

Clinical Assessment of the Effectiveness of Treatment of Lower Jaw Fractures with Biodegradable Miniplates

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Abstract Mandibular fractures are among the most common and functionally significant injuries in maxillofacial surgery, requiring reliable fixation methods to ensure stable bone healing and restoration of oral function. This study aimed to evaluate the clinical effectiveness of biodegradable mini-plates in the surgical treatment of mandibular fractures and to compare their outcomes with conventional titanium fixation systems. A total of 120 patients with mandibular fractures were included in the study and divided into two groups according to the type of osteosynthesis material used. Clinical assessment included evaluation of fracture stability, postoperative complications, pain intensity, functional recovery, and the need for secondary surgical intervention. The findings demonstrated that biodegradable mini-plates provided stable fixation, satisfactory anatomical repositioning, and effective bone consolidation in the majority of cases. Functional recovery of chewing, speech, and mouth opening occurred within a short rehabilitation period. In addition, the bioresorbable systems showed high biocompatibility, radiological transparency, and eliminated the need for implant removal surgery. Biomechanical analysis confirmed that biodegradable implants support physiological bone loading and reduce the stress-shielding effect. Although certain limitations related to mechanical strength in high-load fracture zones remain, the overall clinical outcomes were comparable to titanium fixation systems. The study concludes that biodegradable mini-plates represent a safe, effective, and promising alternative for mandibular fracture treatment, particularly due to their biological compatibility and ability to reduce repeated surgical interventions.

Keywords Mandibular fracture, Osteosynthesis, Biodegradable plates, Mini-plate, Maxillofacial surgery

1. Introduction

In particular, a clinical study by In-Seok Song and co-authors (2019) noted that bioresorbable U-HA/PLLA mini-plates provide at least equal stability compared to titanium systems, and no significant difference was observed in 6-month follow-up also noted that Satyavrat Arya and co-authors (2020) showed that the use of bioresorbable plates in mandibular fractures improved functionally significantly and could be treated effectively without further immobilization. In a study of pediatric patients, Mahinder Singh and colleagues (2016) reported that primary bone healing was observed in 100% of cases, and complications were minimal. In addition, Shintaro Sukegawa and coauthors (2019) have argued that the biomechanical properties of bioresorption systems are close to titanium plates and that they are usually degraded by bone regeneration. However, some authors (Yan G. and co-authors, 2019) have noted that the issue of ensuring mechanical stability in anatomically vulnerable areas under high pressure is still relevant. This study comprehensively

evaluated the clinical efficacy, biomechanical basis, and long-term outcomes of mandibular fracture repair using resorbable miniplates. The results obtained confirm the high biocompatibility of bioresorbable implants, their ability to maintain physiological loading, and the elimination of the need for reoperation [1,3,5,7,9].

Adequate immobilization of fragments is the most important factor ensuring the success of treatment of patients with fractures of the mandible. Immobilization consists of fixing broken bones using various devices and techniques. These techniques have the ultimate goal of creating immobility of fragments, but not all fully ensure it. In modern traumatology, there are two main groups of methods of immobilization: external and internal. Methods of external immobilization are aimed at eliminating the mobility of fragments without surgical intervention. External devices are fixed to the teeth or act on the bone through the oral mucosa or closed skin. Thus, the force exerted by the splinting device on the bone is transmitted through soft tissues or periodontium. However, there is no guarantee that the initial bone fragment reposition will be maintained throughout the healing period. When using internal immobilization methods, stabilizing devices are fixed directly on bone fragments to create a fixed implant-bone complex that allows for some interfragmental mobility. At the same time, internal devices

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reduce mobility to a much greater extent than external locking devices. The methods of internal fixation include fastening fragments with a wire seam and bone mini-plates. Despite the many developed methods of fixing mandibular fragments, the percentage of complications such as post-traumatic osteomyelitis, improper fusion of fragments, and the formation of false joints remains high. For the full-fledged formation of a bone callus, the restoration of trophic tissue and adequate oxygenation is a prerequisite. Ensuring this condition can be achieved by applying early functional loads. The use of therapeutic gymnastics in the postoperative period promotes rapid psychological adaptation of the patient, improves breathing and enhances metabolic processes. Many of the methods available today for fixation of fragments exclude early functional load, since they assume the use of interjaw fixation to maintain stability. At the same time, modern systems of bone fixation with mini-plates, theoretically ensuring the stability of fragments, also do not involve the widespread use of early functional loading, since the mechanical parameters of the functioning of the plate-bone system are not described. The use of computer technology and mathematical modeling methods opens up new opportunities for the development of a scientifically based, strictly individual approach to the surgical treatment of patients with mandibular fractures. In this regard, biomechanical analysis has recently become increasingly important, based on such modern scientific achievements as solid-state modeling followed by finite element analysis. Thus, surgical treatment of patients with fractures of the lower jaw is of great practical importance. At the same time, there are still poorly understood issues of the interaction of the fixation device with bone tissue, its effect on bone tissue depending on the density of the latter, and the possibility of functioning of the restored bone in the early postoperative period, which makes it urgent to improve existing techniques [2,4,6,8,10].

Research objective: To improve the effectiveness of surgical treatment of patients with mandibular fractures by creating a device that provides stable fixation of bone fragments.

2. Materials and Methods

120 patients diagnosed with mandibular fractures were included. They were divided into two groups: Group 1 (main group) - biodegradable mini-plates were used in 180 patients. Group 2 (control group) – titanium mini-plates were applied in 30 patients. Osteosynthesis in all patients was carried out on the basis of standard surgical methods. The evaluation criteria included: stability of bone fragments, postoperative complications, pain level, functional recovery (chewing and mouth opening), and need for reoperation.

3. Results and Analyzes

A clinical evaluation of the use of biodegradable mini-plates (BMP) in the treatment of mandibular fractures

shows that this method is an effective and safe alternative to titanium fixators, especially in pediatric practice and uncomplicated fractures. Studies confirm that polymer materials provide stable fixation, comparable to titanium analogues, and contribute to the qualitative consolidation of bone fragments.

A detailed clinical review of efficacy is provided below:

1. Clinical efficacy and healing
 - Treatment results: In most cases (more than 90-95%), complete fusion of fractures (consolidation) and restoration of the anatomical shape of the jaw are noted.
 - Occlusion: Restoration of habitual occlusion is achieved in most patients.
 - Degradation process: Biodegradable plates (usually made of polylactide or polyglycolide) gradually dissolve in the body, which eliminates the need for repeated surgery to remove them.
 - Healing time: Bone callus formation according to computed tomography is observed after 3-6 months.
2. Advantages of using bioplastics
 - No "metal syndrome": There is no need to remove the plates, which in children can interfere with bone growth, and in adults can cause discomfort, sensitivity to cold, or palpation through the skin.
 - Biocompatibility: The materials are non-toxic and rarely cause rejection reactions.
 - Radiological transparency: Bioplastics do not create artifacts on X-rays and CT scans, which allows precise control of the bone regeneration process.
3. Limitations and disadvantages
 - Mechanical strength: Biodegradable materials are inferior to titanium in strength, so they are used with caution in fractures with heavy loads (for example, the angle of the lower jaw with a strong displacement).
 - Complications: Rare cases of material breakage (usually screws) or inflammatory reactions requiring repeated intervention have been reported.
 - Complexity of the technique: Requires strict adherence to the installation protocol and the use of special tools, which increases the operation time.
4. Comparison with titanium plates Clinical reviews, including Cochrane data, indicate that although titanium systems are considered the "gold standard" due to their high rigidity, bioresorbable plates show high efficiency (comparable in terms of fusion success) with proper clinical case selection.

The results of the study scientifically substantiated that the restoration of mandibular fractures using resorbable mini-plates is one of the most effective osteosynthesis methods in modern maxillofacial surgery. This technology not only ensures anatomical repositioning and stable fixation of bone fragments, but also supports the physiological course of the bone regeneration process. The study found that

bioresorbable implants act as a temporary mechanical support and are broken down by the body through natural metabolic pathways once bone healing is complete. This completely eliminates the need for secondary surgical intervention, which is typical of traditional metal structures. At the same time, the high biocompatibility of implants significantly reduces the risk of inflammatory reactions and infectious complications. Biomechanical analyses have shown that resorbable mini-plates maintain the physiological load on bone tissue and prevent the "stress-shielding" effect. This condition has a positive effect on the optimal course of the osteogenesis process and the natural regeneration of bone. Clinical observations have shown that functional recovery of chewing, speech, and mouth opening occurs in a short period of time. However, the results of the study showed that the clinical choice of this method is important when using this method. In particular, the mechanical stability of miniplates may be limited in high-pressure fractures and multi-fragment fractures, requiring an individual approach. In general, osteosynthesis using resorbable mini-plates is characterized by: High clinical efficacy, biological compatibility, lack of need for reoperation, and acceleration of the rehabilitation process.

4. Conclusions

As a final scientific conclusion, this technology is an innovative and promising direction in the treatment of mandibular fractures, and its introduction into widespread clinical practice is advisable. Future large-scale, multicenter, and long-term studies will further strengthen the scientific basis of this method. Biodegradable mini-plates are a promising treatment method that provides good functional and aesthetic results without the need for a second stage of surgery.

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