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MODERN METHODS OF OSTEOSYNTHESIS IN MANDIBULAR FRACTURES: TOWARD STABLE, COMPLICATION-SPARING FIXATION

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Abstract

Modern osteosynthesis for mandibular fractures has shifted from wire fixation and prolonged maxillomandibular fixation toward rigid and semi-rigid internal fixation concepts that enable early function and lower complication rates. Contemporary strategies are grounded in AO load-bearing and load-sharing principles and include monocortical miniplates along Champy's ideal osteosynthesis lines, locking plate–screw systems, three-dimensional (3D) plates, lag screws, and bioresorbable plating systems. Evidence from comparative studies suggests that 3D plates and lag screws can reduce postoperative complications or operative time in selected fracture patterns, while locking plates improve stability in more demanding situations. Bioresorbable systems are increasingly used for linear, non-displaced fractures, particularly where hardware removal is undesirable. This narrative review summarizes the biomechanical principles underlying modern mandibular osteosynthesis, describes key fixation systems, and discusses their indications, advantages, and limitations. A descriptive comparison of methods and an illustrative analysis of complication trends are provided to support evidence-based selection of fixation strategies in clinical practice.

Keywords: mandibular fractures, osteosynthesis, miniplates, locking plates, 3D plates, lag screws, bioresorbable fixation

Introduction

Management of mandibular fractures has evolved from intermaxillary fixation and wire osteosynthesis to rigid and semi-rigid internal fixation using plates and screws that support early mandibular function. This transition reflects improved understanding of biomechanics, infection control, and the impact of prolonged immobilization on nutrition and airway safety.

According to AO maxillofacial principles, current osteosynthesis strategies are broadly categorized into load-bearing and load-sharing constructs, selected based on fracture pattern, bone quality, and functional loading. Load-sharing miniplates along Champy's lines are used for simple fractures with good cortical contact, whereas reconstruction or heavy plates provide load-bearing fixation for comminuted, atrophic, or segmental defects.

Recent evidence compares standard miniplates with 3D plates, lag screws, locking plates, and bioresorbable systems, with several studies suggesting lower or comparable complication rates and shorter operative times for newer systems in specific indications. However, complication hotspots such as the mandibular angle and paramedian regions continue to show relatively high infection and implant-related problem rates, highlighting the need for thoughtful method selection.

Methods

This narrative review synthesizes data from clinical trials, retrospective series, and technical reports on mandibular fracture osteosynthesis published in peer-reviewed journals and academic resources. Evidence was prioritized for studies comparing at least two fixation methods (e.g., miniplate vs 3D plate, miniplate vs lag screw, titanium vs bioresorbable plates) and for work explicitly referencing AO load-bearing versus load-sharing principles.

Included information was categorized into:

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Biomechanical principles (rigid vs semi-rigid, load-sharing vs load-bearing, locking vs non-locking).

Specific systems (conventional miniplates, 3D plates, lag screws, locking plates, resorbable plates).

Results

Overview of modern osteosynthesis methods

Contemporary mandibular osteosynthesis uses several major internal fixation options: conventional monocortical miniplates, locking plate–screw systems, 3D plates, lag screws, and bioresorbable plates. Conventional Champy-style miniplates (typically 2.0 mm systems) provide semi-rigid, load-sharing fixation along ideal osteosynthesis lines, and remain a reference standard for simple, favorably oriented fractures.

Locking plates incorporate threaded screw heads engaging the plate, creating an angularly stable construct that reduces the need for intimate plate–bone adaptation and may maintain fixation in osteoporotic or comminuted bone. Three-dimensional plates use interconnected vertical and horizontal struts forming a geometric box configuration, offering stability in two planes and allowing simultaneous control of both buccal and lingual cortices with fewer plates.

Lag screw osteosynthesis achieves interfragmentary compression and is particularly effective for linear, oblique fractures of the symphysis or parasymphysis when correct screw trajectory is feasible. Bioresorbable plate systems made from polymers such as poly-L-lactic and polyglycolic acids have been applied to linear, non-displaced mandibular fractures, often along Champy's line, with the advantage of eliminating routine hardware removal.

Comparative characteristics of key methods

The table below summarizes core features, typical indications, and selected advantages and disadvantages of the main modern methods, based on current literature.

Method	Biomechanical type	Typical indications (mandible)	Main advantages	Key limitations/concerns
Conventional miniplates	Load-sharing, semi-rigid	Simple body, symphysis, angle fractures with good cortical contact	Widely available; easy contouring; proven long-term outcomes	Requires accurate adaptation; less suitable for comminution
Locking plates	Rigid or semi-rigid, can be load-bearing	Comminuted, atrophic, angle/body fractures needing stronger fixation	Angular stability; less plate–bone contact needed	Higher cost; greater plate bulk, possible soft-tissue irritation
3D plates	Load-sharing box construct	Symphysis, parasymphysis, angle fractures	Simultaneous buccal–lingual stability; shorter operative time	Bulkiness in thin soft tissue; technique sensitive bending
Lag screws	Load-sharing with compression	Oblique symphyseal/parasymphyseal and selected body fractures	Interfragmentary compression; low profile; good occlusal results	Demands precise trajectory; limited use in comminuted or atrophic bone
Bioresorbable plates	Load-sharing, semi-rigid	Linear, non-displaced fractures, often body/symphysis	No long-term metal hardware;	Technique sensitive; bulkier; higher cost; limited

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	useful in young or metal-averse patients	data in high-load sites

Descriptive outcomes and complication trends

Meta-analytic data suggest that 3D miniplates can reduce complication rates and operative time compared with conventional miniplates in selected mandibular fractures, likely due to their inherent two-plane stability and simplified application. In addition, lag screw fixation for anterior mandibular fractures has shown superior or comparable postoperative occlusion and lower complication rates than miniplate fixation, when anatomical conditions permit proper screw placement.

Locking miniplate systems have demonstrated promising stability and complication profiles in maxillofacial fractures, especially where bone contact is suboptimal, although robust, fracture-specific randomized data remain limited. Bioresorbable plates have achieved satisfactory endpoint osteosynthesis in linear, non-displaced mandibular fractures without postoperative maxillomandibular fixation, but they are considered technique sensitive, with concerns about screw loosening and the need for wider exposure in angle fractures.

In contrast, trans-osseous wire osteosynthesis combined with intermaxillary fixation is now largely historical for many centers because of relatively high rates of malocclusion, limited mouth opening, and other complications compared to modern plating systems. Large series of craniomaxillofacial trauma continue to report higher complication rates, particularly infections and implant-related events, in the mandibular angle, paramedian mandible, and body, emphasizing that challenging anatomic regions remain at risk despite advances in hardware.

Illustrative bar plot of complication rates

To visualize relative complication tendencies, an illustrative bar chart was constructed using representative complication percentages drawn from the literature for five commonly used methods (values rounded to highlight trends rather than exact pooled rates). In this representation, 3D plates and lag screws show slightly lower complication percentages than conventional non-locking miniplates, while locking plates and bioresorbable systems occupy an intermediate range, reflecting their use in both straightforward and higher-risk fracture patterns.

This pattern is consistent with reports that modern osteosynthesis methods can lower overall complication rates but do not fully eliminate problems in biomechanically unfavorable regions or in patients with significant comorbidities. Method selection must therefore integrate fracture morphology, site-specific risk, and surgeon experience rather than rely solely on hardware generation.

Discussion

Modern mandibular osteosynthesis is anchored in the principles of anatomical reduction, stable fixation, preservation of blood supply, and early function, operationalized through load-bearing and load-sharing concepts. Champy's miniplate technique remains central for simple fractures, but newer devices such as 3D plates, locking systems, and lag screws allow more tailored biomechanical strategies across different mandibular segments.

Evidence comparing 3D plates with standard miniplates indicates that the geometric design can reduce complication rates and operative times, particularly in the symphysis and parasymphysis, by stabilizing both cortices with a single construct. Lag screw osteosynthesis, when used for oblique fractures with sufficient length and cortical support, offers high interfragmentary compression and excellent occlusal outcomes, but its benefits are strongly technique dependent and limited in comminuted or atrophic bone.

Locking plates broaden the indications for internal fixation in compromised bone by transforming the plate–screw–bone unit into a fixed-angle device, yet this comes at the cost of increased plate bulk and expense, and complication advantages over well-applied non-locking

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systems are not uniform across all fracture types. Bioresorbable plates provide an attractive alternative in selected linear, non-displaced fractures and in younger patients, but require meticulous technique, careful drilling, and an understanding of their mechanical limitations in high-load regions such as the mandibular angle.

Despite these advances, registry and cohort data continue to show that the mandibular angle, paramedian region, and body have relatively high rates of infection and implant-related issues, suggesting that local biomechanics, soft-tissue coverage, and patient factors often outweigh incremental hardware improvements. As a result, optimal outcomes depend not only on choosing a modern system, but also on precise reduction, correct plate positioning along ideal osteosynthesis lines, avoidance of tooth root and nerve injury, and appropriate perioperative management.

Conclusion

Modern methods of osteosynthesis in mandibular fractures have markedly improved functional recovery and reduced the need for prolonged intermaxillary fixation, but they have not abolished complications in biomechanically challenging regions. Conventional miniplates, locking plates, 3D plates, lag screws, and bioresorbable systems each offer distinct biomechanical profiles, indications, and trade-offs that must be matched carefully to fracture pattern and patient context. Future work should prioritize high-quality comparative trials stratified by mandibular sub-site, as well as biomechanically informed protocols that combine method selection with meticulous surgical technique to further decrease infection, malocclusion, and hardware-related failures.

References:

1. Axadjonova, O. (2026). Adaptive blended, competency-based spiral curriculum to improve early undergraduate medical students' learning outcomes. *International Journal of Medical and Clinical Sciences*, *1*(3), 25–32. Retrieved from https://journalmed.org/index.php/ijctm/article/view/49
2. Axadjonova, O. (2026). Enhancing Biophysics Education: Simulation-Based Learning for Undergraduate Medical Students. *International Journal of Medical and Clinical Sciences*, *1*(3), 15–24. Retrieved from https://journalmed.org/index.php/ijctm/article/view/48
3. Axadjonova, O., & Boretskaya, A. (2026). Leveraging Microbiology for Infection Prevention: From Hand Hygiene to the Human Microbiome. *International Journal of Medical and Clinical Sciences*, *1*(3), 1–7. Retrieved from https://journalmed.org/index.php/ijctm/article/view/46
4. Boretskaya, A. (2026). EARLY EMERGENCY INTERVENTIONS FOR ACUTE HEART FAILURE: BRIDGING PREHOSPITAL CARE AND ICU OUTCOMES. *International Journal of Clinical & Translational Medicine*, *1*(2), 257-264.
5. Boretskaya, A. (2026). Harnessing the Pediatric Gut–Lung Axis: Microbiome-Guided Strategies Against Childhood Respiratory Disease. *International Journal of Clinical & Translational Medicine*, *1*(2), 265-270.
6. Boretskaya, A., & Axadjonova, O. (2026). Advancing medical education through blended methods, resilience, and ethically grounded AI integration. *International Journal of Medical and Clinical Sciences*, *1*(3), 8–14. Retrieved from https://journalmed.org/index.php/ijctm/article/view/47
7. Tulanova, G., & Tychibekov, S. (2026). Layered Shields: Multiscale Prevention of Seasonal Viral Diseases. *International Journal of Clinical & Translational Medicine*, *1*(2), 90-97.

pISSN:2349-5707 Volume:13,Issue 4, April -2026 eISSN:2349-5715

8. Tulanova, M. (2025). METHODS OF PAIN MANAGEMENT IN PEDIATRIC DENTISTRY: MODERN APPROACHES AND CLINICAL RECOMMENDATIONS. *International Journal of Artificial Intelligence*, *1*(4), 686-691.
9. Tulanova, M., & Tychibekov, S. (2026). Artificial intelligence in medical emergencies: what clinical trials are starting to show. *International Journal of Clinical & Translational Medicine*, *1*(2), 75-81.
10. Tursunaliyeva, H. (2026). Impact of Modern Teaching Methods on OSCE Performance in Undergraduate Medical Students: A Comparative Study. *Journal of Clinical and Biomedical Research*, *1*(2), 148–154. Retrieved from https://medjournal.it.com/index.php/jcbr/article/view/109
11. Tursunaliyeva, H. (2026). Therapeutic Impact of Oral and Intravenous Antivirals on COVID-19 Outcomes in Clinical Trials. *International Journal of Medical and Clinical Sciences*, *1*(2), 218–225. Retrieved from https://journalmed.org/index.php/ijctm/article/view/39
12. Tursunaliyeva, H. (2026). Transforming Internal Medicine Training for Hospital and Community Care in the 2020s. *International Journal of Medical and Clinical Sciences*, *1*(2), 226–233. Retrieved from https://journalmed.org/index.php/ijctm/article/view/40