IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 2 Ser.18 (February. 2023), PP 43-52
www.iosrjournals.org

Management of Maxillofacial Fractures Using Titanium Microplates – An Original Research Study

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Abstract: *Several modalities of management of maxillofacial fractures have been tried in the last few decades. Different osteosynthesis materials such as stainless steel wire , skeletal pins and various plating systems have been used for fixation of bony fragments. Microplates provide adequate fixation of midfacial fractures and can be selectively used for mandibular fractures. They show negligible palpability in the thin maxillofacial regions, very minimal thermal conductivity, highly malleable, so easily adaptable to complex facial contours and highly biocompatible. Microplates give a very good access and easy placement without disturbing adjacent anatomic structures.*

Background*: This study is about the management of fractures of maxillofacial region by open reduction and internal fixation using titanium microplates. To evaluate the efficacy of fixation using titanium microplates and screws in the management of maxillofacial fractures.To assess various advantages and disadvantages of titanium microplates over other systems*

Materials and Methods*: A prospective study was conducted on 20 patients who sustained fractures of maxillofacial region. Patients were randomly selected irrespective of age and sex. All the patients underwent Open Reduction and Internal Fixation of maxillofacial fractures with 1.2 mm Titanium Microplates under General or Local anaesthesia.*

Results*: Satisfactory results were obtained in all the patients during the surgical procedure intraoperatively and also post-operatively. Plate adaptability to the underlying bone and intraoperative stability of fractured segments is good . Microplates provide adequate fixation of maxillofacial fractures.*

Conclusion:*Considering the above results , it can be concluded that titanium microplates may be considered as a valid tool in the management of maxillofacial fractures.*

Key Words*:Microplates , Open Reduction and Internal fixation, Osteosynthesis*

Date of Submission: 20-02-2023 Date of Acceptance: 03-03-2023

I. Introduction

The face occupies the most prominent position in the human body rendering it vulnerable to injuries quite commonly.[1] The surgical treatment of craniomaxillofacial trauma involves the restoration of both form and function via a complex interplay between the facial bony skeleton and its soft tissue envelope. [2]Craniomaxillofacial fixation has evolved significantly over the past 200 years.[3] Osteosynthesis implies functionally stable internal fixation of bone fractures which allows the early recovery of function. The bone ends need to be held in stable close apposition to allow uneventful healing.[4] Wire osteosynthesis has been the main stay for stabilization of small thin bones of the facial skeleton. Although in many instances, they have been found to be satisfactory for fracture management , wires lack the rigidity afforded by plates.Plate and screw systems have evolved in to two types. Historically larger bicortical systems have been used primarily in the mandible in order to withstand forces of mastication. Smaller unicortical systems have been used in the middle and upper face in order to overcome deformational forces of trauma or surgery.[5] Although compression plates were used for bony fixation in the maxillofacial region , they have been superceeded by miniplate osteosynthesis.[4]

Miniplate osteosynthesis has found wide application throughout the facial skeleton.CHAMPY originally developed miniplate osteosynthesis for the treatment of mandibular fractures. By placing the plates at the most biomechanically favourable site to neutralize the tension forces causing fracture distraction , one can minimize the plate thickness, with the consequent advantage of increased malleability. The acknowledged role of miniplate osteosynthesis in mandibular fractures has resulted in its application to bony fixation in midface.
Wires do not provide three dimensional stability and a minisystem has the disadvantage of fracturing thin bone during screw insertion . The screws may be too large to be placed where little bone is protecting anatomic

structures such as infraorbital nerve , the mental foramen and the tooth surfaces. Further more miniplates are frequently palpable under the thin skin of the orbital , nasal , frontal regions , sometimes give rise to thermal hypersensitivity , both necessitating plate removal.[6]

HANS G LUHR is credited with first reducing the scale of minifixation systems to a microplate variety. Their malleability allows for easier insertion in to more limited access incisions and permits minute alterations in position once fixed in to place. Their smaller size and lower profile allow for an unsurpassed aesthetic result in the thin skinned regions of the orbit and nasoethmoid region. Smaller microplate hole spacing permits smaller comminuted bone segments to be fixated , allowing restoration of preinjury anatomy in three dimensions.[5]

The purpose of this study is to evaluate Titanium Microplates as a method of fixation in the management of maxillofacial fractures.

II. Material And Methods

Thisprospective study was conducted on twenty patients who sustained maxillofacial fractures. Patients wererandomly selected irrespective of age and sex. All the patients underwent open reduction and internal fixation in maxillofacial fractures under General or Local anaesthesia using 1.2 mm Titanium Microplates.

Inclusion criteria:

- Patients of both genders irrespective of age who sustained maxillofacial fractures.
- Patients in whom microplates were used as a method of fixation.

Exclusion criteria:

- Medically compromised patients where open reduction and internal fixation is contraindicated
- Preoperatively infected fracture sites.
- Patients who are not willing to come for long term follow ups.

Methodology:

In all the twenty patients open reduction and internal fixation done. As per the surgical principles all the twenty patients underwent a thorough pre-operative evaluation comprising of:

1.Detailed case history
2.Clinical examination
3.Radiographic examination
4.All necessary haematological investigations
5.Pre anaesthetic evaluation.

The outcome of the surgical procedure was explained to every patient included in this study and informed consent was taken before the surgery.

In all the twenty patients , the method of surgical approach is either intraoral or extraoral based on the fracture site. Cases were performed under general or local anesthesia. In all the cases , titanium microplates were used to stabilize the fracture segments after reduction .

The following materials were used in the surgical procedure.

- Bard Parker handle no.3.
- Blade no.15.
- Maxillofacial trauma kit and 1.2mm titanium microplates with 0.8mm screws
- Polygalactin, 3-0 absorbable suture material [Vicryl].
- Polypropylene, 4-0 non-absorbable suture material [Prolene]

The microplates were evaluated intra-operatively and post-operatively for various parameters. Post-operative clinical evaluation was done at the intervals of 1 week, 1month and 3months respectively.

Intra-operative parameters: They include

- Ease of application of microplates when compared with other systems.
- Adaptability of plate to underlying bone.
- Intraoperative stability of the fractured segments following fixation of microplates.

Post operative parameters: They include

- Post-operative occlusal discrepancy
- Adequacy of reduction radiographically.
- Presence or absence of wound dehiscence.
- Plate exposure / infection.
- Adequacy of mouth opening.

Post-operatively I.V drugs were used for 5 days.

- Injection Taxim [Cefotaxime] 1gm 12 hourly.
- Injection Metrogyl [Metronidazole] 500mg 8 hourly .
- Injection Voveran [Diclofenac Sodium] 75 mg 12 hourly.
- Injection Rantac [Ranitidine] 50 mg 12 hourly. All the drugs were continued for 5 days postoperatively.

III. Results and Observations

This study is with a sample size of 20 patients who sustained fractures of maxillofacial region. Patients were randomly selected irrespective of age and sex. All the patients underwent open reduction and internal fixation with titanium microplates in maxillofacial fractures under General or Local anaesthesia.

Following Table No1 shows details of all twenty patients who sustained maxillofacial fractures and treated with titanium microplates.

Serial No	**Age/Sex**	**Diagnosis**
Case 1	4/F	Left Subcondylar Fracture With Symphyseal Fracture Of Mandible
Case 2	25/M	Left Fronto Zygomatic Fracture
Case 3	33/M	Right Zygomatic Complex Fracture
Case 4	45/M	Right Zygomatic Complex Fracture
Case 5	25/M	Right Zygomatic Buttress Fracture
Case 6	14/F	Left Mandibular Body Fracture
Case 7	48/M	Right Zygomatic Buttress Fracture With Left Parasymphysis Fracture Of Mandible
Case 8	36/M	Right Fronto Zygomatic Fracture And Right Subcondylar Fracture
Case 9	25/M	Left Zygomatic Complex Fracture I
Case 10	45/M	Left Zygomatic Complex Fracture
Case 11	35/M	Right Zygomatic Buttress Fracture
Case 12	29/M	Right Zygomatic Complex Fracture
Case 13	33/M	Left Fronto Zygomatic Fracture
Case 14	35/M	Left Zygomatic Complex And Bilateral Parasymphysis Fracture
Case 15	24/M	Frontal Bone Fracture With Bilateral Zygomatic Maxillary Fracture
Case 16	23/M	Right Zygomatic Buttress Fracture
Case 17	30/M	Dento Alveolar Fracture Involving Piriform Aperture
Case 18	19/M	Right Zygomatic Complex And Right Parasymphyseal Fracture
Case 19	23/ M	Right And Left Zygomatic Complex Fracture.
Case 20	35/M	Right Zygomatic Buttress And Right Condylar Fracture

Following parameters were evaluated:

Intra-Operative Parameters:

- Ease of application of titanium microplates when compared with other systems.
- Adaptability of plate to underlying bone.
- Intraoperative stability of the fractured segments following fixation of titanium microplates.

Post Operative Parameters:

- Post-operative occlusal discrepancy.
- Adequacy of reduction radiographically.
- Presence or absence of wound dehiscence.
- Plate exposure / infection.
- Adequacy of mouth opening.

Evaluation of all the twenty patients revealed the following:

- Easy positioning of plate during osteosynthesis of maxillofacial fractures is obtained in all the cases.
- Plate adaptability to the underlying bone is good in all the cases.
- Intraoperative stability of fractured segments following fixation with microplates was satisfactory.
- A good adequate occlusal stability is seen in all patients.
- Adequacy of reduction radiographically in all the patients were seen.
- No evidence of plate exposure was elicited in all the patients.
- No sign of plate infection is noticed in any of the patients.
- Fracture of screw head while inserting was seen in case no 10.
- Microplate and miniplate combination was used in case no 4 , 7, 8 , 9 , 14, 18, 20.

- Case no 1 is a paediatric mandibular symphyseal fracture and left subcondylar fracture where titanium microplates were used in the symphyseal region in order to avoid damage to the underlying toothbuds and a miniplate at the condylar region resist displacement of fracture segments.
- Case no 7, 14, 18, are zygomatic complex fractures associated with parasymphyseal fractures where microplates were used in zygomatic region and miniplates were used in displaced parasymphyseal fractures.
- Case no 8 and 20 are zygomatic fractures associated with condylar fractures where microplates were used at zygomatic fracture region and miniplates at condylar region.
- Case no 9 is zygomatic complex fracture involving left fronto zygomatic region, zygomatic buttress and zygmatic maxillary region where microplate and miniplate combination was used with miniplate at buttress region as it was displaced grossly.

IV. Discussion

The maxillofacial skeleton is commonly fractured due to its prominent position . The location and pattern of the fractures are determined by the mechanism of injury and the direction of impact. In addition, patient's age and the presence of teeth have a direct effect on the characteristic pattern of such injuries.[1,7] The incidence of maxillofacial injuries is on the rise due to the increase in the number of motor vehicle accidents. Road traffic accident (RTA) still remains the commonest cause of these injuries. These fractures have gained the attention of surgeons attempting to achieve improved and more predictable outcome by open reduction and internal fixation (ORIF). [7] The other main causes worldwide includes assaults , falls , sport related injuries and civilian warfare.

The surgical treatment of Craniomaxillofacial trauma involves the restoration of both form and function via a complex interplay between the facial bony skeleton and its soft tissue envelope. However, it was not until the introduction of open reduction and internal rigid fixation techniques for the facial skeleton that the basic orthopedic principles of accurate fracture reduction, bone fixation, and healing could be applied.[2]It is well established that bone healing is optimized by precise anatomic reduction and rigid immobilization. Although it is difficult to demonstrate, there is general agreement that compression of a fracture site is a useful adjunct to stability. Studies have shown more rapid healing and a greater resistance to separation when a fracture is placed under compression. Compression probably does not stimulate osteogenesis rather, provides intimate apposition and mechanical stability, allowing primary healing to occur.[8]At any given time, different regions of the same bone will be in equilibrium, under compression, or under tensile forces. This will depend on the mechanics of their articulations and muscle attachments. Fixation appliances, to neutralize muscular forces, must be placed at the area of tension to absorb tensile forces. When this is accomplished, it eliminates tension and reduces compressive forces in the compression area, leading to an equal distribution of forces over the fracture surface.[4,8]

In an effort to optimize bone repair and minimize the necessity of intermaxillary fixation, many different systems and methods of internal fixation have been devised. Interosseous wiring has not been successful when used without concomitant maxillomandibular fixation (MMF) for fracture reduction and immobilization. Although interfragmentary compression can be established with wires, the compression is not maintained. Wires lack adequate rigidity, directional control, and surface-to-bone surface contact area to maintain rigidity under functional forces. Even a screw 2 mm in diameter has a contact surface area seven times greater than that of a 0.5 mm wire. Because the wires have such a small surface area and are not intimately in contact with bone throughout their length, they lack directional control. Excessive tightening in an attempt to establish compression often leads to tearing of the bone as a result of stress concentration.[6,8]

Rigid internal fixation by compression bone plates was developed for the treatmentof long-bone fractures. Bicortical screw engagement is required to provide axial compression of the bone fragments at sites of tension resulting from the fracture displacement. For bicortical screw fixation in the mandible, bone plates have to be sited at the lower border to avoid damage to the teeth and inferior dental canal. Application of compression plates to the side of compression, the lower border, is biomechanically unfavourable, resulting in distraction at the side of tension, the dental arch. A tension band at the upper border is therefore required to overcome this distraction and maintain the correct occlusion. In addition, the application of compression to the convex buccal surface of the mandible results in a distraction of the fracture at the lingual plate which is difficult to overcome.[4]

Schilli recommends bicortical screw fixation with a "dynamic compression plate" to treat fractures of the maxillofacial region. As a member of the AO/ASIF group, he believes that bicortical fixation enhances stability and that tapped screw holes maximize screw-to-bone-surface area contact. Plates are placed at the compression region of the mandible, necessitating an arch bar or placement of a small plate near the alveolar ridge to manage the tension band. When these methods are not possible, an eccentric dynamic compression plate is recommended to manage both the tension band and the compression region.[4,8]

Lag screws can be used alone or as a supplement to plate osteosynthesis dependent on the anatomy of the fracture site. The principle of osteosynthesis with lag screws is that the screw threads engage only the cortical bone across the fracture line from the site of screw insertion. When the screw is tightened into the threads of the inner cortical layer and countersunk into the outer cortical layer, compression is applied and maintained at the fracture site .[8]

An original technique of osteosynthesis for reduction and immobilization of fractures and osteotomies of the facial skeleton is described by **Francois X Michelet** .The technique of application of miniaturized screwed plates with stellite plates of 12 , 18 , 25 mm length and 4mm width are used. The proper fixing of plates and screws on the cortical bone assures the immediate and unchanging stability of fragments.This does not need the use of the traditional and uncomfortable intermaxillary immobilization or at least allows shortening of it or its intermittent use. The structure of the facial bones is basically different from that of the mandibular bone. The presence of sinuses, orbits, and nasal fossae add to the lamellar nature of this fine cortical bone . The small screwed stellite plates proved to be resistant enough for immobilizing this kind of fractures. [9]

Maxim Champy et al described the modified Michelet's (1973) technique of mandibular osteosynthesis, which consists of monocortical juxta-alveolar and sub-apical osteosynthesis, without compression and without inter-maxillary fixation. This technique can be used in many types of mandibular fracture, single or multiple, associated or isolated, except in the case of a fracture of the condylar neck and in the presence of pre-existing infection. This has been demonstrated by anatomical verifications and biomechanical studies of the resistance of the outer cortical plate. The study of the moments, with regard to the mathematical model of the mandible, shows that at the level of the horizontal ramus there are almost only flexion moments, the value of which increases from the front backwards. In the anterior part of the mandible, there are mainly moments of torsion. They are higher the nearer they are to the mandibular symphysis . Therefore, the principle of osteosynthesis is to re-establish the mechanical qualities of the mandible, taking into account the anatomical conditions.[4, 10]

As a result of **Champy**'s multidisciplinary experimentation and clinical experience, they infer, in contrast to **Spiessl** and **Schargus** (1971), **Luhr**(1972), and **Schilli**(1973), that the compression of the fragments is no longer advisable because there exists, due to the masticatory forces, a natural strain of compression along the lower border. Consequently, this compression can be excessive and thus can result in bone lysis. The use of a too rigid lower border plate is inadvisable because it will result in the "shield effect". The use of compression makes the reestablishment of normal occlusion more difficult. It requires access through a transcutaneous approach.[10]

Therefore, the technical advantages of miniplate osteosynthesis are as follows:

1) small and easily adapted plates
2) monocortical application
3) intraoral approach
4) functional stability
5) biomechanically favourable.

These miniplates produce adequate stability and render IMF unnecessary. [4]

The acknowledged role of miniplate osteosynthesis in mandibular fractures has resulted in its application to bony fixation in the midface. Access via intraoral, paraorbital, or bitemporal incisions allows the use of miniplates at all levels for the fixation of reduced maxillary fractures. The midface can be viewed as a structure composed of airfilled sinuses reinforced by vertical and horizontal buttresses which transmit biomechanical forces. The vertical buttresses are the piriform rim and malarbuttress, which may be plated, and the pterygomaxillary column. The horizontal buttresses are the frontal bar, zygomatic arch, infraorbital rim, and maxillary alveolus, all of which may be plated. In any degree of midfacial fracture, the height, width, and anteroposterior dimensions can be reconstructed by miniplate osteosynthesis. [4]

The role of miniplates in the midface may be superseded by the recently developedMicroplates. The reason that implants of the existing plating systems are over-dimensioned for use in certain areas of the facial skeleton is due to the fact that rigidity, i. e. the neutralization of any mechanical stress during bone healing, was first applied to the long bones. Those long bones of the extremities and likewise the strongest bone of the facial skeleton, i.e. the mandible, are exposed to strong muscle forces. In these skeletal areas relatively large implants are needed to withstand these forces and protect the fracture site from any stress. This is absolutely true to this day. But numerous areas of very thin bony structures in the craniofacial skeleton do not require such large implants because they are not exposed to any strong muscle action. On the other hand those areas - particularly when they are severely comminuted - need optimal reduction and fixation in all three dimensions. This three dimensional fixation can only be achieved by plates - as opposed to wires which actin 2 dimensions, i. e. against tension forces only. These requirements will be fulfilled by a plate- and screw-system of micro-dimension. [11]

Hans George Luhris credited with first reducing the scale of minifixation to the microplate variety. For application within special anatomical areas, such as the naso-ethmoidal area, the orbit and the frontal sinus wall and for infant cranio-facial surgery a Vitallium micro-plate-system has been developed, with screws of 0.5 mm diameter. The micro-plates of 0.5 mm thickness, provide rigid fixation of very thin bony structures, and at the same time, minimal interference with the overlying soft tissues.[11,12,13]

Microplates are a supplement to the larger plating systems. They are generally indicated in fractures and osteotomies of thinner bones where no muscle or masticatory forces are present . the main indications for microplate fixation in trauma are the following selected types of facial fractures.

- Nasoethmoidal fractures
- Fractures of the infraorbital area
- Fractures of the frontal sinus walls
- Reconstruction of the skull [11,12]

The thin bones at the nasoethmoidal area are particularly suitable for microplates that can be contoured in three dimensions around the nasal bones. Because of their small size and the very low plate screw profile , they do not interfere with the thin soft tissue cover in this area and therefore are superior to the larger miniplates. The infraorbital area where microplates are favoured. This is true not only with fractures in children, but also with many cases of infraorbital fractures in adults. Fractures of the frontal sinus walls and the supraorbital area are favourite indications for microplates. Since with one plate only , multiple fragments can be stabilized and the convex shape of the frontal area is reestablished. Fixation of bone grafts that bridge defects of skull is another example where microplates have proved to be very useful.[12,]

Their malleability allows for easier insertion in to more limited access incisions and permits minute alterations in position once fixed in to place. Their smaller size and lower profile allow for an unsurpassed aesthetic result in the thin skinned region. Microplates are more than 50% smaller in overall size than miniplates. The plates come in a limited number of configurations (straight, L, T, and H-shaped) and may easily be adapted to most skeletal sites because they can be bent in all three dimensions due to their thinness and the design of the connection bar between the holes. This feature to be particularly useful when one end of the plate has to be moved or recontoured (eg, if a screwhead shears off or there is poor adaptation of a portion of a plate to the bone surface) because it can be done without having to simultaneously remove all the screws and reposition the entire plate. The small size of the plates and screws inherently demands a more exacting surgical technique.[11,12,13]

Despite its advantages in select midfacial sites, the efficacy of microfixation in the mandible is unknown and, most likely, much more limited due to the increased forces manifest with near-continual motion and mastication. Its application in nonstress- bearing mandibular sites, such as the chin, is obvious. The microplates may be extended close to or over tooth-bearing bone because the microscrews can be placed into the interdental spaces without risk to root injury. [13]

Microsystem for internal fixation of maxillofacial fractures was introduced because of a growing demand for smaller systems and the improved technical ability to produce them .Microdimensioned osteosynthesis plates have the advantage that they can anatomically fix small bone pieces, which was not possible with the earlier wiring techniques or the larger miniplate systems . These smaller plating systems could only be used where torsional forces from muscles of mastication would not disrupt the reduction .**Hardt and Gottsauner** stated that microplates are often sufficient in children because of lesser torsional force applied on broken segments in children. Microplate technique is performed with minimal effort, more convenient access and less stripping of surrounding periosteum. Their low profile and tiny screws decrease the chance of neurovascular injury so less postoperative paresthesia and possible damage to adjacent teeth . They also decrease the interference with current imaging modalities such as radiography, magnetic resonance imaging or computed axial tomography.[14, 15]

Although the first use of rigid internal fixation with a plate and screws is credited to **Hansmann** in 1858, the first application of rigid internal fixation to the facial skeleton is credited to **Schede**, who described use of steel plates and screws to fixate mandible fractures in 1888. It was not until the development of materials that were more resistant to corrosion in the early 20th century, though, that internal fixation for the facial skeleton became more widespread. [2,3]

Alloys of chromium, nickel, and molybdenum, or ‘‘stainless steel,’’ and later in 1936 Vitallium (an alloy of cobalt, chromium, and molybdenum developed by the Austenal Laboratories, York, PA) paved the way due to their improved corrosion resistance. Vitallium found its first use in the face for a mandibular fracture by **Bigelow** in 1943. In an attempt to find a material that had the inertness of Vitallium combined with the usability of stainless steel, **Leventhal** in 1951 proposed use of titanium for fractures. In 1967, **Snell** described his use of titanium hand fracture plates for the facial skeleton, and **Luhr** introduced one the first dedicated facial plating systems (the Mandibular Compression System) in the late 1960s. [2]

Plate and screws of the microsystem developed by **Luhr**consist of vitallium[11,12], that has twice the tensile strength, 50% more yield strength, and twice the hardness of the other metals. An added benefit is that the yield strength of Vitallium nearly doubles upon bending, compared with only a mild increase with titanium. The result is that plates manufactured from Vitallium are thinner (0.5-mm-profile microplates) than their steel or titanium counterparts (0.8-mm-profile microplates). It was additionally touted as having excellent tissue biocompatibility, not unlike titanium. However, although experimental in vivo studies confirm that the resistance to corrosion is similarly high for titanium and cobalt-based alloys, they differ in their respective products of corrosion. Titanium produces mainly uncharged inorganic compounds as corrosion products, which cause minimal physiologic tissue insult, and, thus, it behaves biologically inert. In contrast, alloys such as stainless steel and Vitallium produce charged species (ions), which cause tissue insult and concomitant foreign body reaction or sequestration. [2]

Titanium plating systems are made from pure titanium and varying amounts of oxygen or from titanium alloys. Titanium is less rigid and, thus, more easily adaptable than stainless steel while maintaining sufficient strength. It forms a protective oxide that helps it to resist corrosion and achieve good tissue biocompatability. Titanium also possesses the unique ability to bind to bone, a property known as osseointegration. Thus, unlike stainless steel screws, which typically loosen over time, the release torque of titanium screws ironically exceeds the insertion torque. Titanium plating systems for maxillofacial trauma are currently available from all the major manufacturers. [2]

In our study we have evaluated 20 patients who sustained maxillofacial fractures treated using 1.2mm Titanium Microplates with 0.8mm diameter screws with open reduction and internal fixation under general or local anesthesia. Among them 18 cases of middle third of face and a case of paediatric mandibular symphyseal fracture and a case of mandibular body fracture in a young adolescent were treated with titanium microplates. Out of these 18 cases , 5 cases had concomitant fractures of mandible of which 2 are condylar fractures and 3 are parasymphyseal fractures which are treated with miniplates osteosynthesis.

D.A.Mitchell et al hold data on 20 patients treated by multipoint fixation at the frontozygomatic suture with 0.5mm Vitallium microplates . The reduced fractures were stabilized by two side by side microplates, one lying anterior and one lying posterior on the lateral orbital rim. They concluded that , although the 0.8 mm microsystem devised by Luhr was not recommended for osteosynthesis at the frontozygomatic suture , in view of wide range of opinion as to exact need and appropriate method for fixation , 0.8 mm microsystem provide an acceptable compromise. By doubling the contact area as well as providing a more rigid geometric pattern, the side by side microplates appear to overcome the problems of limited rigidity.[16]The frontozygomatic suture line represents very thick bone that is ideal for rigid fixation. Unfortunately, plates in this area are readily palpable, and therefore it is usually advisable to use smaller plates at this location, provided that the fracture is not too unstable. [17]

In our study , we have reduced and fixed 8 frontozygomatic fractures with 1.2 mm titanium microplates which eliminated the use of side by side 0.5mm microplates to stabilize the suture and adequate stability of the fracture segments achieved after fixation of 1.2 mm titanium microplates and adaptability of plate to the underlying bone was good.

Walid A Abdullah et al evaluated the use of one titanium microplate in the fixation of displaced paediatric parasymphyseal mandibular fractures.[15]
In our study we have treated a case of displaced paediatric mandibular symphyseal fracture with microplate at the inferior border of the mandible which maximized the advantage of without any risk of injuring the teeth buds and without effecting the stability of the fracture fixation. The general rule in surgery, namely that "as little alloplastic material as possible but as much as necessary" should therefore be applied here as well.[15] According to this, we used the least amount of titanium by using one microplate at the inferior border and with supplemental interdental wiring at the upper border, without losing the required stability needed for fracture healing and decreased the risk of injury to the roots or teeth buds. The mechanical properties of titanium microplates were enough to produce stability in paediatric mandibular fractures and this is also may be due to that the strength of musculature of children is less than adults.

According to Davison et al the paediatric mandible is fairly malleable, fractures tend to be less displaced and more bone growth expected, absolute compression of the fracture edges together is not necessary. The results of microplates in this study were promising as they provide adequate stability of fracture segments with minimal complication and at the same time microplates had low profile and enough rigidity which suitable for mandibular fracture in children.[14,15]In another study by **Uckan** et al and in which mandibular corpus fractures were fixed with titanium plates and screws in growing rabbits, it was shown that the metallic fixation did not result in either mandibular asymmetry or growth restriction. Cephalometric analysis was used to evaluate these potential effects.[18]The results of their study have shown that the metallic fixation of mandibular symphyseal fracture does not affect the mandibular growth in vertical and sagittal planes in growing rabbits.

Syed zakaullah evaluated mandibular fracture using 1.3 mm low profile titanium miniplates.[19]

In our study , we have done a case of left mandibular body fracture and we consider that 1.2 mm microplate can be used in the body region as there was no muscle pull exerts in that anatomical area and no significant occlusal discrepancy is seen. The microplate technique is performed with minimal effort, more convenient access, and less stripping of the surrounding periosteum. Because this is a monocortical technique, there is less chance for iatrogenic damage to adjacent teeth by misdirected wire passing burs. Most importantly, however, less manipulation of the fracture segments is required to provide stabilization.

Daniel E .O Hara et al done a quantitative biophysical study on the role of microfixation in malar fractures and concluded that combination of lateral buttress fixation with miniplate fixation in conjunction with microfixation at zygomaticofrontal and infraorbital rim regions exhibited stable characteristics over the range of forces applied. [5]

Strong and Sykes propose a combination of systems of miniplates and microplates in the different buttress of support of the zygomatico maxillary complex fractures.[20]

In our study , combination fixation of microplate and miniplate was employed in a case of zygomatico complex fracture. We feel that reduced scale and three dimensional confirmability of microfixation system at zygomaticofrontal region, in concert with the stability of miniplate in the midface buttress , provided unparalled balance between stability and aesthetics in the management of zygoma fractures.

Schortinghuis et al evaluated complications of internal fixation of maxillofacial fractures with microplates. Two kinds of complications were studied. First, there were complications that occur during application of the osteosynthesis system. These included drill breakage during drilling, plate breakage during bending, screw head stripping, and screw breakage during insertion, screw failure and the need to use emergency screws, dropping of micromaterial in the operative field, and the inappropriate insertion of screws in anatomic structures such as tooth roots or nerves. These complications are referred to as perioperative complications. Second, complications involving the healing of fractures fixed using the microsystems were studied. These complications included infection at the fracture site, exposed hardware, improper location of screws and plates, and dislocation of bone parts fixed using microplates. Finally, palpability of the implanted material and pain were studied. These are referred to as postoperative complications. In case of material removal, difficulties can occur such as screw head stripping and screw or plate breakage.[6]

In our study one microscrew with a length of 6mm broken at its screw head during its insertion at the left frontozygomatic suture region in case no 10. Dropping of micro material in the operative field occurred very less often . All the fractures appeared to be stable. Complications were minimized with increased use and proper technique. Postoperatively, no hardware was exposed intraorally or extraorally, nor did an infection occur around the osteosynthesis material during follow-up. An explanation could be that microplates are much thinner than miniplates and easier to adapt to thebone, and therefore produce less tension on the muscles in the gingivobuccal region, decreasing the risk of dehiscence and infection. We did not encounter displacement of microplates or bony parts leading to nonanatomic healing of fractures. Apparently, the microplates had enough holding power to keep the midfacial fractures reduced.

Microsystems proved to be a reliable modality to fix fractures of the maxillofacial skeleton. Complications can be considered incidental and of neglectable clinical significance.

V. Conclusion

In our study we have evaluated the titanium microplates intraoperatively and post operatively for various parameters in management of maxillofacial fractures. Among them 18 cases of middle third of face and a case of paediatric mandibular symphyseal fracture and a case of mandibular body fracture in a young adolescent were treated with titanium microplates.

In all the twenty patients , the method of surgical approach is either intraoral or extraoral based on the fracture site. Fracture site was exposed and reduced to anatomic position. Fixation done using 1.2 mm microplates and 6mm or 8mm screws. Intra-operative and post-operative evaluation was done.

The results of our study suggest that :

- Titanium microplates provide adequate fixation of fractures.
- Negligible palpability in the thin midfacial region.
- Highly malleable , so easily adaptable to complex facial contours.

- Highly biocompatible.
- Minimum pressure is required during tightening of screws as excessive pressure can lead to breaking screw head.
- Microplates can be adequately used for internal fixation in selective mandibular fractures i.e, undisplaced and paediatric fractures.

Considering the above results , it can be concluded that microplates may be considered as a valid tool in the management of maxillofacial fractures.

Further studies regarding the microplate system in a larger sample size would provide us with a strong evidence of this system in the forthcoming years.

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Dr.Venu Sameera Panthagada, et. al. "Management of Maxillofacial Fractures Using Titanium Microplates – An Original Research Study." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 22(2), 2023, pp. 43-52.