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Review Article

Exploring AO and Its Plating Systems: A Comprehensive Narrative Review

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Abstract

Introduction: Maxillofacial injuries, found in 5-33% of severe trauma cases, commonly result in mandibular fractures, especially in the symphysis/parasymphysis region (31.97%), surpassing zygoma fractures (25.3%). Treatment options include open or closed reduction, and the AO/ASIF, established in 1958 by Swiss surgeons, aimed to enhance skeletal fracture outcomes through internal fixation.

Methods: English language articles were searched in various databases such as PubMed, Scopus, Science Direct, and Google Scholar. The keywords used for searching are “AO Plating System”, “Maxillomandibular fixation”, and “Recent Advancements.”

Results: The AO/ASIF's impact on maxillofacial surgery is evident through its emphasis on internal fixation since 1958, evolving the AO Plating system with innovations like LC-DCP and LCP. Stability is achieved with craniofacial system miniplates and self-tapping screws, while technological advancements like computer-based navigation, 3D printing, robotics, biodegradable metals, and artificial intelligence have transformed the field.

Conclusion: The present review delves into the influence of the AO Foundation on maxillofacial surgery, highlighting advancements such as LC-DCP and LCP plates that underscore a dedication to stable fixation and blood supply preservation. Innovations like the Limited Contact Dynamic Compression Plate (LC-DCP) and the Locking Compression Plate (LCP) have emphasized the delicate balance between rigid fixation and blood supply preservation. The incorporation of advanced technologies, including computer-based surgical navigation, 3D printing, robotic surgery, and the emergence of biodegradable metals like magnesium, signals a transformative phase in osteofixation options.

Keywords: ao plating system, maxillomandibular fixation, and recent advancements.

INTRODUCTION

Maxillofacial injuries occur in 5-33% of individuals facing severe trauma, either alone or in conjunction with other concomitant severe traumas.[1] The mandible, particularly the symphysis/parasymphysis region, is frequently fractured (31.97%), surpassing zygoma fractures at 25.3%.[2] The main approaches to treat maxillofacial fractures involve open reduction and internal fixation, with alternative options including closed reduction, non-surgical treatment, or referral to a more specialized hospital.[2]

In 1958, a team of Swiss surgeons founded the Arbeitsgemeinschaft für Osteosynthesefragen, or the Association of Osteosynthesis/Association for the Study of Internal Fixation (AO/ASIF). Their goal was to improve outcomes for skeletal fractures by delineating the role of internal fixation, supplementing existing non operative treatments.

Inspired by Danis, Maurice E. Muller played a key role, emphasizing anatomic alignment, stable fixation, gentle techniques, and early mobilization.[3]

The AO Foundation aims for excellence in surgical treatment for musculoskeletal conditions and trauma. Its primary goal is to enhance global patient care by extending and strengthening the AO network of healthcare professionals involved in clinical investigation, research, development, and education. This review article delves into the historical evolution of AO and its Plating System, examining fracture treatment in maxillofacial surgery and underscoring significant progress and contributions from ancient times to the contemporary era. The AO introduced a plethora of plating systems which we will discuss in subsequent paragraphs.

BASICS OF AO/ ASIF PRINCIPLES AND STABLE INTERNAL FIXATION OF MANDIBULAR FRACTURES

The AO Mandibular System is designed to provide firm fixation for mandibular segments. Tailored for durability, it is strategically implanted to withstand and counteract biomechanical forces, preventing deformation and ensuring no micromotion of the bone ends.[4] The clinical idea of fully immobilizing bone ends and keeping the implant and bone within the bounds of normal physiological loading is termed "absolute stability."[5]

To reconstruct the chin and mandibles, craniofacial skeleton surgery and midface fractures, the maxillofacial plating system is designed. There are various forms of plates and screws for fixation of maxilla, mandible and midface including fractures of orbit and zygoma. They also involve plates for mandibular reconstruction after tumor resection. Different sizes and shapes of plates are available as per the needs.

Compressive forces are generated along the basal border, while tensile forces are present along the alveolar border. An imaginary transverse axis, situated roughly along the mandibular canal, distinguishes the alveolar process (tension area) from the basal process (compression area).[4,6] In cases of mandibular fracture, it is essential to counteract forces on both sides of the imaginary axis for a functionally stable reduction. This is accomplished using a system comprising a plate and a tension band, with variations tailored to the specific location and type of the fracture.

A splint works well to offset tension pressures in the mandibular dentulous parts; at the angle and ramus area, a tiny plate may be used for the same purpose.[7] The tension band is omitted in some cases, and a reconstruction plate can counteract tension pressures. Mandibular fracture repair, using plate and tension band techniques, employs plates designed for interfragmental compression. Compression is achieved using static techniques, involving the lag screw and the self-compressing plate.

Compression plates are created to maintain mechanical forces for an extended period, spanning weeks, which is vital for promoting effective primary bone healing.[8] The concept of "absolute stability" differs from situations where "relative stability" applies. In cases of relative stability, methods like wire osteosynthesis may be employed, but they lack the capacity to endure functional loading and require additional support, often in the form of maxillomandibular fixation (splinting).[4,6]

DYNAMIC COMPRESSION PLATE (DCP)

The dynamic compression plate (DCP) is the main tool used by AO/ASIF (Figure 1.) The screw head, which resembles half of a sphere, glides up against a sloping surface (slot edge) that acts as an interface between two cylinders in the DCP's mechanics[4,6,9], where the spherical glide idea is employed.

Figure 1. An essential part of the AO/ASIF mandibular system is a four-holed dynamic compression plate (DCP).

Preloading segments involves placing compressive screws directly into plate slots adjacent to the fracture line. The static compression is achieved using a drill guide to align screw holes either in a neutral or compressive orientation. The two slots closest to the fracture line get compressive screws, while the rest get neutral screws.

Fully tightening the initial screw achieves compression, but adding more compression screws in remaining slots may decrease compression. However, additional screws in the neutral position help maintain static interfragmentary compression. This method promotes faster revascularization, attracting new osteoblastic cells, and expedites the formation of osteons, speeding up primary bone healing.[10]

Precise plate bending is crucial in internal fixation, especially for anatomical alignment in craniomaxillofacial surgery, where considerations like dental occlusion are vital. Mandibular plates from AO/ASIF are designed for nonself-tapping screws, differing from self-tapping screws with a shallower pitch.

BIOMECHANICAL CONSIDERATIONS IN MANDIBULAR FRACTURES

The Groupe d'études en Biomecanique Osseuse et Articulaire in Strasbourg, France, conducted mathematical and experimental studies, forming the basis for the biomechanical principles that underlie monocortical miniplate osteosynthesis.[11] There are some Plate and Screw considerations as the biomechanical prerequisites for achieving ideal levels of osteosynthesis.

It is vital to comprehend the distribution of strains caused in the mandible by external forces. Physiologically coordinated muscle function results in tension forces at the upper border of the mandible and compressive forces at the lower border. Furthermore, studies by Sustrac and Villebrun, along with Weigele, have shown the creation of torsional forces in front of the canines.[12] In addition, Sustrac and Villebrun[12] and Weigele[15] showed that torsional forces are produced anterior to the canines.

In mandibular fractures, these forces can cause distraction in the alveolar crest, potentially leading to fragment displacement. Meanwhile, the compressive force at the inferior border is a physiological and dynamic force along the basal border of the fractured fragments.[16,18] This dynamic compression aligns precisely with the physiological forces experienced by an intact mandible when osteosynthesis is conducted appropriately and there are no deficiencies at the fracture site.[13,14] In reconstructive surgery for atrophic mandibular fractures, septic fractures, pseudoarthrosis, and surgical interruptive osteotomy, interdigitation may not be optimal, leading to reduced or absent friction forces. This necessitates the use of double plate fixation.[19]

Applying a monocortical stable-elastic-dynamic osteosynthesis reduces distraction and torsional stresses at the fracture site while restoring physiological self-compression strains. Due to the unique biomechanical needs of the mandible, a specialized AO/ASIF hardware system is developed, featuring dynamic compression plates, tension band plates, reconstruction plates, and compatible screws.

ECCENTRIC DYNAMIC COMPRESSION PLATE (EDCP)

When conventional dynamic compression plate (DCP) and tension band systems are inappropriate due to specific anatomical or functional mandibular needs, such as in edentulous mandible cases, alternative approaches like the eccentric dynamic compression plate (EDCP) can be utilized.7,21,22 In some cases, the EDCP may not be suitable, like in instances with insufficient mandibular height or central angle fractures incompatible with a six-hole plate. Alternatives such as miniplates and reconstruction plates can be used for edentulous mandibles, while mandibular angle fractures may be addressed with a two-hole tension band plate, DCP, lag screw, or reconstruction plate with the second hole having 45-degree angulation to cause alveolar compression.

RECONSTRUCTION PLATES

Reconstruction plates have various uses in managing mandibular fractures, proving especially beneficial for bridging gaps or managing areas not suitable for compression plating.23 The standard reconstruction plate is applicable in scenarios where alternative compression plates are not feasible, such as in the mandibular angle and ramus regions due to anatomical constraints. Additionally, it proves beneficial in cases involving fragmentation and avulsion, offering stabilization for fragments distant from the fracture gap or fragmentation site.23 Another type of reconstruction plate is the THORP (titanium hollow screw reconstruction plate) system, devised by Raveh. This system is crafted for handling pseudoarthrosis, bone grafting scenarios, and specific extensive fractures.23 The THORP, offered in different configurations, is ideal for cases necessitating immediate or delayed bone grafting to address gap defects (Figure 2.)

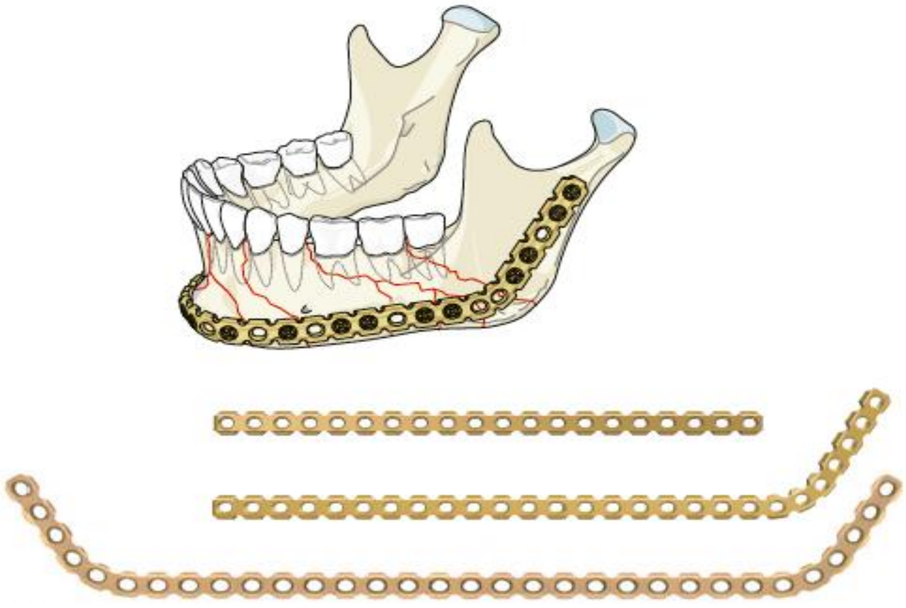

Figure 2. Reconstruction plates 2.4.

Basic Lag Screw Technique

Lag screws enable significant compression application, minimizing the requirement for extensive hardware.[24] Lag screws aim for compression between two bone segments using a single screw, proving versatile in orthopedic and surgical settings. They can be effectively used with various plate types and are suitable for securing independent bone grafts.

BASIC OPERATIVE TECHNIQUE IN THE MANAGEMENT OF MANDIBULAR FRACTURES

The initial step entails removing extensively damaged teeth and implementing maxillomandibular fixation. Once proper tooth alignment is achieved, a surgical procedure is conducted to reveal the affected area. The choice between an intraoral or extraoral approach depends on factors like the presence of lacerations, the degree of segment displacement and fragmentation, or the type of plates needed.[4] Fractures in the mandibular parasymphysis and symphysis typically favor the intraoral approach, ensuring comprehensive exposure and accessibility to the site.[27] In situations needing an intraoral approach behind the mental foramen, a trocar system is used through a submandibular stab incision. Raveh has outlined an unobstructed method for mandible access via intraoral approaches, including the trocar system in the posterior body and ramus regions.

1)Mandibular Symphysis and Parasymphysis Fractures

Several approaches are available for addressing parasymphysis and symphysis fractures, utilizing diverse mandibular hardware setups. The traditional lag screw method commonly utilizes two or three screws, typically of 2.0-mm or 2.7-mm size. The choice is influenced by factors like the patient's mandible size and the alignment of the fracture line (straight or transverse).[25] If there is no fragmentation and the teeth are intact, a combination of a Dynamic Compression Plate (DCP) and a tension band (TB) arch bar can be applied. Another option is the Eccentric Dynamic Compression Plate (EDCP), available in four- or six-hole versions, removing the need for a tension band arch bar. This choice proves beneficial, especially for edentulous patients. In cases of fragmentation, addressing the fracture may involve the use of a reconstruction plate.

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2)Mandibular Body Fractures

The approach to mandibular body fractures depends on the presence or absence of teeth on either side of the fracture line. If teeth are present on either side, the tension band arch bar can be used alongside a six-hole Dynamic Compression Plate (DCP). For unilateral partially edentulous or completely edentulous midbody fractures, traditional treatments like gunning-type stents, splints, or external pin fixation have been utilized. Nevertheless, the Extraoral Dynamic Compression Plate (EDCP) has surfaced as a modern alternative, alleviating the discomfort and constraints linked to these conventional methods.[31] Other alternatives for management of mandibular fractures include miniplates, mini reconstruction plates, rib grafts retained with lag screws.

3) Mandibular Angle Fractures

Angle fractures are commonly divided into central angle type or posterior body/anterior angle type. Transverse and sagittal fractures are further classified as favorable or unfavorable based on their orientation in relation to the pterygomasseteric muscle complex. For angle fractures with monocortical configurations, stability can be achieved by using a two-hole Tension Band Plate (TBP) alongside a four-hole Dynamic Compression Plate (DCP) or a reconstruction plate with a minimum of six holes. In situations with more obtuse mandibular angles, a six-hole Eccentric Dynamic Compression Plate (EDCP) can be utilized.

In cases where limited surface area hinders effective interdigitation and precise control is crucial, an approach involving the initial fixation using a Tension Band Plate (TBP) followed by a Dynamic Compression Plate (DCP) may be required. Another method for handling minimally displaced or easily intraorally reduced mandibular angle fractures is the lag screw technique, originally introduced by Niederdellmann.[60]

4)Mandibular Condyle Fractures

Historically, these fractures were managed with short maxillomandibular fixation (10-14 days) followed by physiotherapy, usually yielding satisfactory outcomes. Yet, certain situations require open reduction and internal fixation for condylar fractures, such as displacement into the middle cranial fossa, fracture dislocation, foreign body presence, and extracapsular displacement. Extracapsular fractures can be addressed with miniplate fixation, offering an alternative that avoids excessive soft tissue stripping from the condylar head and is considered acceptable. Kitayama's innovative lag screw technique stands out as an approach for handling condylar fractures, although it demands technical precision and specific hardware.

5)Multiple Mandibular Fractures

When faced with multiple mandibular fractures, the general procedure involves initially reducing segments with teeth to restore occlusion. Edentate areas are then addressed, followed by fractures in the ramus from the angle to the condyle. Hardware configurations are chosen based on the locations of the fracture sites. Isolated fracture sites allow for the use of individual DCP, EDCP, and lag screws, while closely situated fracture sites may require reconstruction plates. In instances of multiple fractures, a combination of miniplates, lag screws, and larger plates might be necessary.

NEW AO/ASIF 2.4-MM MANDIBLE TRAUMA SYSTEM

The newly introduced AO/ASIF 2.4-mm Mandible Trauma System, crafted from commercially pure titanium, is now accessible. It features the Limited Contact Dynamic Compression Plate (LC-DCP)® as its basic unit. The LC-DCP® addresses issues linked to cortical osteoporosis from the complete surface contact and devascularization of standard plates.28,29 It is thinner at 1.65 mm and uses 2.4-mm self-tapping screws. The 2.4-mm Mandible Trauma System continues to employ a dual-plate tension banding system, providing choices between an arch bar in dentate areas or a TBP (Tension Band Plate) at the angle.30 They are primarily for stabilization, as they do not provide compression. A different option is the Universal Fracture Plate, resembling the Reconstruction plate but with a 2.0 mm thickness. It comes in straight and prebent types, suitable for addressing multiple and fragmented fractures. Notably, this system utilizes self-tapping screws, differing from the usual AO/ASIF systems. The 2.4 Mandible Trauma System adheres to basic AO/ASIF principles, utilizing a two-plate approach (TBP/DCP) during its application.30 While relatively new with limited clinical use, this system addresses the unique biomechanics of the mandible, bridging the gap between the standard 2.7-mm mandibular system and miniplates used in craniofacial surgery.

LAG SCREW TECHNIQUE AND ADVANCED APPLICATIONS

Lag screws provide an effective approach for interfragmentary compression in bone fractures. The stability and consistent compression along the fracture line result in static interfragmental compression, promoting improved healing and alignment of bone fragments.

Biomechanics of Screws

In maxillofacial surgery, cortical screws and cancellous screws are commonly used. Cortical screws, designed for dense cortical bone, are not suitable for use as lag screws in maxillofacial surgery due to their risk of fracture, attributed to their coarse pitch and thin diameter.

In contrast, cancellous screws are appropriate for application in cancellous or spongy bone. In orthopedics, they can act as lag screws if their shaft is partially threaded, allowing the unthreaded part to cross the fracture line. However, this configuration is less common in maxillofacial surgery.[24] The common 2.7-mm cortex screw in mandibular surgery is often used to secure the lag screws.

The grip or holding capability of a screw is affected by three factors: the bone quality surrounding the screw, tensile stresses developed at the bone-screw interface, and the diameter of the screw threads.

Nonself tapping Lag Screws

A screw can function like a lag screw when there is preparation of receiving location. The successful application of lag screws relies on the accurate preparation and alignment of the receiving location. Precisely aligning the receiving location with the bone's long axis and fracture axis is essential. To achieve effective interfragmental compression, the lag screw needs to be equidistant from the fracture edges and directed perpendicular to the fracture plane. Usually, a minimum of two lag screws is necessary for adequate fracture stabilization.

Typically, the central screw should be oriented perpendicular to the bone's axis, while the outer screws should be perpendicular to the fracture. If any screw deviates from being at a right angle to the fracture plane, it may result in segment sliding and diminish resistance to friction and torsion.[31]

Self-tapping Lag Screws

The application of self-tapping screws for the lag screw technique in the mandible requires modifications compared to the non-self-tapping method. The number of screws required for a specific fracture is determined by the anatomical location and characteristics of the fracture, typically demanding a minimum of two screws for most cases. For mandibular angle fractures, a single screw may be adequate, as outlined by NiederdelImann.[32]

Lag screw fixation can be used in various ways depending on the specific situation: Lag screw fixation alone, Lag screw in conjunction with a Stabilization Plate, Lag screw fixation in Fragmented Fractures, Lag screw fixation of Bone Grafts. Surgeons have diverse options for achieving stability and fostering healing in various mandibular fracture scenarios.

BASICS OF STABLE INTERNAL FIXATION OF MAXILLARY FRACTURES

Anatomic Principles of Midfacial Reconstruction

Rene LeFort in1901, delineated the midface unit and the typical fracture scenarios arising from traumatic events.[33,34] His studies uncovered that midfacial fractures exhibit variability influenced by factors such as bone architecture, thickness, impact speed, affected area, weight, and the body's response to force. He categorized these fractures into three levels resulting from disruptions in the midfacial architectural buttresses.

Facial buttresses which include the pterygomaxillary, zygomatic, and nasomaxillary regions are denser sections of bone that provide support to regions transmitting or withstanding forces directed toward the skull base. Traditionally seen as pillars resisting compressive forces, they form the basis for maxillary reconstruction principles, envisioning the static transmission of chewing forces through the skeletal structure.[35,36] The facial buttress system can be best understood as a blend of compression-resistant pillars and tension-countering trusses, drawing parallels with architectural principles seen in Gothic cathedrals.

Midfacial fracture reconstruction via rigid fixation aims to encourage the migration of blood vessels, connective tissue, and Haversian systems for primary bone healing. However, for defects of 1.0 mm or more, midfacial fractures often undergo secondary intention healing.

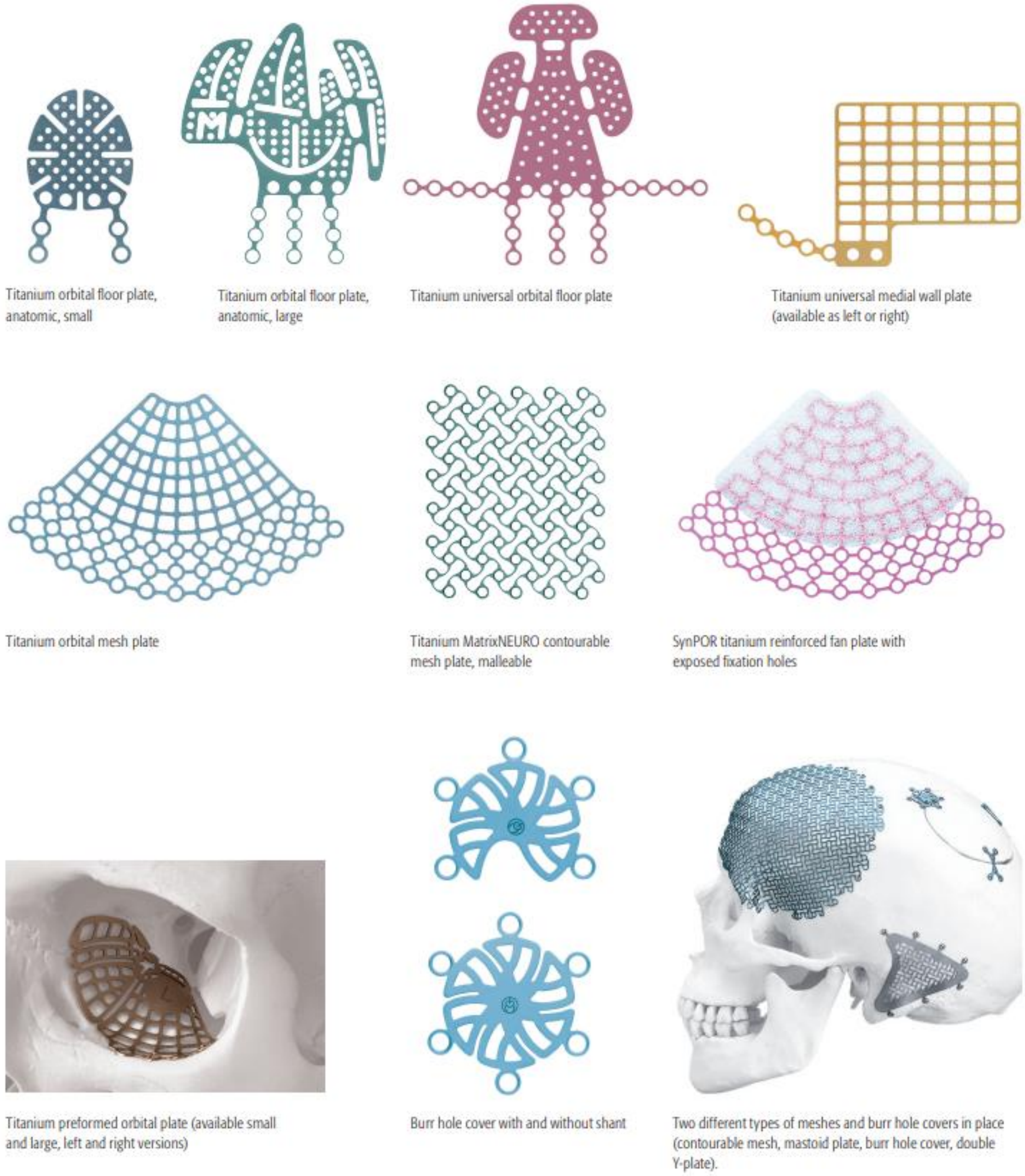
Operative Techniques

General Principles

Ensuring a secure airway is the foremost consideration in preparing a patient with midfacial fractures. Typically, a nasoendotracheal tube is suitable, except for complex nasoethmoidal injuries.[37] If an endotracheal tube is not feasible, a tracheostomy may be attempted. To counter contamination, the use of narrow-spectrum antibiotics is advised. Restoration of occlusion is a fundamental principle of AO/ASIF. The sequence of reconstruction typically involves dentoalveolar reconstruction first, followed by mandibular and midfacial reconstruction.

The Craniofacial System

The craniofacial system encompasses 32 different implant designs, utilizing screws with three different diameters. The 2.0-mm system features 0.85 mm thick plates resulting in a profile of 1.35 mm after screw placement. in various designs (X, H, Y, double-V, L, curved, adaptation, and extended adaptation), providing adaptability to diverse clinical scenarios. Self-tapping screws are utilized in this system. The 1.5-mm system, like the 2.0-mm, has a 0.85 mm thickness for implants, resulting in a 1.2 mm profile after screw placement. Implant designs include L-shaped, V-shaped, curved, and adaptation, with specialized implants for orbital floor repair (Figure 3.)



Titanium orbital floor plate, anatomic, small

Titanium orbital floor plate, anatomic, large

Titanium universal orbital floor plate

Titanium universal medial wall plate (available as left or right)

Titanium orbital mesh plate

Titanium MatrixNEURO contourable mesh plate, malleable

SynPOR titanium reinforced fan plate with exposed fixation holes

Titanium preformed orbital plate (available small and large, left and right versions)

Burr hole cover with and without shant

Two different types of meshes and burr hole covers in place (contourable mesh, mastoid plate, burr hole cover, double Y-plate).

Figure 3. Craniofacial plates: MatrixMIDFACE orbita plates, burr hole covers, and meshes.

The Micro System

The microsystem features 0.5 mm thick implants (0.7 mm for the adaptation plate) with a profile of 0.75 mm after screw placement. It provides configurations such as L, T, Y, H, X, double-Y, curved, adaptation, micromesh, and two specifics to the orbital floor. The microsystem features meticulously crafted paired needle-nose pliers, a compact shear microplate cutter, and microplate holders with a convenient self-locking and self-releasing design. Additionally, the system comes equipped with two quick-coupling screwdrivers.

BASICS OF STABLE INTERNAL FIXATION OF ZYGOMATIC FRACTURES

Zygomatic fractures are commonly encountered injuries affecting the craniomaxillofacial structure, occurring either in isolation or in conjunction with other fractures. The zygoma, a facial bone, forms connections with the frontal, temporal, maxillary, and sphenoid bones. The displacement patterns in these fractures vary based on the direction and force of the traumatic impact. To guide treatment, classification systems have been established, categorizing zygomatic fractures based on expected stability after reduction.

The impact of zygomatic injuries extends to orbital contents, mandibular function, and facial aesthetics. The zygoma plays a crucial role in shaping the lateral wall and orbital floor, affecting factors such as orbital volume, globe position, and facial appearance. While subtle changes may occur in incomplete or minimally displaced fractures, severely displaced or fragmented fractures can significantly affect ocular function. Furthermore, zygomatic fractures can hinder mandibular movement due to their proximity to the mandibular coronoid process.

Internal Fixation of Zygomatic Fractures

Conventional treatments for zygomatic fractures generally yield good results if the fractured segments are stable post-reduction. Unstable fractures may require internal fixation with wires. Various surgical approaches can either facilitate rigid fixation or assist in open manipulation without fixation. Rigid fixation is advantageous for unstable zygomatic fractures, fragmented fractures, or those with avulsive defects, unlike wire osteosynthesis which may fall short in these scenarios. Severe fractures involving the orbital floor may lead to significant globe position issues like enophthalmos or exophthalmos, necessitating intensive intervention with rigid internal fixation and reconstruction using bone grafts, lyophilized dura, cartilage, silastic implants, or orbital floor plates to ensure proper globe position and improve both aesthetic and functional outcomes.

Selection of Hardware

The AO/ASIF hardware for zygomatic injuries includes craniofacial system miniplates, such as miniDCP and mini-adaptation plates, secured with 2.0- and 1.5-mm self-tapping screws and 2.4-mm emergency screws. MiniDCP plates are used in thicker bone areas like the frontozygomatic region for stable fixation. Microsystem plates are used for small fragments and low-profile areas, especially around the orbital rims. Pre-bent semilunar orbital miniplates are frequently used in the frontozygomatic and infraorbital regions, while the orbital floor plate is valuable for infraorbital rim fixation and orbital floor reconstruction. Straight mini-adaptation plates are used as needed, though less common in the zygomaticotemporal region unless dealing with unstable arch fractures or other associated fractures. Proper hardware selection is crucial for stable fixation and successful zygomatic fracture treatment.

Selection of Surgical Approaches

Surgical treatment of zygomatic fractures requires careful selection of access sites based on the fracture's pattern and location. Access points include lacerations, brow incision, superior eyelid crease, blepharoplasty, lower eyelid crease, transconjunctival, maxillary buccal vestibules, preauricular, bicoronal, and stab (bone hook). Approaches like Gillies, stab (bone hook), and posterior maxillary buccal vestibule are unsuitable for fixation placement. Rigid internal fixation varies by fracture location. For complete frontozygomatic fractures, a single plate through a brow incision can stabilize the zygoma. Multiple fractures may require additional plates. Infraorbital rim reduction and orbital floor exploration address ophthalmoplegia, enophthalmos, exophthalmos, orbital content prolapse, and unstable fractures. The zygomaticomaxillary buttress, accessed intraorally, is useful when transcutaneous incisions are rejected or additional maxillary fractures are present.

DISCUSSION

The AO/ASIF sought to enhance the outcomes of non-surgical therapies by emphasizing the role of internal fixation in treating skeletal fractures. The history of bone plating dates back to 1565, with the first recorded use on a cleft palate crafted from molten gold. However, challenges such as malunions, nonunions, and bone infections persisted due to the lack of sterile techniques and plates offering rigid fixation. Various plating systems evolved over the years, including Hansmann's retrievable bone plates in 1886, the AO/ASIF Dynamic Compression Plates in 1969, and the Locking Compression Plate (LCP) in 2000, revolutionizing the field.

The AO Plating system, established by the AO/ASIF in 1958, has played a pivotal role in craniomaxillofacial surgery. Over time, the system evolved to include a comprehensive armamentarium of screws, plates, and tools, offering various options for fixation needs. In 1990, the Limited Contact Dynamic Compression Plate (LC-DCP) aimed to balance rigid fixation with blood supply preservation. Subsequent innovations like the Locking Compression Plate (LCP) in 2000 incorporated external fixation principles with internal and locking technology, further advancing fracture treatment techniques.

The AO Foundation's classification system for fractures of the long bones, officially adopted in 1986, underwent refinements to address reliability issues. The present third-generation CMF AO classification reflects advancements in methodology. Future developments may involve merging CT scan images with classification charts, using automatic analysis to enhance evaluation precision and diagnose imperfections previously unnoticed.

Artificial intelligence (AI) plays a significant role in anticipating unknown factors through algorithms in maxillofacial and plastic surgery. Its utilization spans various areas, including rhinoplasty, orthognathic surgery, cleft lip and palate procedures, implant augmentation, and cancer diagnosis. AI relies on data-driven algorithms derived from digital imaging, 3D photography, intraoral scans, and three-dimensional photographs to predict results and plan surgeries without human intervention.[96-97] Overall, the future of maxillofacial surgery is characterized by ongoing research and technological advancements that aim to enhance precision, efficiency, and the scope of fracture classifications and treatments.

Conclusion

In conclusion this narrative review provides an outline of the historical development of the AO Foundation as well as a comprehensive overview of its plating system being utilized in maxillofacial surgery. The AO Plating system has played a crucial role in shaping the field, continually adapting to the changing landscape. Innovations like the Limited Contact Dynamic Compression Plate (LC-DCP) and the Locking Compression Plate (LCP) have emphasized the delicate balance between rigid fixation and blood supply preservation. The incorporation of advanced technologies, including computer-based surgical navigation, 3D printing, robotic surgery, and the emergence of biodegradable metals like magnesium, signals a transformative phase in osteofixation options. The integration of virtual reality (VR) and augmented reality (AR) technologies holds immense promise, providing real-time visualization and interactive feedback. The pivotal role of artificial intelligence (AI) in maxillofacial and plastic surgery offers a glimpse into a future where technology plays a central role in enhancing precision and efficiency in these intricate medical procedures.

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Ethical Approval

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