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The Impact of Different Osteosynthesis Techniques on Postoperative Outcomes in Parasymphysis Mandibular Fracture Management: A Review

[1]Dr. C.S. Sathish Kumar

[2]Dr. Dharani Bai KB

[3]Dr. Dharshini Priya K

[4]Dr. Pradeep Christopher

[5]Dr. K. Senthil Kumar

[1]Reader [2]House Surgeon [3]House Surgeon

[4]Professor, HOD [5]Professor

Abstract

Parasymphysis mandibular fractures present unique biomechanical and anatomical challenges due to complex tensile, compressive, and torsional forces in the anterior mandible. Various osteosynthesis techniques, including rigid reconstruction plates, semi-rigid miniplates, lag screws, hybrid systems, and interosseous wiring, are employed to restore mandibular function, aesthetics, and stability. Rigid fixation offers absolute stability and is indicated in comminuted or edentulous fractures, while semi-rigid miniplates preserve periosteal blood supply and are preferred for simple, non-comminuted fractures. Screw selection, single versus double plating, and load-sharing versus load-bearing approaches influence clinical outcomes. Postoperative evaluation demonstrates generally favorable functional recovery, with stable occlusion, restored masticatory efficiency, and early rehabilitation. Complications, including infection, hardware failure, and sensory disturbances, remain low, particularly with single high-profile miniplates and appropriately applied lag screws. Optimal outcomes are achieved by tailoring fixation strategies to fracture pattern, bone quality, and biomechanical requirements, emphasizing evidence-based, patient-specific decision-making.

Keywords: Parasymphysis fracture, Mandible, Osteosynthesis, Miniplates, Reconstruction plate

Introduction

The parasymphysis region of the mandible, located laterally adjacent to the symphysis and roughly bounded by the roots of the mandibular canines, represents the anterior portion of the mandibular body just lateral to the midline of the chin.[1] Biomechanically, this region is subjected to complex forces during function, with the superior border experiencing tensile stress and the inferior border enduring compressive forces during mastication, while bilateral torsional and bending stresses occur during activities such as biting and clenching. These forces influence fracture patterns, which commonly present as non-comminuted transverse or oblique fractures, although combined parasymphysis and bilateral subcondylar fractures may lead to gonial angle splaying, necessitating careful reconstruction to restore mandibular arch form.[2] Clinically, stable fixation of parasymphysis fractures is essential for maintaining mandibular function, including mastication, speech, and occlusal relationships, as well as achieving favorable aesthetic outcomes given the anterior prominence of this region. Inadequate or improper fixation can result in malocclusion, mandibular instability, altered biomechanics, functional deficits, and unfavorable cosmetic results.[3] Despite the long-standing use of miniplate fixation along Champy's "ideal lines" and the availability of various techniques including single or dual miniplates, lag screws, spanning plates, and wiring methods there remains significant variability in clinical practice and no clear consensus on the optimal approach for all fracture types.[4] The challenge lies in balancing operative efficiency, hardware profile, biomechanical stability, and complication risk, emphasizing the need for continued comparative evaluation to guide standardized, fracture- and patient-specific treatment strategies that restore both function and aesthetics.[5] This article gives an overview on the impact of different osteosynthesis techniques on postoperative outcomes in parasymphysis mandibular fracture management.

Review of Literature

The impact of different osteosynthesis techniques on postoperative outcomes in the management of parasymphysis mandibular fractures demonstrates notable variability in complication rates, healing patterns, and recovery timelines.[4] Comparative studies have consistently highlighted that the choice of fixation system plays a critical role in influencing clinical outcomes such as infection, malocclusion, hardware failure, and bone healing.[5] For instance, evaluations of single versus dual miniplate osteosynthesis indicate that single high-profile miniplates are associated with fewer complications, including reduced incidence of iatrogenic dental injuries and postoperative infections, compared to the use of two miniplates (Ehrenfeld et al), suggesting that a less invasive yet biomechanically adequate approach can be beneficial in selected cases.[6] When comparing transosseous wiring to miniplate fixation, miniplates have shown marginally lower rates of postoperative infection and malocclusion, although these differences often do not reach statistical significance (Razziq et al., 2020), highlighting that both methods remain clinically viable but that miniplates may offer enhanced functional stability and patient comfort.[7] Additionally, the use of locking versus non-locking miniplates has been shown to confer improved mechanical stability and more predictable healing outcomes without significantly prolonging operative time (Bandyopadhyay et al., 2020), making locking systems a favorable option in fractures requiring precise anatomical reduction.[8] Multicenter audits report that approximately 76.9% of patients undergoing parasymphysis fracture repair remain free from major complications, with nerve injuries and postoperative infections being the most frequently observed adverse events; these outcomes are notably influenced by the type of osteosynthesis employed, surgeon experience, and patient-specific factors such as fracture complexity and bone quality (Balasundram et al., 2020).[9] Despite these observations, the overall effectiveness of each osteosynthesis technique can vary depending on individual anatomical and clinical considerations, underscoring the necessity for a personalized, evidence-based approach to selecting fixation methods.[9]

Classification of Osteosynthesis Techniques

Rigid and Semi-Rigid Fixation in Parasymphysis Mandibular Fractures

Osteosynthesis of parasymphysis mandibular fractures can be broadly classified into rigid and semi-rigid fixation, each offering distinct biomechanical properties and clinical implications. Rigid fixation utilizes reconstruction plates or load-bearing plates to provide absolute stability by effectively resisting torsional and bending forces, bearing the full functional load, and preventing interfragmentary motion, thereby facilitating direct primary bone healing without callus formation.[10] This approach is particularly indicated in comminuted fractures, edentulous mandibles with compromised bone quality, and fractures with unfavorable patterns that demand strong stabilization. The key advantages of rigid fixation include high mechanical rigidity, prevention of micromotion, and suitability for fractures subjected to significant functional stress.[11] However, the technique is associated with certain limitations, including bulkier hardware, longer operative times, and the need for extensive periosteal stripping, which can compromise blood supply and potentially affect bone and soft tissue healing. In contrast, semi-rigid fixation, typically achieved using Champy's miniplates or monocortical plates, functions as a load-sharing system, allowing controlled micromotion at the fracture site.[12] This preserves periosteal blood supply and promotes secondary bone healing through callus formation, making it ideal for simple, non-comminuted parasymphysis fractures in dentate patients with good bone quality where anatomical reduction can be accurately achieved. Advantages of semi-rigid fixation include reduced risk of injury to the mental nerve and tooth roots, less bulky hardware, shorter operative times, and better preservation of vascular supply to the fracture site. Nevertheless, its mechanical strength is lower compared to rigid plates, rendering it less suitable for comminuted or severely displaced fractures where higher stability is required to withstand functional loads.[13]

Other Osteosynthesis Techniques

In addition to rigid and semi-rigid fixation, several alternative or adjunctive osteosynthesis methods are employed in parasymphysis mandibular fracture management, depending on fracture complexity and patient-specific factors. Lag screws are particularly useful for simple, oblique fractures, providing rigid interfragmentary compression and enabling early functional restoration; they are relatively quick and cost-effective but require precise surgical technique and are limited in comminuted fractures due to the risk of stress shielding.[14] Bioresorbable plates offer the advantage of avoiding long-term hardware complications and eliminating the need for removal, making them suitable for younger patients or individuals with metal allergies; however, their lower mechanical strength and variable degradation rates restrict their use in load-bearing regions. Hybrid systems, which combine elements of rigid and semi-rigid fixation such as three-dimensional plates or a combination of miniplates and lag screws are particularly valuable in complex or mixed-pattern fractures where conventional techniques alone may not provide sufficient stability.[15] Interosseous wiring, including single-loop or figure-of-eight configurations, remains a viable option in resource-limited settings, achieving semi-rigid fixation with biomechanical performance approaching that of miniplates, though plating continues to be the standard of care due to superior stability and predictability. Comparative studies highlight that the use of a single AO locking reconstruction plate for linear non-comminuted parasymphysis fractures can reduce operative time and hardware bulk without compromising fracture healing, postoperative occlusion, or masticatory function, whereas load-sharing miniplates are generally preferred for simple, non-comminuted fractures and load-bearing reconstruction plates are reserved for more complex or displaced fractures.[16] Lag screws, when anatomical conditions allow, typically require at least two screws to neutralize rotational forces and provide three-dimensional stability. Overall, while multiple osteosynthesis options exist, the selection of the optimal technique should be guided by fracture pattern, bone quality, and biomechanical demands to achieve the best postoperative outcomes, balancing functional recovery, stability, and surgical efficiency.[17]

Comparative Considerations in Osteosynthesis: Miniplates, Reconstruction Plates, and Screw Selection

The choice of osteosynthesis in parasymphysis mandibular fractures involves careful consideration of plate type and screw configuration to balance stability, healing, and surgical efficiency. Miniplates, typically 2.0 mm or smaller, function as load-sharing devices that allow controlled micromotion, thereby preserving periosteal blood supply, and are generally favored for simple, non-comminuted fractures in dentate patients.[18] In contrast, rigid reconstruction plates are thicker, load-bearing systems designed to resist full functional loads, making them suitable for comminuted fractures or edentulous mandibles; however, they are bulkier, require longer operative times, and may compromise periosteal blood supply. Finite element analyses and clinical studies suggest that miniplates provide sufficient stability within physiological limits and may offer particular advantages in bilateral parasymphysis fractures, while reconstruction plates can reduce the need for prolonged maxillomandibular fixation.[19] Regarding miniplate configuration, single miniplate fixation is less time-consuming, preserves periosteal vascularity, and is effective for many simple fractures, whereas double miniplate fixation enhances mechanical stability in fractures subject to higher functional demands or displacement and may lower the risk of malocclusion or deviation; studies indicate that double miniplates can reduce complications such as plate exposure and occlusal issues in mandibular angle fractures, suggesting similar benefits may apply to the parasymphysis region.[20] Screw selection also influences outcomes: monocortical screws engage only the outer cortex, minimizing the risk of injury to tooth roots and neurovascular structures, and support load-sharing osteosynthesis in line with Champy's principles; bicortical screws engage both cortices, providing more rigid fixation, and are typically employed with load-bearing plates or lag screws for displaced or comminuted fractures. In clinical practice, monocortical screws are preferred for most parasymphysis fractures to balance stability and safety, reserving bicortical screws for cases where maximal rigidity is required.[21]

Postoperative Outcomes Following Parasymphysis Mandibular Fracture Management

Postoperative outcomes following parasymphysis mandibular fracture management are generally favorable when appropriate osteosynthesis techniques are employed, with consistent restoration of function, bone healing, and low complication rates.[22] Functional recovery typically includes stable occlusion, effective masticatory efficiency, and restored mandibular mobility, allowing early functional rehabilitation and timely removal of maxillomandibular fixation in many protocols. Sensory deficits related to the inferior alveolar nerve are usually transient and primarily attributable to preoperative trauma rather than surgical intervention, resolving within weeks to months.[23] Radiographic follow-up demonstrates fracture union within approximately 4 to 8 weeks, with evidence of callus formation and bone continuity; non-union or malunion is uncommon when fixation is correctly applied, though delayed healing may occur in cases of infection or poor bone quality. Hardware stability is generally maintained, with minimal incidences of plate fracture or loosening, particularly when modern titanium systems are used. Complication rates remain low, with postoperative infections ranging from 1% to 7% and being largely manageable with conservative measures. Sensory disturbances affecting the mental or inferior alveolar nerve occur in 7–10% of cases but tend to resolve over time, while soft tissue irritation and plate exposure are less frequent with intraoral approaches. Operative parameters vary with fracture complexity and fixation method, typically ranging from 30 to 90 minutes for surgical time, minimal intraoperative blood loss, and an average hospital stay of 4 to 7 days, largely influenced by systemic factors or postoperative infections.[24] Comparative studies indicate that single high-profile miniplate fixation is associated with shorter operating times and fewer postoperative complicationsn such as root injury, plate exposure, wound dehiscence, and the need for secondary hardware removal compared to dual miniplate techniques, without compromising occlusal stability or fracture healing. Similarly, lag screw fixation, when applied appropriately, provides rigid interfragmentary compression and stable three-dimensional fixation, resulting in favorable functional and radiographic outcomes.[25]

Conclusion

This Review indicates that parasymphysis mandibular fractures can be effectively managed using a variety of osteosynthesis techniques, with outcomes largely dependent on fracture pattern, bone quality, and biomechanical demands. Single high-profile miniplates and semi-rigid load-sharing systems provide adequate stability for simple, non-comminuted fractures, minimizing operative time, hardware bulk, and postoperative complications, while rigid reconstruction plates and bicortical screws are preferred for comminuted, displaced, or edentulous fractures requiring maximal load-bearing support. Lag screws and hybrid systems offer additional options in anatomically favorable or complex cases. Future research should focus on high-quality comparative studies, including randomized controlled trials and long-term functional and aesthetic outcomes, as well as biomechanical modeling to optimize personalized fixation strategies and develop standardized, evidence-based guidelines for parasymphysis fracture management.

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