need for secondary removal surgery, especially in young patients.

The introduction of biodegradable fixation systems has significantly expanded the possibilities of modern maxillofacial surgery. Biodegradable mini-plates are composed primarily of polymers such as polylactic acid (PLA), polyglycolic acid (PGA), and their copolymers, which gradually degrade within biological tissues after fulfilling their stabilizing function. These

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systems provide temporary fixation during bone regeneration and subsequently undergo hydrolysis into biocompatible metabolites eliminated by the body.

Biodegradable osteosynthesis devices eliminate the need for additional surgical intervention for hardware removal and reduce long-term foreign body reactions. Their use is especially advantageous in pediatric patients, where metallic plates may interfere with facial growth and development. Despite the growing popularity of biodegradable systems, questions remain regarding their mechanical strength, stability during mastication, degradation behavior, and clinical reliability in complex mandibular fractures.

This study aims to evaluate the effectiveness of biodegradable mini-plates in improving the outcomes of surgical treatment of mandibular fractures and to analyze their advantages and limitations compared with conventional metallic fixation systems.

Materials and Methods

The study included patients diagnosed with mandibular fractures who underwent surgical treatment using biodegradable mini-plate fixation systems. Clinical evaluation was carried out based on patient history, physical examination, radiographic imaging, and assessment of occlusal relationships. Fractures involving the mandibular body, angle, symphysis, and parasymphysis regions were included in the study.

Preoperative assessment involved panoramic radiography and computed tomography to determine fracture localization, displacement degree, and associated soft tissue injuries. Surgical treatment was performed under general anesthesia following standard aseptic protocols. Open reduction and internal fixation were achieved using biodegradable mini-plates and screws adapted according to fracture configuration and anatomical characteristics.

The biodegradable systems used in this study were manufactured from copolymers of polylactic and polyglycolic acids, characterized by gradual hydrolytic degradation over a period of several months. Postoperative management included antibiotic therapy, anti-inflammatory medications, oral hygiene maintenance, and dietary recommendations.

Clinical evaluation criteria included:

- stability of fracture fixation;
- restoration of occlusion;
- postoperative pain and edema;
- wound healing quality;
- presence of infection or inflammatory reactions;
- bone regeneration dynamics;
- functional rehabilitation outcomes.

Radiographic monitoring was conducted periodically to evaluate callus formation, bone consolidation, and degradation behavior of the fixation devices.

Results

The clinical application of biodegradable mini-plates demonstrated satisfactory stabilization of mandibular fractures in the majority of patients. Early postoperative evaluation revealed adequate fixation stability and restoration of functional occlusion. Most patients experienced moderate postoperative edema and pain, which gradually subsided within the first postoperative week.

Radiographic examination confirmed progressive bone healing and satisfactory fracture consolidation without significant displacement of fragments. The biodegradable plates maintained sufficient mechanical support during the critical stages of bone regeneration.

The incidence of postoperative complications was relatively low. Minor inflammatory reactions were observed in isolated cases and were successfully managed with conservative therapy. No severe foreign body reactions or significant plate exposure were noted during follow-up observation.

Patients treated with biodegradable fixation systems reported improved comfort due to the absence of metallic hardware sensation and reduced anxiety related to secondary surgery for

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plate removal. Functional recovery of mastication and mandibular mobility occurred within expected rehabilitation periods.

In pediatric and young adult patients, biodegradable systems demonstrated additional advantages by minimizing interference with mandibular growth and reducing the risk of long-term tissue irritation.

Discussion

The successful treatment of mandibular fractures depends largely on achieving stable fixation while minimizing surgical trauma and postoperative complications. Titanium mini-plates remain highly effective; however, the disadvantages associated with permanent metallic implants continue to stimulate the search for alternative materials.

Biodegradable mini-plates represent an important advancement in craniofacial osteosynthesis. Their ability to gradually degrade after bone healing eliminates the need for implant removal surgery, thereby reducing patient morbidity, healthcare costs, and psychological stress.

The biomechanical properties of biodegradable materials have improved considerably over recent years. Modern polymer-based systems provide adequate rigidity for many mandibular fractures, particularly in regions subjected to moderate functional loads. However, highly comminuted fractures and defects exposed to excessive masticatory forces may still require metallic fixation systems due to their superior mechanical strength.

One of the most important advantages of biodegradable fixation devices is their biocompatibility. The degradation products are metabolized naturally by the body, reducing the risk of chronic foreign body reactions. Furthermore, these systems do not interfere with radiographic imaging and avoid stress shielding phenomena associated with metallic implants.

Despite their advantages, biodegradable systems possess certain limitations. Their mechanical resistance remains lower than titanium systems, and degradation processes may occasionally induce localized inflammatory reactions. Proper patient selection, fracture classification, and surgical technique are therefore critical for successful outcomes.

Future developments in biomaterials engineering may further enhance the mechanical properties, degradation kinetics, and biological integration of biodegradable osteosynthesis systems. The incorporation of bioactive compounds, antibacterial agents, and osteogenic factors into fixation materials represents a promising direction for improving bone healing and reducing postoperative complications.

Conclusion

Biodegradable mini-plates are an effective and promising alternative to conventional metallic fixation systems in the surgical treatment of mandibular fractures. Their use provides adequate stabilization, satisfactory bone healing, reduced postoperative discomfort, and elimination of secondary surgery for hardware removal.

The clinical advantages of biodegradable fixation systems include improved patient comfort, favorable biocompatibility, reduced long-term complications, and enhanced rehabilitation outcomes. These systems are especially valuable in pediatric and young adult patients due to their minimal interference with skeletal growth.

Although biodegradable mini-plates have certain mechanical limitations compared with titanium systems, continuous advancements in biomaterial technology are expanding their clinical applications. Careful patient selection and appropriate surgical planning remain essential for achieving optimal therapeutic results.

The integration of biodegradable osteosynthesis systems into maxillofacial surgery contributes significantly to the modernization of mandibular fracture management and improves the overall effectiveness of surgical rehabilitation.

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