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MODERN OSTEOSYNTHESIS IN THE TREATMENT OF MANDIBULAR FRACTURES: CLINICAL OUTCOMES AND COMPLICATIONS

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Abstract. This study examines modern osteosynthesis methods used in the treatment of mandibular fractures, with particular attention to their clinical effectiveness, functional outcomes, and possible postoperative complications. The paper discusses the use of titanium miniplates, locking plate systems, three-dimensional plates, and reconstruction plates in achieving stable fixation and restoration of mandibular anatomy. Particular emphasis is placed on bone healing, restoration of dental occlusion, mandibular function, and the prevention of complications such as infection, malocclusion, neurosensory disturbances, delayed union, nonunion, and hardware-related problems. The importance of accurate diagnosis, appropriate fixation technique, careful surgical planning, and postoperative monitoring in improving treatment outcomes is also highlighted.

Keywords: mandibular fracture, osteosynthesis, titanium miniplates, locking plates, three-dimensional plates, reconstruction plates, internal fixation, clinical outcomes, postoperative complications, maxillofacial surgery.

Mandibular fractures are among the most common traumatic injuries of the maxillofacial region and represent an important clinical problem in oral and maxillofacial surgery. Due to the prominent anatomical position and mobility of the mandible, it is highly susceptible to trauma caused by road traffic accidents, falls, sports injuries, interpersonal violence, and occupational accidents. Fractures may occur in different anatomical regions of the mandible, including the symphysis, parasymphysis, body, angle, ramus, and condylar process. Depending on the location, degree of displacement, presence of associated soft-tissue injuries, and general condition of the patient, mandibular fractures may significantly impair mastication, speech, swallowing, occlusion, and facial symmetry.

The primary goal of treatment is to restore the anatomical continuity of the mandible, achieve stable fixation of bone fragments, re-establish normal dental occlusion, and enable early functional recovery. In recent decades, the management of mandibular fractures has undergone significant development with the introduction of modern osteosynthesis techniques. Open reduction and internal fixation using titanium miniplates, reconstruction plates, locking plate systems, and various screw-based fixation methods has become widely used in clinical practice. These techniques provide greater stability of bone fragments and may allow earlier mobilization compared with prolonged maxillomandibular fixation.

Modern osteosynthesis is based on the principles of accurate fracture reduction, stable fixation, preservation of blood supply, and early restoration of function. Depending on the type and location of the fracture, surgeons may use monocortical or bicortical screws, conventional miniplates, three-dimensional plates, locking systems, or load-bearing reconstruction plates. Selection of an appropriate fixation method is influenced by fracture complexity, bone quality, degree of comminution, presence of infection, dental status, and surgeon experience.

Despite considerable improvements in surgical techniques and fixation materials, postoperative complications remain an important concern. Possible complications include surgical site infection, malocclusion, delayed union, nonunion, plate exposure, hardware failure,

neurosensory disturbances, wound dehiscence, and limitation of mandibular movement. The frequency and severity of these complications depend on multiple factors, including fracture pattern, timing of surgery, oral hygiene, smoking, systemic diseases, treatment technique, and patient compliance.

Therefore, evaluating the clinical effectiveness and safety of modern osteosynthesis methods is essential for improving treatment outcomes in patients with mandibular fractures. Analysis of postoperative healing, functional recovery, restoration of occlusion, complication rates, and the need for secondary interventions can help determine the advantages and limitations of different fixation techniques. The present study focuses on the use of contemporary osteosynthesis methods in mandibular fracture treatment, with particular attention to clinical outcomes, postoperative complications, and factors influencing successful recovery.

Modern osteosynthesis plays a central role in the surgical treatment of mandibular fractures. The main objective of this approach is to achieve accurate repositioning of the fractured bone segments and maintain their stability throughout the healing period. Stable fixation allows restoration of the normal anatomical shape of the mandible, dental occlusion, masticatory function, and facial symmetry. In comparison with prolonged maxillomandibular fixation, modern internal fixation methods often provide earlier mandibular movement, improved patient comfort, and faster return to normal daily activities.

Several osteosynthesis systems are currently used depending on the location and severity of the fracture. Titanium miniplates are among the most commonly applied fixation devices because of their biocompatibility, mechanical strength, relatively low profile, and ease of adaptation to the mandibular surface. In simple and minimally displaced fractures, one or two miniplates with monocortical screws may provide sufficient stability. In more complex fractures, especially comminuted fractures or fractures associated with significant bone defects, reconstruction plates or locking plate systems may be required.

Locking plate systems offer several advantages in selected clinical situations. In these systems, the screw locks directly into the plate, creating a more stable construct and reducing the need for perfect contact between the plate and bone surface. This may help preserve periosteal blood supply and decrease the risk of bone compression beneath the plate. Such systems are particularly useful in fractures with poor bone quality, severe displacement, multiple fragments, or increased mechanical load.Three-dimensional plate systems have also been introduced for the management of mandibular fractures. These plates are designed to provide multidirectional stability and resistance to torsional forces. Their geometric configuration may improve fixation while reducing the number of screws required in some cases. However, their effectiveness depends on the fracture pattern and anatomical region. Therefore, the choice of fixation system should always be based on individual clinical and radiological evaluation.

The surgical approach may be intraoral, extraoral, or combined. An intraoral approach has the advantage of avoiding visible facial scars, while an extraoral approach may provide better visualization in complex fractures. Regardless of the surgical approach, precise reduction of bone fragments and restoration of pre-traumatic occlusion are essential. Intraoperative assessment of dental occlusion is especially important because even minor displacement may result in postoperative malocclusion and functional impairment.

Clinical outcomes after osteosynthesis are generally evaluated according to several parameters, including bone healing, restoration of occlusion, mandibular mobility, reduction of pain and swelling, return of sensory function, and absence of infection. Successful treatment is characterized by stable union of the fracture, symmetrical mandibular movement, normal or near-normal mouth

opening, and satisfactory chewing function.Despite improvements in fixation systems and surgical techniques, complications may still occur. Postoperative infection is one of the most common complications and may be associated with poor oral hygiene, delayed treatment, open fractures, smoking, systemic disease, or contamination of the surgical field. Infection may present with pain, swelling, purulent discharge, wound dehiscence, or plate exposure. Management may include antibiotic therapy, local wound care, drainage, and, in severe cases, removal or replacement of fixation hardware.Malocclusion is another clinically important complication. It may occur as a result of inadequate fracture reduction, improper fixation, undetected associated fractures, or postoperative displacement of bone fragments.

Mild occlusal disturbances may sometimes be corrected with short-term elastic guidance, whereas severe cases may require secondary surgical intervention.

Neurosensory complications are particularly relevant in fractures involving the mandibular body, angle, and parasymphysis because of the close relationship with the inferior alveolar nerve. Patients may experience temporary or persistent numbness, tingling, or altered sensation of the lower lip and chin. The risk of nerve dysfunction depends on the initial trauma, degree of displacement, surgical manipulation, and location of screw placement.

Other possible complications include delayed union, nonunion, hardware loosening, screw fracture, plate fracture, wound dehiscence, limited mouth opening, and chronic pain. Delayed union or nonunion may be associated with inadequate stability, infection, poor vascularity, severe comminution, or systemic factors that interfere with bone healing. Careful preoperative planning, stable fixation, appropriate postoperative care, and regular follow-up are therefore essential for reducing complication rates.Postoperative management is also an important part of successful treatment. Patients are usually advised to maintain adequate oral hygiene, use antiseptic mouth rinses, follow a soft or semi-liquid diet, avoid excessive mechanical loading, and attend regular follow-up visits. Analgesics and antibiotics may be prescribed when clinically indicated. Early controlled mandibular exercises may help prevent joint stiffness and improve functional recovery.

Modern imaging techniques, particularly computed tomography and three-dimensional reconstruction, have significantly improved preoperative evaluation of mandibular fractures. These methods allow accurate assessment of fracture lines, displacement, comminution, and involvement of adjacent anatomical structures. In complex cases, virtual surgical planning and patient-specific fixation devices may further improve surgical precision and predictability.Overall, successful treatment of mandibular fractures depends not only on the fixation system itself but also on fracture characteristics, surgical technique, timing of treatment, patient-related risk factors, and postoperative compliance. Modern osteosynthesis has expanded the possibilities of stable fixation and early functional rehabilitation, but careful patient selection and individualized treatment planning remain essential.

Modern osteosynthesis methods have significantly improved the management of mandibular fractures by providing stable fixation, accurate anatomical reduction, restoration of occlusion, and earlier functional rehabilitation. Titanium miniplates, locking plate systems, three-dimensional plates, and reconstruction plates offer different mechanical advantages and can be selected according to the location, complexity, and severity of the fracture.Clinical outcomes are generally favorable when appropriate fixation methods are combined with accurate reduction, atraumatic surgical technique, infection control, and proper postoperative care. Nevertheless, complications such as infection, malocclusion, neurosensory disturbances, delayed union, nonunion, and hardware-related problems may still occur.

Therefore, the choice of osteosynthesis technique should be individualized for each patient. Careful diagnosis, detailed preoperative planning, precise surgical execution, and regular postoperative monitoring are essential for reducing complications and achieving optimal functional and aesthetic results. Further clinical studies comparing different fixation systems may help improve treatment protocols and contribute to the development of safer and more effective methods for the management of mandibular fractures.

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