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Mandibular Fracture Fixation: A Comprehensive Review Of Resorbable Vs Titanium Plates

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Abstract

The management of mandibular fractures has evolved considerably with the advent of rigid internal fixation. This review article provides a comprehensive synthesis of the last decade of literature, comparing the use of titanium and bioresorbable plates. We examine their distinct biomechanical properties, clinical outcomes, patient-reported satisfaction, and economic implications. While titanium remains the established benchmark due to its superior mechanical strength and reliability in complex, high-stress fractures, recent evidence suggests that resorbable plates are a viable, and often superior, alternative for specific indications. The primary advantage of resorbable systems is their ability to provide temporary fixation followed by complete absorption, thereby avoiding the need for a second surgery for hardware removal. The review concludes that the optimal choice of material is not universal but must be tailored to the specific fracture type, patient demographics, and surgeon's expertise, reflecting a shift towards a more personalized approach to care.

Key words : Mandibular fracture, stable bone fixation, titanium plates,bioresorbable polymers

Introduction

The modern surgical management of mandibular fractures centers on achieving stable bone fixation to restore function and occlusion. For over three decades, titanium plates have been the undisputed standard of care, lauded for their inert nature, exceptional strength-to-weight ratio, and proven track record. This approach has largely replaced historical methods like intermaxillary fixation, which caused prolonged patient discomfort and a high rate of complications. However, the permanence of titanium hardware is not without drawbacks, including the risk of palpable implants, thermal sensitivity, and most significantly, the potential need for a second surgical procedure for hardware removal. In response to these limitations, bioresorbable polymers, primarily derived from poly-L-lactic acid (PLLA) and polyglycolic acid (PGA), have emerged as a promising alternative. These materials are engineered to provide adequate mechanical support during the critical healing

phase before gradually breaking down and being absorbed by the body. The following review delves into the key aspects of this material choice, drawing upon the latest evidence to inform clinical practice.

Biomechanical Properties and Clinical Performance

The fundamental difference between titanium and resorbable plates lies in their mechanical behavior and how they interact with the healing bone.

- Titanium's Static Rigidity: Titanium's high modulus of elasticity provides robust, static fixation that is crucial for resisting the powerful and complex forces exerted on the mandible during mastication [12, 19]. This rigidity ensures a stable environment for healing, which is particularly vital in comminuted or highly unstable fractures. However, this superior stiffness can lead to stress shielding, where the plate bears the majority of the mechanical load, potentially hindering the bone's natural remodeling and strengthening process [12].

- Resorbable's Dynamic Support: Resorbable plates are designed to provide a dynamic form of support. Their lower initial mechanical strength and elasticity allow for a more gradual transfer of stress to the healing bone as the implant degrades over time [16]. This controlled degradation, a process of hydrolysis, provides a "temporary scaffold" that supports the fracture and then disappears, promoting a more natural bone healing trajectory [16]. While some early resorbable plates were prone to greater deformation, recent advancements in polymer composites have significantly improved their strength, making them suitable for an increasing number of fracture types.

Clinical Outcomes and Complication Rates

Recent systematic reviews and meta-analyses provide a clear picture of the comparative clinical outcomes. Multiple studies conclude that there is no statistically significant difference in overall complication rates—including infection, malunion, or non-union—between patients treated with resorbable and titanium plates for a broad range of fractures [5, 6]. However, a key distinction emerges in the incidence of hardware-specific complications. Titanium plates are associated with a higher rate of elective hardware removal, a procedure that is frequently performed in pediatric patients to prevent growth interference or in adults who experience symptoms such as pain, thermal sensitivity, or plate palpability [2, 17]. The use of resorbable plates completely eliminates the need for this second, often costly, surgical intervention.

Patient-Centered and Economic Considerations

The choice of fixation material has profound implications for a patient's quality of life and the overall cost of care.

- Patient Satisfaction: Studies on patient satisfaction reveal that while both methods yield good functional outcomes, the elimination of a second surgery is a significant driver of patient satisfaction with resorbable plates [17, 18]. The peace of mind that comes from a hardware-free recovery and the avoidance of a second round of anesthesia, hospital stay, and post-operative discomfort are major benefits that are difficult to quantify. Cost-

- Effectiveness: Although the initial cost of resorbable plates is higher than that of titanium, a

True cost-effectiveness analysis must account for the total cost of care [13]. The expenses associated with a second surgery for hardware removal—including operating room time, anesthesia, hospital fees, and lost income for the patient—can quickly make the titanium option more expensive in the long run. For a growing number of cases, resorbable plates represent a more economically sound choice for both the patient and the healthcare system.

Surgical and Fracture-Specific Indications

The decision to use one material over the other should be based on a careful assessment of the fracture type, location, and patient age.

● Ideal Candidates for Titanium: Titanium remains the definitive choice for high-stress fractures, particularly those in the mandibular angle and body, or in cases of severe comminution and displacement [8, 14]. Its unwavering stability is paramount in these complex situations. Additionally, a surgeon's familiarity and comfort with titanium's handling characteristics may also influence its use.

● Ideal Candidates for Resorbable Plates: Resorbable plates are highly recommended for low-stress fractures, such as those in the symphysis or parasymphysis [9]. They are also the preferred choice for pediatric patients, where the risks of growth restriction and the high probability of future hardware removal make titanium a less favorable option [2]. Their use in condylar fractures is also gaining traction, as they avoid the risks associated with placing permanent hardware in the anatomically sensitive area of the temporomandibular joint [15].

Future Directions and Innovations

The future of maxillofacial fixation is characterized by rapid innovation. Research is focused on developing new generations of resorbable materials with improved mechanical properties and a more predictable degradation profile [16]. Emerging technologies are poised to revolutionize the field:

● 3D Printing: Patient-specific resorbable implants, precisely contoured to the patient's unique anatomy using 3D printing, are becoming a reality. This technology promises to improve surgical accuracy, reduce operative time, and enhance aesthetic outcomes [2].

● Smart Implants: The next frontier involves developing "smart" resorbable implants that can do more than just provide support. These implants could potentially release antibiotics to prevent infection or deliver growth factors to accelerate bone healing, integrating therapy directly into the fixation process.

● Hybrid Systems: A combination of both materials in a single case is also being explored, using a small titanium plate for initial rigid fixation and a resorbable plate for secondary support and long-term stability.

In conclusion, while titanium has served as a reliable cornerstone of maxillofacial surgery, the field is moving towards a more individualized approach. Resorbable plates are no longer a niche alternative but a legitimate and often superior choice for a growing number of cases, representing the next step in providing safer, more efficient, and patient-centered care.

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