



A NEW "TRINITY" MINI PLATE FOR MANDIBULAR OSTEOSYNTHESIS : AN IN VITRO STUDY

Orthopaedics

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ABSTRACT

The mandible is the largest and strongest facial bone, by virtue of its position on the face and its prominence; it is commonly fractured when maxillofacial trauma has been sustained. (1)Mandibular fractures represent the second most common facial fractures after the nasal bone and symphyseal/parasymphyseal fracture comprises 15.6 to 29.3% of mandibular fractures (2).

Symphyseal fracture can be induced when a trauma is directed towards the symphyseal region where compressive strain develops along the buccal aspect whereas tensile strain develops along the lingual aspect. This produces a fracture that begins in the lingual region and spreads toward the buccal (3) Un-displaced, single and closed fractures are usually managed by closed method with maxillo-mandibular fixation (MMF). Displaced open and multiple fractures are treated by open reduction and internal fixation (ORIF). Displaced, open and multiple fractures are treated by ORIF by various methods like intraosseous wiring, miniplate osteosynthesis and reconstruction plate with bone graft. (4) Fixation by conventional S.S. Mini plate carries high morbidity and infection rates. Where as the probable limitation of 3D plates may be excessive implant material (5) hence the new design of mini plate has been developed in an attempt to overcome limitations of previous fixation techniques and to acquire better retention as well as stability.

KEYWORDS

Biomechanics , Miniplate osteosynthesis ,Internal fixation, Paresthesia of mental nerve ,Symphyseal , Miniaturized screwed plates.

INTRODUCTION :-

The mandible is the second most common bone to be involved in facial fractures, and the goal of treatment is to return it to its preoperative shape, function, and aesthetics. (6)

According to tam study on incisal biting, the symphyseal region has the most negative bending moment where compression developed at the superior border and tension at the lower border on molar loading. The symphyseal region reveal torsion moment. The maximum bending moments are 1.5 times higher than the maximum torsion moment. (7)

It is always difficult to adapt the osteosynthesis plates in the region of the mental foramina. (6) mental nerve paresthesia is a very common complication due to dissection and stretching of the mental nerve in this region (8). Additionally, trauma itself may compromise the neurovascular function of the mental nerve. (9) Clinically, three-dimensional miniplates were found to be better than two dimensional miniplates in terms of cost, ease of surgery, lesser implant material and operative time. However, 3D miniplates were unfavorable for cases where fracture line was oblique and in close proximity to the mental foramen, where they were difficult to adapt and there were more chances for tooth-root damage and inadvertent traction of the mental nerve. (10) Hence, Contemporary design of the conventional mini plate has been created which follows Champy's ideal osteosynthesis line in a closed horse shoe shaped configuration which will allow preservation of mental foramen yet achieving stable fixation.

Trinity mini plate has one sub apical arm, one arm at lower border (of mandible) and two vertical connecting arms.

MATERIALS & METHODS :-

To test the new design of mini plate acrylic mandible is used in this study.

Synthetic acrylic mandibles were fabricated in Department of Oral and Maxillofacial surgery, K.D. Dental college & hospital, Mathura, Uttar Pradesh. The customized Trinity mini plate (Indian patent application no. 201821007039A) were fabricated of horse shoe shaped configuration.

Kamevama et al. in 1989 used acrylic bars as a substrate to study different fixation systems for management of mandibular fracture. According to the study of Vieru et al. 2015, Acrylic resin can be used for creation of mandibular models for the purpose of biomechanical study. (7)

The specimens to be investigated were Trinity mini plate supplied by S.K. surgicals & conventional 4 hole with gap, 2 hole with gap s.s. mini plate by Orthomax surgicals, osteofixation systems. The osteofixation plates and screws were fixed to polymethylmethacrylate (PMMA) replica of mandible, that simulated bone segments. There was no interfragmentary

contact to simulate the most unfavourable clinical situation. Three screws were inserted in both PMMA blocks according to the prescriptions of the individual manufacturer (with prescribed burs and taps). The holes were irrigated with saline before insertion of the screws, to simulate the in situ lubrication. The tensile test was performed as a standard loading test. The 2 PMMA blocks, linked by the osteofixation device, were mounted in a test machine. Regarding the tensile tests, the 2 PMMA blocks and thus the osteofixation plate were subjected to a tensile force with a constant speed of 5 mm/min until fracture occurred. (according to ASTM D 4501 Guideline) During testing the applied force was recorded by the load cell of the test machine. Plate Screw Construct Tensile Strength:- in the plate screw construct test, the test specimen was loaded in a direction parallel to the long axis of the acrylic tube / PMMA block / mandible at a constant speed of 5mm/min until failure of fixation.

The yield load (N), maximum load (N) were recorded and failure mode was visually determined.



Fig.1. Acrylic (PMMA) model of mandible excluding ramus and condyle



Fig. 2 Digital tensile testing machine

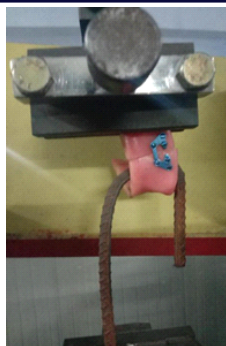


Fig. 3. Set-up of Trinity mini plate and PMMA block for tensile strength measurement (according to ASTM D 4501 Guideline) tested at Apex assesment labs pvt,ltd.,Delhi-NCR, India.



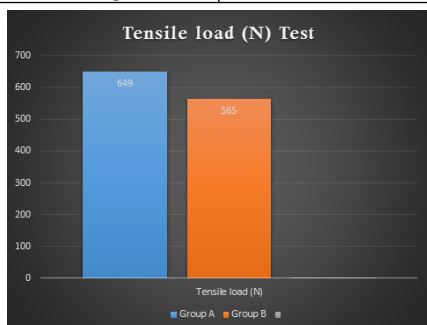
Fig. 4. Set-up of S.S. mini plate and PMMA block for tensile strength.

RESULTS:-

Through this study, polymethylmethacrylate (PMMA) replica of mandibles, Trinity mini plate supplied by S.K. surgicals & conventional 4 hole with gap ,2 hole with gap s.s. mini plate by Orthomax surgicals, osteofixation systems were used as regards the parasymphysis region for tensile strength ,there were significant differences between these two osteofixation system.The tensile strength measurement of Trinity mini plate ,was 649 N whereas tensile strength measurement of conventional Champy's S.S. mini plate were 565 N , when the osteofixation plate were subjected to a tensile force with a constant speed of 5 mm/min until fracture occurred.(according to ASTM D 4501 Guideline) During testing the applied force was recorded by the load cell of the test machine.

Table 1. Tensile load results

Test plate system	Test results ,N
Conventional s.s. mini plate	565 N
Trinity titanium mini plate	649 N



Graph .1 Comparison of Tensile Load (N) Test among Group A (Trinity min plate) & Group B (Conventional s.s. mini plate)

so , according to the result we can conclude that tensile strength of trinity mini plate is 14% more than the conventional stainless steel mini plate system.Trinity mini plate system is thus more rigid than the conventional stainless steel mini plates.

DISCUSSION :-

Modern traumatology started with the development of osteosynthesis,

which was a major step forward in craniomaxillofacial surgery. With the development of osteosynthesis in maxillofacial surgery different systems have been designed. They have become smaller, more simple to handle and extraoral incisions can be avoided. Miniplate fixation of mandibular fractures has become a standard. Through biomechanical test we can expect the behavior of different fixation systems for the mandibular fracture under standardized conditions that would be useful in making decisions clinically.

The mandible is the largest and strongest facial bone, by virtue of its position on the face and its prominence; it is commonly fractured when maxillofacial trauma has been sustained .(1)Mandibular fractures represent the second most common facial fractures after the nasal bone and symphyseal/ parasymphyseal fracture comprises 15.6 to 29.3% of mandibular fractures (2).

Symphyseal fracture can be induced when a trauma is directed towards the symphyseal region where compressive strain develops along the buccal aspect whereas tensile strain develops along the lingual aspect. This produces a fracture that begins in the lingual region and spreads toward the buccal(3) Un-displaced, single and closed fractures are usually managed by closed method with maxillo-mandibular fixation (MMF). Displaced open and multiple fractures are treated by open reduction and internal fixation (ORIF). Displaced, open and multiple fractures are treated by ORIF by various methods like intraosseous wiring, miniplate osteosynthesis and reconstruction plate with bone graft.(4) Fixation by conventional S.S. Mini plate carries high morbidity and infection rates .Where as the probable limitation of 3D plates may be excessive implant material(5) hence the new design of mini plate has been developed in an attempt to overcome limitations of previous fixation techniques and to acquire better retention as well as stability.

Acrylic mandibular substrate has been used because it has good physical properties, cheap, available and can be molded to different structures. Kamevama et al 1989 used acrylic resin bars as substrates to study different fixation systems for management of mandibular fractures. Also, Feller et al 2002 used acrylic models in their experimental study to evaluate combination of microplate and miniplate for osteosynthesis of mandibular fracture. According to the study of Vieri et al 2015, acrylic resin can be used for creation of mandibular models for the purpose of biomechanical study.change of the shape of the plate may play a favorable role in stability of the fracture keeping other factors fixed as dimension of the plate and number and dimension of the screw of the screws. (7)

Through this study, there was significant difference between Trinity mini plate & Conventional s.s. mini plate ,Trinity mini plate showed more stability than Conventional s.s. mini plate and this may be due to closed horse shoe shaped construct that surround the fracture segment provide three dimensional stability.

Thus Superiority of Trinity mini plate plate on conventional plate was also concluded.

CONCLUSION :-

The results of this study suggest that though miniplates are commonly used,the proposed customised Trinity mini plate has proved to be more effective than Conventional s.s. mini plate in terms of tensile strength.Thus the Trinity mini plate was more rigid than Conventional s.s. mini plate , hence it will hold fracture segments in more stable position.

Further prospective clinical studies are required to determine the effectiveness of this new plate design under actual clinical conditions.

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