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Review Article

Fixation Systems in Craniofacial Trauma- A Review

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***ABSTRACT*:**
Cranial and maxillofacial trauma management is one of the main treatments that has been provided by a maxillofacial surgeon. Advent of several fixating systems took place over the years. The prime and significant advantage of the fixation to stabilize the fracture site without immobilization so as to provide the patient a comfortable healing period. Whatever the type of plating system implied, the principles of fracture fixation should remain the same, and the same should be attained post-fracture reduction and fixation. The objective should be to achieve least postoperative morbidity and also early return to the function for patient.

Keywords: Maxillofacial Plating System; Miniplate Fixation; 3D Plate Fixation; Bioresorbable Plates.

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INTRODUCTION

One of the cornerstones in the treatment provided by the maxillofacial surgeon is the management of cranial &maxillofacial trauma. This can vary from a simple mandibular fracture to the complex craniomaxillofacial traumas. The main objective of the treatment is to restore the form and function of the injured tissue as much as possible. Moreover, in order to aid in this treatment modality, the oral and maxillofacial surgeon employs several varying fixation modalities according to theirpreference.[1]

Over recent years, abundance of fixation systems have been introduced. In the present article, review of various fixation modalities that have been introduced over the time, some are still in use, while others have been outdated as well as some other extinct. Although the techniques have been extinct but they have acted as a stepping stones for the development of newer plating techniques and also aided in understanding the current modalities.[2]

Various Fixation techniques

The bone plates are the most common and significant modality for the fixation of the fractures and importance of the bone plate lies in stabilizing the fracture without immobilization of the jaw, which provides the patient with a comfortable healing period. The plating techniques are broadly categorized as non-compression plating techniques, compression plating techniques, and mini-plates. [3]It is of significant importance to differentiate whether the system used is non-compression or compression. For the former, a gap should be present in between the fracture segments, while in compression, the bones should be in tight contact. In the compression system, the tight contact osteosynthesis leads to direct bone healing without any intermediary callus formation while the other does. Irrespective of the system used, they all impart sufficient strength to the fixation and hence restoring full strength.[4]

Non-compression small plates-The small compression orthopaedic plates have been used in the past. Moreover, they do not have any additional benefit over the recently developed miniplates, which is the reason they got extinct from the oral and maxillofacial surgery.[5]

The compression plates

AO dynamic compression plates-In the development of the mini plates for the maxillofacial region, these are the forerunners and the current plating systems are either modifications or based on the same principle. [6]Mostly, they are used for fixation of the mandibular fractures. The anatomical requirements need these plates to be fixed in lower border of the mandible. Thereby, this system tends to get open up from the superior lingual border with the opening of contralateral fracture in cases of bilateral fracture, while tightening leading to the occlusal discrepancies.[6, 7] Unlike the miniplates, these plates engage the lingual cortex and thereby making its placement more complex because of the presence of an inferior alveolar nerve. The presence of pear-shaped holes is the specialty of compression plates that will be at least two in number. They will be placed on either side of the fracture line or can also be placed ipsilaterally with the widest part of the pear-shaped hole near fracture line. Once the plate placed and fracture is stabilized, the screw is inserted near the narrow portion of the hole. [4, 5, 6]

The eccentric dynamic compression plate- It was first introduced by Schilli in 1977 in order to counter the drawbacks of AO dynamic compression plate. Unlike the conventional compression plates, in order to prevent the opening of the fracture, lateral oblique holes are made to distribute some of the forces to the superior border. All the other techniques remain same including the screw plates, except for the presence of the oblique lateral holes.[6, 7]

AISI standard plates-These plates had two parts- one is compression part and the other is retention part. The retention part contained the normal screw holes which held the plates in place and also adapted to the contour of bone, while the compression half contained an oblong sliding hole and also an oval compression hole. Due to this unique oblong sliding hole and the oval compression holes, this system has got very less movement during the compression than that of the other systems. [8]Unlike the other systems where a change in angulation of the plate is required rather than having a separate design, this system has the advantage of having a different plate for angle region providing the compression.

Non-compression mini/micro-plates

Mini-plates- Robert WR reported the first mini plates (metacarpal plates) to be used for the fixation of fractures in the maxillofacial region, [8] after treating a series of the mandibular fractures. These plates were made of cobalt-chrome alloy and also were difficult to manipulate and adapt to the mandible. Lately, the titanium mini-plates have been introduced instead of stainless-steel plates which have excellent biocompatibility and also radiological compatibility.

Microplates

The microplates were developed amid growing demand for the smaller systems which can provide both the superior functional as well as mechanical properties. The micro-plating systems usually have their diameter < 1.5 mm. They have an inherent advantage that they can be employed in fixation of small bone pieces which was not possible otherwise. The microplates have overcome the limitations of the miniplates that are used in the maxillofacial region, especially in the midface region which are often more palpable under skin in the orbital, nasal as well as frontal regions and also occasionally leads to development of the thermal hypersensitivity making its removal a prerequisite. [9]The miniplates are better in the load-bearing ability compared to the miniplates. Thereby, it is limited to midface or the upper third region. However, because of the inherent design of the thinness, during placement of the microplates, screw or drill fracture, bone stripping due to over tightening, reduced holding power leading to the displacement of the fracture post-surgically result in unanatomical healing.[10]

Bioresorbable/biodegradable plates

Kulkarni et al. in 1971, [8] initially reported the use of Bioresorbable plates in maxillofacial surgery. It has been concluded from the studies using Bioresorbable

plates in the 1970s that they were not mechanically adequate, needed maxilla-mandibular fixation and was in excess bulk to be used in the craniomaxillofacial region. The bioresorbable plates were made usingpolyglycolic (PGA)/polylactide (PLA), polyglycolide, PGA/tri-methylene carbonate and polydioxanone. In 1997, Bessho et al introduced miniplate systems using bioresorbable plates. Earlier, a single polymer bioresorbable plates were used which either got degraded too quickly or undergone slow degradation, there not providing any additional benefit over the conventional metal plates. [11] Hence, this led to development of the multi-polymer bio-resorbable plates, mostly a combination of PLA and PGA. Thereby, these possessed the superior properties than their single polymer counterparts. Moreover, co-polymers of lactate with glycolide or L-lactide with D, L-lactideare especially interesting forthe craniomaxillofacial region as they possess an attractive combination of both strength and also resorption profiles. Onto this combination, the addition of trimethylene carbonate (TMC) into the polymer backbone, further enhanced its usability in the maxillofacial region with the added benefits of the malleability as well as strength. While aiding in the fracture, once the healing is complete, these plates get harmlessly degraded over the time, thus, providing an advantage to both the patient and surgeon, because there is no requirement for the second surgery for removal of plates.[9, 10, 11] It is especially useful in the cases of pediatric fractures because the metal plates impair growth and also thereby necessitate removal once placed. They also eliminate the concerns about the long-term tissue reactions associated with metal plates.[10, 11]

3-dimensional plates (3D plates)-3D plates are a relatively newer technique and also beginning to be employed in maxillofacial fixation and is also started gaining its popularity in the recent times.[12] In 1913, Lambotte introduced an aluminium-made geometrically closed quadrangular plate. The basic form for a 3D plate is quadrangular 2-by-2-hole plate with rectangular or square segments. Other forms include 3-by-2 or4-by-2. The plates are adapted according to Champy's principles and also fixed to the bone with monocortical self-cutting screws. They are also available in various shapes- like triangular plates for the fixation of condylar fractures. There are other reports which also state that, it is much more difficult in 3D plates, as we are trying to adapt the planes rather than a line like in miniplates. These 3D plates have improved biomechanical stability as compared to the conventional plates because of their design. Whereas most studies have reported good results in the linear fracture fixation of mandible, but there have been complications in oblique fracture fixation, like segmental mobility and infection. 3D plates also have more material than the conventional plates because of the vertical components attaching the two horizontal components. 95 fractures of the mandibular body were treated by Farmand and Dupoirieux using 4-holed square plates; and recorded the complications of one late infection and one plate breakage. Other studies also concluded that there is increased plate fracture in 3 D plates unlike the conventional plating system. As it is a newer system, thereby, more long-term studies required to be done in order to attain a definitive results regarding the 3D plating systems.

CONCLUSION:

Irrespective of the type of the plating system implied, the principles of fracture fixation should remain the same, and also the same should be attained post-fracture reduction and fixation. The goal must be to achieve the minimum postoperative morbidity and early return to the form and function for the patient.

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