



Review Article

Evolution of The Efficiency of Various Methods of Fixation for Zygomatico Maxillary Complex Fractures

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ABSTRACT

Back Ground: Despite the prevalence of zygomaticomaxillary complex (ZMC) fractures, there is no consensus regarding the best approach to management. The aim of this review is to discuss the evolution and compare the efficiency of various fixation methods of zygomatico maxillary complex fractures.

Objective: To discuss the evolution and compare the efficiency of various fixation methods of zygomatico maxillary complex fractures.

Data Sources: A detailed search was undertaken on major electronic databases. The search was restricted to English language.

Review Methods: Randomised controlled trials, experimental studies were included in the review.

Conclusions: This narrative review concluded that there was enough evidence to suggest that patients may benefit from rigid and semirigid internal fixation using miniplates in zygomatico maxillary complex fractures

Key words: Zygomatic complex fractures, Semirigid fixation, drill free screws.

Introduction

Maxillofacial trauma by their varying nature imparts and a high degree of emotional as well as physical trauma to the patients. The anatomy of the cranio facial skeleton is complex where it functions as a three dimensional unit. As a result of the complexity isolated fractures of the facial bone is a rare incidence.⁽¹⁾

Midfacial fractures can either occur alone or combined with other injuries such as mandibular, ophthalmologic, cranial, thoracic as well as upper and lower long bone injuries⁽²⁾. The existing data regarding fracture of the face varies in site, extent and etiology depending on the subjects studied. These diverse causes of fracture of oral and maxillofacial region can be because of differences in risk as well as traditional and cultural factors among countries which in turn is influenced by the severity of injury.⁽³⁾

Objective

To discuss the evolution and compare the efficiency of various fixation methods of zygomatico maxillary complex fractures

Literature Review

A thorough literature review available for relevant literature in English language was done. The number of articles reviewed for this review is around 40–45 articles, articles selected were on English language.

Studies Related To Conventional Methods Of Fracture Reduction And Fixation

A comprehensive report of the use of transmaxillary Kirschner wire is done on 1952 which stated that it provide stability after the reduction of zygomatic fractures. The main disadvantages were that the wire technique puts at risk the structures of the contralateral orbit. Rotation of the malar bone against the frontal process is possible as the pin is usually inserted parallel with the frontal and horizontal planes.

Later in 1964 selfcure acrylic is used to manufacture the splints and cemented them on the teeth. Acrylic splints can be ready to effect immobilization within two hours of taking impressions as compared to cast metal splints (6-8 hours). This results in very early immobilization of the fractured bones, with considerable benefit to the patient. This reduced time factor is also a great advantage in the

treatment of the patient with skeletal damage and facial lacerations.

In 1972 box frame fixation offers simple immobilization of the midfacial fracture, with or without associated mandibular injury. The technique does not require complicated apparatus and is very easy. No dressings are required and patients can be mobilised immediately after the operation. Although they have to sleep on their backs, the patients are comfortable. The removal of the apparatus at the end of 6 weeks is painless, and can be done in minutes in an outpatient unit. The resulting scars are not usually unaesthetic. Minimal pin tract infection has been encountered. Box frame is usually applied between the 6th and 12th day, when the swelling has subsided.

On performing a clinical study, in 1976 proved that internal wiring fixation is better than fixation of pack in the antrum when stay in the hospital, restoration of infraorbital nerve function, position of the orbits, bilateral palpebral fissure symmetry and the final aesthetic results are considered. However, in the antral packing group, the result was better when jaw movements and occurrence of permanent double vision were compared.

Retrospective examination of 21 subjects having maxillary fractures treated at the Medical Center Hospital of Vermont in Burlington in 1983 by thorough comprehensive dental and ENT clinical analyses, revealed no nonunion in any patient examined and compared each patient's lateral cephalogram with computerized norms suggested that elongation of face did not occur when Inter maxillary fixation alone was the principal method of repair.

In a study conducted using Champy miniplates in the treatment of facial fractures and in the correction of the post traumatic deformities, in birth craniofacial deformities, and bony deformities occurring secondarily, the advantages of plating are summarized as reduced time of operation, rigid fixation during the surgery, adequate and good fixation of bone grafts, and the skill to take out the intermaxillary fixation in children after the procedure or during the immediate postoperative days.

Klotch and Gilliland 1987 evaluated internal fixation using AO miniplates compared to the already existing therapy (utilizing a combination of IMF, and interosseous wiring, or bone grafting) for the treatment of serious mid third fractures. They concluded that internal fixation gives very good stabilization and correction of serious mid third injuries with less complications and fast return to routine job for most patients.

Wu et al 1998 evaluated the stability of miniplate osteosynthesis for midface fractures and found that RIF provided good three dimensional stability. The fixation of zygomatico frontal suture and zygomatico maxillary suture were the key for obtaining sufficient stability, and at least two fixation screws were required above zygomatico frontal suture.

Studies Related To Various Advancements In Midface Fracture Reduction And Fixation

Manson and coworkers 1985 have proved that immediate extensive ORIF with bone grafting done primarily provides superior aesthetic results in midthird of face. fractures in poly trauma patients. Orbital reconstruction most frequently requires bone grafts. They concluded that extended ORIF and bone grafting simultaneously has an added advantage over the aesthetic results obtained from facial fracture treatment. Also, structural bone union and pre operative facial structure could be restored if soft tissue contraction is not present

In a study done by Rudolf and Coworkers⁽³⁹⁾ 1987, treating unstable zygomatic fractures with resorbable poly (L-lactide) (PLLA) plates and screws, the results showed that this method of fixation gives good stability over a sufficiently long period to enable undisturbed fracture healing.

Francel TJ in 1992⁽⁴⁰⁾ summarized the complications of rigid fixation in the management of craniomaxillofacial trauma as prominence, infection, exposure, and migration of the osteosynthesis appliances. The frequency of infection and exposure may be decreased with antiseptic irrigation, correct placement of plates, attention to proper mucosal closure, and mucosal-saving techniques.

In a retrospective study by Niessen et al⁽⁴¹⁾ 1996 comparing the late results of patients with an isolated zygomatic fracture and dislocation, who have been treated with the Gillies procedure alone or with stabilizing transosseous wires, proved that even the stabilized zygomatic complexes (22%) could, due to the pull of the muscle masseter, still rotate around the axis of stabilization and this causes asymmetry in 60% of the cases. Unstable fractures and dislocations, however, need an open reduction and an adequate stabilization with miniplates at the frontozygomatic suture and infraorbital rim.

Lee et al⁽⁴²⁾ 1997 utilized endoscopic-assisted technique of open reduction and rigid fixation for management of complex midfacial fracture to facilitate

the anatomic repair of associated zygomatic arch and orbital floor fractures. The results obtained proved that the technique minimized ocular globe manipulation and concomitantly eliminated the need for coronal scalp and lower eyelid incisions.

In 1997 stated that in case of significant midface retrusion due to bone loss, a framework reconstruction using 2.0mm titanium mesh molded and fixed rigidly in place, followed by application of hydroxyapatite cement onto the mesh allow restoration of normal skeletal structure. No overcorrection is required if this method of reconstruction is used.

In a study by Enislidis and coworkers 1998, a new material for osteosynthesis fixation of zygomatic fractures was used and after six month follow-up period, there was uneventful bone healing with no complication regarding the hardware. advantages of the new material is that its malleable when heated, and adapting fast to the bone surface, and second operation can be avoided for implant removal.

In another study of 44 patients by Schortighuis et al 1999 with maxillofacial trauma treated by open reduction and internal fixation using 1.0 and 1.5-mm microplates for fixation revealed a perioperative complication rate of 1.2% for the 1.0-mm screws, primarily malposition. No complications were observed with the 1.5-mm system and there was no instance of exposed hardware

In a study by Park and his co-workers 2001, for the repair of 39 orbital fractures, Titanium mesh screen 1.0 (SYNTHEs) were used either as an onlay implant or as cover implant to repair severely crushed fracture on the orbital rim or maxillary wall segments. The advantages of using titanium mesh screen were its high rigidity and malleability, fewer artifacts on the follow up CT scans and ability to restore and fix easily even crushed tiny bony pieces without loss and achieve more accurate three dimensional anatomical reconstruction of orbital wall fracture.

Paludetti et al 2003 conducted a study comparing various techniques for midface fracture fixation, it is concluded that the use of titanium mini and microplates, are easy to apply and offer optimal reduction and stabilization and hence well-suited for surgical application. Resorbable mini-plates are more advantageous in paediatric patients since titanium plates interfere with cranial-facial growth and, also make both CT and MRI artifacts. Moreover, these could create problems, in the event of oncologic disease that requires radiotherapeutic treatment. Use of

absorbable materials reduces the risk of inflammatory complications following titanium implant rejection requiring removal of these devices.

Marcin Kozakiewicz 2009 used 3-D virtual and anatomical models on the basis of computed tomography images. Using rapid prototyping, these were used as templates to form titanium mesh implants, which are then used intra operatively as guides to aid correct implant placement in the orbit for the reconstruction of orbital floor defects.

Kloss et al 2011 stated that in the management of midfacial fractures complications occur after 6 and 12 months. Nerve parasthesis and sensitivity to the material were most prominent. Hence careful decision should be taken regarding surgical treatment

Vijay Ebenezer 2012 in his study stated that microsystem has good and paramount use in midface fractures. The advantages noted are adequate fixation of fractures, with negligible palpability in the thin midfacial region, minimal thermal conductivity, high malleability to easily adapt to complex facial contours and high biocompatibility. In addition, it gives a very good access and easy placement without disturbing adjacent anatomic structures.

In a study by Mehra 2013, craniofacial suspension using POP head cap is found to be a quick, simple and efficient immobilization of middle third fracture with/without associated mandibular fracture.

Carron and co-workers 2014 ultrasonically vibrated the pin to fill the pilot holo grooves created by the drill with the pin material. The material fills the grooves completely even at less than 90° angles and behaves analogous to screw threads. This provides a tremendous advantage in hard-to-reach midface areas because pilot holes may be drilled at less than 90° angles and the plate screw construct will maintain stability, unlike its titanium counterpart. The two properties of the absorbable system may help overcome the issue of achieving stability when perpendicular placement would be difficult.

Studies Related To Self Tapping And Drill-Free Screws

Drill Free Screws (DFS) were developed in 1998 by Heidemann as having a cork screw and cutting flutes which are specially formed which enable insertion of the screws without drilling. Tests performed to analyze the holding power of drill free screws and self-tapping

titanium screws showed that the holding power of drill free screws is between 70 and 104% of the holding power of self-tapping titanium screws.

In a prospective study performed by Heidemann 1999 to investigate the clinical efficiency of mini and micro-drill free screws (DFS) and also to determine areas in maxillofacial traumatology and orthognathic surgery, where this new type of screw may be recommended for clinical use; this study proved that micro- and mini-DFS has adequate rigidity and stability for the fixation of bone fragments in the central and lateral midface and in the anterior mandibular area. However, the application of DFS in the mandibular angle region is not recommended.

In a study evaluating the clinical use of self drilling screws in the craniomaxillofacial area, Ralf Schon et al 2000 found that ease of insertion without previous drilling and less use of instruments reduced the operating time. Screw fractures occurred, when the screws were inserted forcefully in the periorbital area. They concluded that miniplate osteosynthesis and the fixation of cortical and cortico-cancellous bone grafts using self-drilling screws proved to be reliable.

Holmes and co-workers 2000 suggested the technique for the use of bicortical screws that two forward turns followed by one backward turn excludes the shaft from the pitch of the screw during insertion and removal.

Heidemann 2001 on comparing the metal/osseous interface and bone remodeling after insertion of self-tapping screws and drill free screws found that DFS had higher screw/bone contact and significantly more residual bone in the region of the screw threads. The greater amount of original bone in the threads of drill free screws demonstrated that the insertion of drill free screws did not cause harm to the surrounding bone. Both the results obtained are important for osteosynthesis in regions where thin cortical bone is present, such as the central midface.

Coburn 2002 recommended the placement of self-tapping IMF screws with careful bur hole drilling, with slow bur speed and copious irrigation with sterile saline. Also, the screw insertion speed should be judicial and should not be forced once resistance is felt.

Alpert and his coworkers 2003 stated that self-drilling, self-tapping screws are showing much superior quality while fixing screws into soft and cancellous bone graft. The self-drilling principle has an added advantage of

avoiding the a drill hole thus shortening the process of orif and requiring less instruments.

Gibbons AJ 2003 stated that drill free IMF bone screws may be used as temporary IMF to support the fracture during definitive plating for military purposes. At the end of the surgery the IMF is released, the occlusion checked and the screws removed. If postoperative elastic traction is required, for example in mandibular condylar fractures, the screws may be left in place and removed at a later date.

Yan Chen et al 2008 compared the influences of self drilling and self tapping titanium implant modalities on orthodontic microimplants and surrounding tissues biomechanically and histologically. The tendency to fracture and the percentage of bone-to-implant contact values was greater in the self-drilling group. It proved that self-drilling microimplants can provide better anchorage and hence can be recommended for use in the maxilla and in thin cortical bone areas of the mandible.

Mischkowski RA et al 2008 in their study were compared with four miniscrew types for anchorage of the skeleton regarding the property such as biomechanical, contributing to primary stability. A drill-free screw having a conical design can achieve better and higher primary stability compared with self-tapping screws which is cylindrical. This effect was more visible during the insertion of torque estimations compared to pull-out tests. The Dual Top screws, were highly susceptible to fractures.

Jin-Seo Park and coworkers 2009 did 3D finite element analysis to evaluate the strain induced in the cortical bone surrounding an orthodontic microimplant during insertion in a self-drilling manner reported that the upper limit for normal bone remodeling, were observed in the peri-implant bone along the whole length of the microimplant. Level of strains in the vicinity of either the screw tip or the valley part was similar. The study concluded that bone strains from a microimplant insertion in a self-drilling manner might have a negative impact on the physiological remodeling of cortical bone.

In an animal study using scanning electron microscopy by Juliana GG and co-workers 2010, comparing self-drilling and self-tapping screws the bone debris formed with self-drilling screws is not the result of the heat generated, but rather the result of biologically active bone tissue capable of reacting with the screw and improving its performance and hence, bone debris formed during

the installment of the self-drilling screws is considered beneficial.

Nandini and colleagues 2011 compared the use of self-tapping IMF screws to the conventional Erich arch bars for intermaxillary fixation in the treatment of mandibular fractures. Self tapping IMF screws reduce the operating time and the risk of needle stick injuries. Oral hygiene maintenance and patient compliance were good with IMF screws as compared to arch bar

Sumit Yadav 2012 in a study evaluating microdamage accumulation after mini implant placement by self-drilling (without a pilot hole) and self-tapping (screwed into a pilot hole) insertion techniques found that the self-drilling technique resulted in greater total crack lengths in both the maxilla and the mandible.

Conclusion

Results of the narrative review of literature shows that semi rigid internal fixation using self tapping screws is the best method of fixation of zygomatico maxillary complex fracture and drill free screws can be used as an alternative to self tapping screws which is evidenced by similar success rate of both screws.

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