

# Efficacy of Microplates versus Miniplates in the Management of Maxillofacial Fractures

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## Abstract

**Introduction:** Increased facial trauma has led to advances in techniques of internal fixation, improvements in plating system, refinements in exposure of facial skeleton fueling the rapid use of internal fixation for the management of facial fractures. Evaluating 40 patients with confirmed midfacial (Le Fort I and II) and mandibular fractures, this study presents the efficacy of microplate in comparison with miniplate in terms of load bearing capacity, stability at the fracture site and postoperative palpability. **Objectives:** To evaluate the efficacy of microplates in comparison with miniplates in maxillofacial trauma. **Materials and Methods:** Study sample consists 40 subjects, 20 each in two groups clinically and radiographically diagnosed with Group 1 (maxillary) and Group 2 (mandibular fractures) which were subdivided into 10 each treated with miniplate and microplate respectively. Postoperatively, stability of fracture, bite force, need for postop MMF, pain, infection, wound dehiscence, mouth opening, occlusion and palpability was noted. All cases have been evaluated clinically for various parameters for minimum of 3 months to assess any postoperative complications. **Results:** We found microplates are stable enough and have adequate load bearing capacity. Due to close adaptability and less hardware, postoperative palpability is less but larger sample study with long term follow up is necessary to conclude its efficacy in load bearing fracture sites.

**Keywords:** Bite force efficacy, bite force device, microplate, miniplate

## INTRODUCTION

The strenuous pace of modern life with high speed travel and increasingly violent society has made facial trauma, a form of social disease from which no one is immune.<sup>[1]</sup> The prevalence of maxillofacial injuries varies from 17% to 69%, and this large difference might be due to various environmental factors, socioeconomic conditions, cultural reasons, and traffic rules.<sup>[2,3]</sup> About 1.25 million people die each year as a result of road traffic accidents (RTAs)<sup>[4-6]</sup> out of which the frequency of all-terrain vehicle collisions and motor cycle accidents constitute about 32% with 8% of maxillofacial injuries, mean age being 31 years with more male victims over female.<sup>[7,8]</sup>

Maxillomandibular fixation is still the primary mode of immobilization while open and closed reduction depends on the site of the fracture.<sup>[9]</sup> Nonrigid fixation allows interfragmentary movement across the fracture line and includes techniques such as intraosseous wiring, interdental bridging wiring and interdental bridging wiring for stabilization though it can also result in malunion or nonunion on

occasion.<sup>[10]</sup> Rigid fixation helps to overcome these flaws by preventing interfragmentary distancing under active load. This includes reconstruction plates, bone plates, lag screws, compression plate, and arch bar across a fracture.<sup>[11]</sup> The goal of compression plating systems described by AO, was establishing absolute stability across a fracture, where traction perpendicular to the fracture was applied by the plate itself.<sup>[12]</sup> Then, Champy *et al.* developed the technique of Michelet *et al.* to describe a method of monocortical, small-plate osteosynthesis utilizing malleable plates inserted

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intraorally.<sup>[13,14]</sup> Luhr developed the microfixation system revolutionizing the operative management of maxillofacial fractures (MFFs).<sup>[15]</sup> It was designed with an intention to reduce the bone plate ratio and minimize the hardware to facilitate close adaptation at the fracture site.<sup>[14,16]</sup> The use of microplates is considered meaningful shift in the practice as it is less traumatic to soft-tissue causing minimum tissue interference, resistance to corrosion, special design of connecting bars between the plate holes serves proper contouring that provides 3-dimensional geometric stability, patient comfort on the basis of palpation and thermal conduction due to the thin cutaneous cover.<sup>[17-21]</sup> Microplates are used for internal fixation of MFFs as they require less manipulation and are associated with lower likelihood of iatrogenic damage than miniplates that justifies the ability to maintain anatomic apposition of the bone segments, which translates into functional and aesthetic results jeopardizing the fracture stability and the cost of system.<sup>[22-24]</sup>

Hence, we decided to conduct a clinical prospective study to evaluate the efficacy of microplates over miniplate osteosynthesis in terms of occlusal stability, stability of the fracture involved along with the postoperative biting efficiency using bite force device.

### Aim and objectives

This study aims to evaluate the efficacy of microplates over miniplates in the management of maxillofacial trauma in terms of stability the fracture site and load bearing capacity with the help of bite force device.

## MATERIALS AND METHODS

### Study sample collection

The study sample consists of 40 patients above the age of 16 years [Tables 1 and 2] reporting to the Department of Oral and Maxillofacial Surgery, at a teaching dental hospital with confirmed clinically and radiographically diagnosed midfacial or mandibular fractures. Written informed consent was taken from all patients. Ethical clearance was taken from institutional ethical board.

### Inclusive criteria

- Patients of above 16 years to 60 years
- Patients of both sexes
- Patients with confirmed clinical and radiographic diagnosis of Maxillary-Le Fort I, II fractures/mandibular – any one fracture
- Dentate patient.

### Exclusion criteria

- Patients who refused to sign consent form
- Comminuted fracture
- ASA III and IV
- Any maxillary or mandibular fracture undisplaced/fracture not involving occlusion
- Combination of any maxilla and mandibular fracture.

**Table 1: Site of maxillary fracture**

	Males	Females
Group 1A		
Lefort 1	5	2
Lefort 2	2	1
Total		10
Group 1B		
Lefort 1	6	1
Lefort 2	3	0
Total		10

**Table 2: Site of mandibular fracture**

	Males	Females
Group 2A		
Coronoid	0	0
Condylar	1	0
Ramus	1	0
Angle	2	0
Body	2	1
Alveolar process	0	0
Symphysis	2	1
Total		10
Group 2B		
Coronoid	0	0
Condylar	1	0
Ramus	1	0
Angle	2	1
Body	2	1
Alveolar process	0	0
Symphysis	1	1
Total		10

### Patient we evaluated on following parameters

1. Pain-Visual Analog Scale
2. Occlusion-intercuspatation of molars and canine
3. Bite force efficacy – Gnathodynamometer (Axpert-An ISO 9001)
4. Facial symmetry
5. Infection
6. Plate exposure
7. Mouth opening
8. Hardware palpability
9. Swelling
10. Need for postoperative maxillomandibular fixation (MMF)
11. Radiographic assessment.

All patients have been evaluated at 1<sup>st</sup> and 3<sup>rd</sup> postoperative month.

- Radiographic assessment - Reduction of fracture fragment assessed using score between 1 and 3
- 1-precise anatomic reduction
- 2-slightly displaced but satisfactory occlusion
- 3-poorly reduced that requires second surgery
- Bite force device [Figure 1] - The bite force will be recorded using bite fork at anterior and posterior teeth.

## Surgical procedure

Under general anesthesia with oral or nasal intubation, after standard painting and draping, local anesthesia was infused at the fracture site. Incision was placed accordingly and full thickness flap was raised retracting the tissues and neurovasculature. At times, cautery was used during dissection to achieve a bloodless field. The fracture was exposed and reduction was done in the maxilla and/or mandible. Adequate exposure of the fracture segments was obtained. Anatomical reduction was done. Fixation was done with stainless steel miniplates and microplates according to the location with varying screw diameters and lengths. The area was irrigated with betadine and saline. Wound was closed using 3-0 silk or vicryl or in layers where 5-0 prolene was used.

## Statistical analysis (subsection)

“Data were expressed as percentage, mean and standard deviation. Statistical significance level was defined at  $P = 0.05$ .”

## RESULTS

A total of 40 patients were evaluated. Distribution was on the basis of the type of maxillary and mandibular fracture [Tables 1 and 2], treated with mini/microplate. Group 1A-Maxilla (Miniplate), Group 1B-Maxilla (Microplate), Group 2A-Mandible-(Miniplate), Group 2B-(Microplate). Statistically significant values in terms of palpability [Figures 2 and 3] were found in Group 1B-Maxilla (Microplate) and Group 2B-Mandible (microplate). When load bearing capacity [Figures 4 and 5] was measured with bite force device [Figure 1] three months postoperatively in all groups, it was insignificant in the first month for microplate groups, which was less compared to the miniplate groups due to occlusal selfadjustability.

## DISCUSSION

Maxillofacial trauma has remained a menace in the health-care industry, contributing significant workloads in many



Figure 1: Bite Force Device (Axpert-An ISO 9001)

maxillofacial units and stretching meager human and material resources.<sup>[25-28]</sup> Collected data by the World Health Organization from different countries such as India, Japan, the United Arab Emirates, Pakistan, Turkey, and Brazil show that 36%–75% of MFFs were related to RTA.<sup>[29-31]</sup> AO-ASIF guidelines of rigid fixation follow four basic principles ensuring adequate treatment of fractures: bony segment reduction, stable fixation and immobilization of fragments, maintaining blood supply, and early function.<sup>[32-35]</sup> First presented in Atlanta in November 1987, Hans Luhr defined clinical indications for the use of microplating systems, including nasoethmoidal fractures, infraorbital fractures, frontal sinus fractures, and calvarium reconstruction.<sup>[14,36]</sup>

We performed a study in 40 patients dividing them into two main groups treated with miniplate and microplate in maxillary and mandible emphasizing on the load bearing capacity with biting force device and other parameters such as pain, facial asymmetry, occlusion, wound dehiscence, need for postoperative MMF, and mouth opening. Follow-up was carried out till 3 months. In our study, pain persisted for both groups, maxilla and mandible, treated with miniplate and microplate which was same till the 1<sup>st</sup> week and gradually decreased till the end of the 3<sup>rd</sup> month postoperatively. No statistically significant difference was found among these groups. Similarly, Schortinghuis *et al.*<sup>[37]</sup> and Lee *et al.*<sup>[38]</sup> found no significant difference in pain in their studies treated with mini and microplate.

On comparing facial asymmetry, no significant difference was found except for one patient treated with miniplate in maxilla that presented swelling till first week which gradually subsided. Al Sayed,<sup>[39]</sup> Ozkan and Cil<sup>[40]</sup> found no instances of facial asymmetry, malar asymmetry or diplopia.

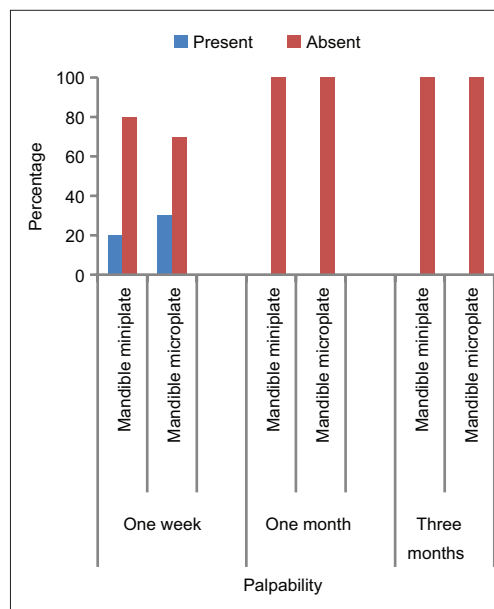
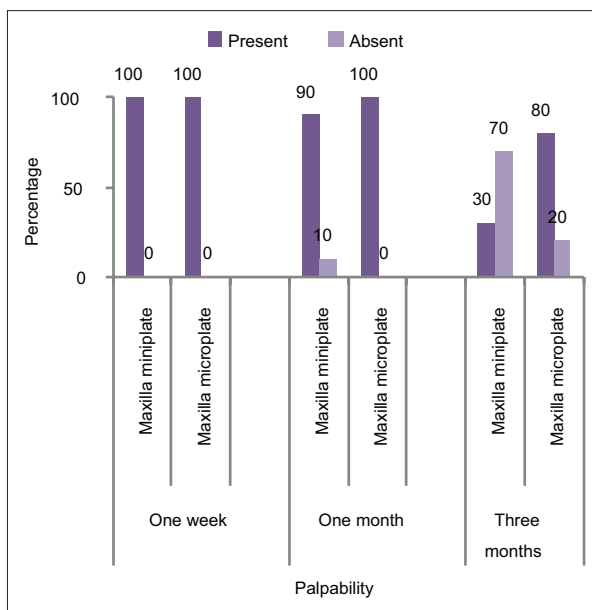
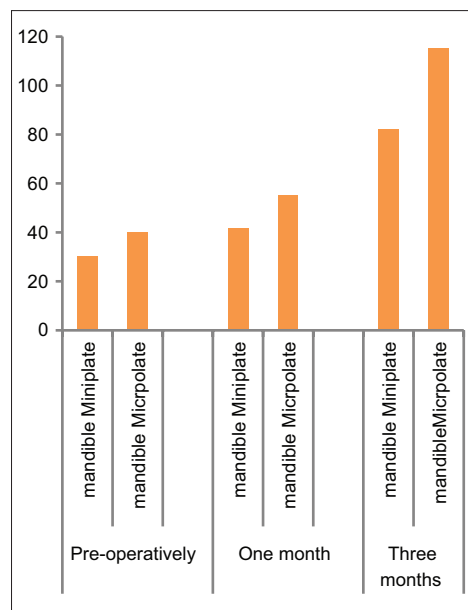


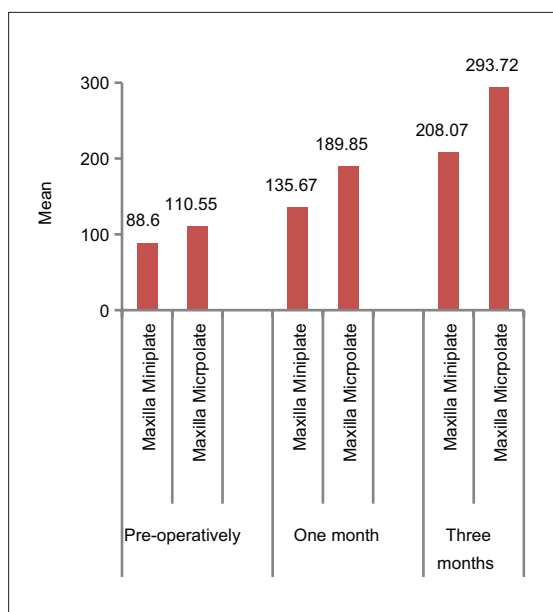
Figure 2: Comparison of presence or absence of palpability among patients treated with mandible microplates/mini-plates



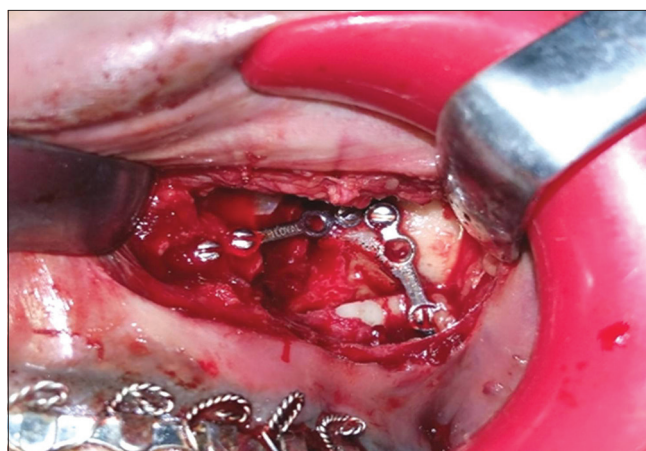
**Figure 3:** Comparison of presence or absence of palpability among patients treated with maxilla microplates/mini-plates



**Figure 4:** Comparison of biting force among patients treated with different treated by mandible microplate/miniplate



**Figure 5:** Comparison of biting force among patients treated with different treated by maxilla microplate/miniplate



**Figure 6:** Open reduction and internal fixation maxilla (microplate)

We found no significant values for infection except for two patients treated with miniplate in maxilla which was managed by antibiotic coverage and periodic irrigation.

Occlusal discrepancy among the groups presented no significant values except for two patients treated with microplate which was managed by IMF for 3–4 weeks’ postoperatively. Sadove and Eppley,<sup>[41]</sup> Gupta *et al.*,<sup>[42]</sup> Xie *et al.*,<sup>[43]</sup> Huston and Stassen (2016)<sup>[44]</sup> Anand *et al.*,<sup>[45]</sup> Abdullah (2009), Ozkan and Cil, Anand *et al.*<sup>[45]</sup> found no significant difference among their study groups for fractures treated with microplates in terms of infection and plate exposure. Burm *et al.* (2002),<sup>[46]</sup>

Jack (2005),<sup>[47]</sup> Abdullah WA (2009),<sup>[48]</sup> Ahmed *et al.*,<sup>[49]</sup> Joon and Burm<sup>[50]</sup> reported no significant difference for occlusal discrepancy between both the groups treated with miniplate and microplate. They concluded that the use of microplates is acceptable due to their property of selfadjustability of occlusion.

Plate extrusion was seen in two patients, one in infraorbital and other in mandibular angle, both treated with miniplate which was managed by plate removal, antibiotic coverage, planning of second surgery using microplate and MMF, respectively. No statistically significant results were found for wound dehiscence, need for postoperative MMF and mouth opening among the groups, except for 1 patient with mandibular fracture treated with miniplate where wound dehiscence was noticed which was managed by irrigation and resuturing. Haug and Morgan,<sup>[51]</sup> Lee *et al.*, Abdullah (2009), Ahmed *et al.* also concluded that wound dehiscence for microplates



**Figure 7:** Open reduction and internal fixation mandible (microplate)

is less than miniplates. Haug and Morgan<sup>[52]</sup> found no occlusal discrepancies during follow-ups using microplates for mandibular angle fracture which was also treated for 6 weeks of IMF for microadaptation. Cawood 1985 and Xie *et al.* noted more mouth opening in condylar fractures and other mandibular fractures respectively treated with microplate than those treated with miniplates.

In our study, we found significant values for palpability in fractures of maxilla and mandible treated with microplate than miniplate. Sadove and Eppley Lee *et al.*, Schortinghuis *et al.* also concluded that microplates provide less palpability due to close adaptability at the fracture site.

Mccleod (1992), Xie *et al.* advocated that microplates facilitate small incisions, resulting in reduced risk of nerve damage. Load bearing capacity of miniplates in mandibular fractures are comparatively more than that of microplates but maxillary fractures treated with microplates shows relatively adequate biting efficiency which was measured by jaw biting force device postoperatively during follow-up till 3<sup>rd</sup> month. Few weeks postoperatively, load bearing capacity of microplates was found to be less than that of miniplates but after 3 months, positive correlation was found between the values that presented statistically insignificant values in terms of load bearing among the groups. Tate *et al.*<sup>[52]</sup> found similar values of load bearing among fractures treated with mini and microplate 3 months' postoperatively which is because of the mechanism of muscle splinting at the time of fracture where selective components of the neuromuscular system activates and deactivates to take forces of the damaged bone. Bite force is related to different factors such as tactile impulses, pain and pressure reception in periodontal ligament, number of residual teeth, and visible decrease in bite force with age owing to age dependent deterioration of dentition. Feller *et al.*<sup>[53]</sup> concluded that masticatory load exceeding 200N on the plates occurs only 3 months after osteosynthesis. Cawood<sup>[54]</sup> found normal weight was restored by the test group in 4 weeks and was more than that to the control group where direct fixation with miniaturized plates was not done.

We found the use of microplates [Figures 6 and 7] can be considered in the management of facial fractures indicating minimum use of hardware, less bone plate ratio, fracture stability, less wound dehiscence, and adequate strength at the fracture site.

## CONCLUSION

Various plating systems are long drawn in the management of facial trauma complementing the goals of reconstruction and functional stability. Designs of these systems depended on the material and adaptability as handling properties, strength and force distribution as functional outcomes. We found microplates cannot withstand load in unfavorable mandibular fractures thus limiting its use in load bearing areas. However, our study forms a basis for using microplates in facial fractures though we recommend for a larger sample sized study with long-term follow-up that determines the use of microplate for fixation in MFFs.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

1. Chaurasia A, Katheriya G. Prevalence of mandibular fracture in patients visiting a tertiary dental care hospital in North India. *Natl J Maxillofac Surg* 2018;9:123-8.
2. Vujcich N, Gebauer D. Current and evolving trends in the management of facial fractures. *Aust Dent J* 2018;63 Suppl 1:S35-47.
3. Singaram M, Udhayakumar RK. Prevalence, pattern, etiology, and management of maxillofacial trauma in a developing country: Aretrospective study. *J Ocran Assoc Oral Maxillofac Surg* 2016;42:174-81.
4. Albayati A, Amjad & Lateef, Ishraq. Characteristics of Traffic Accidents in Baghdad. *Civil Engineering Journal*.2019; 5:940-949. 10.28991/cej-2019-03091301.
5. Hamad AA, Lateif RH. Statistical analysis of mortality and morbidity due to traffic accidents in Iraq. *J Eng* 2018;24:20-40.
6. World Health Organization. Global Status Report on Road Safety 2015. World Health Organization; 2015.
7. Holmes PJ, Koehler J, McGwin G Jr., Rue LW 3<sup>rd</sup>. Frequency of maxillofacial injuries in all-terrain vehicle collisions. *J Oral Maxillofac Surg* 2004;62:697-701.
8. Parashar A, Sharma RK. Unfavourable outcomes in maxillofacial injuries: How to avoid and manage. *Indian J Plast Surg* 2013;46:221-34.
9. Koshy JC, Feldman EM, Chike-Obi CJ, Bullocks JM. Pearls of mandibular trauma management. *Semin Plast Surg* 2010;24:357-74.
10. Patel A, Karlis V. Principles of Fixation for Maxillofacial Trauma. *Oral and Maxillofacial Trauma* 2013. p.808-827. 10.1016/B978-1-4557-0554-2.00033-2.
11. Soodan KS, Priyadarshni P, Das D, Gupta M. "Techniques of rigid internal fixation for mandibular fractures". *Acta scientific dental sciences*. 2018;2.12: 153-159.
12. Gassner R, Tuli T, Hächl O, Rudisch A, Ulmer H. Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21067 injuries. *J Craniomaxillofac*. 2003;31:51-61.
13. Sadhwani BS, Anchlia S. Conventional 2.0 mm miniplates versus 3-D plates in mandibular fractures. *Ann Maxillofac Surg* 2013;3:154-9.
14. Michelet FX, Deymes J, Dessus B. Osteosynthesis with miniaturised screwed plates in maxillofacial surgery. *J Maxillofac Surg* 1973;1:79-88.
15. Luhr HG. Indications for use of a microsystem for internal fixation in

- craniofacial surgery. *J Craniofac Surg* 1990;1:35-52.
16. Mitchell DA, Macleod PR, Bainton R. 2point fixation at the fronto- zygomatic suture with microplates: A technical note. *Int J Oral maxillofac Surg* 1995;24:151-2.
  17. Guna TP, Sathyanarayanan R. Evaluation of efficacy of microplates in the management of zygomatic complex. *Research* 2006;11:4398-4403.
  18. Kellman RM, Schilli W. Plate fixation of fractures of the mid and upper face. *Otolaryngol Clin North Am* 1987;20:559-72.
  19. Sengezer M, Sadove RC. Reconstruction of midface bone defects with vitallium micromesh. *J Craniofac Surg* 1992;3:125-33.
  20. Strong EB, Sykes JM. Zygoma complex fractures. *Facial Plastic Surg* 1990;14:105-15.
  21. Pinczover EF, Stanley RB. Rigid fixation of malar fractures. Operative techniques in otolaryngology-head and neck surgery 1995;6:104-10.
  22. Zaky MM, Fayed NA, Shehab MF, Hellal US. The use of microplates for fixation of mandibular fractures: A systematic review. *J Med Sci Res* 2019;2:1-7.
  23. Eppley BL, Sadove AM. Application of microfixation techniques in reconstructive maxillofacial surgery. *J Oral Maxillofac Surg* 1991;49:683-8.
  24. Neff A. Open reduction and internal fixation in temporomandibular joint traumatology: Current concept and future perspectives. *Stomatol Dis Sci* 2019;3:2.
  25. Odai ED, Obuekwe ON. Is there any difference in the treatment outcome of maxillofacial fractures following use of rigid or semi-rigid osteosynthesis? *JMBR Peer-Rev J Biomed Sci* 2013;12:120-17.
  26. Aziz SR, Ziccardi VB, Borah G. Current therapy: Complications associated with rigid internal fixation of facial fractures. *Compend Contin Educ Dent* 2005;26:565-71.
  27. Abosadegh M, Rahman SA. Epidemiology and incidence of traumatic head injury associated with maxillofacial fractures: A global perspective. *J Int Oral Health* 2018;10:63-70.
  28. Rao S, Raghani MJ. Cranio-maxillofacial injuries in polytrauma patients. *J orthop Traumatol Rehabil.* 2013;6:44-6.
  29. Goil P, Jain A, Gupta NK. Association of head injury and maxillofacial trauma: A prospective case-control study. *Indian J Appl Res* 2016;6:528;31.
  30. Al-Khateeb T, Abdullah FM. Craniomaxillofacial injuries in the United Arab Emirates: A retrospective study. *J Oral Maxillofac Surg* 2007;65:1094-101.
  31. Yasir S. Facial trauma among patients with head injuries. *J Imab Annu Proc Sci Pap* 2014;20:535-8.
  32. Greenberg AM, editor. Basics of ao/asif principles and stable internal fixation of mandibular fractures. In: *Craniomaxillofacial Fractures*. New York: Springer; 1993.
  33. Müller M.E., Allgöwer, M., Schneider, R., Willenegger, H. New york: springer-verlag 1991;50:1-3.
  34. Oikarinen K, Altonen M, Kauppi H, laitakari K. Treatment of mandibular fractures. *J Craniomaxillofac Surg* 1989;17:24-30.
  35. Uthoff HK, Poitras P, Backman DS. Internal plate fixation of fractures: Short history and recent developments. *J Orthop Sci* 2006;11:118-26.
  36. Beals SP, Munro IR. The use of miniplates in craniomaxillofacial surgery. *Plast Reconstr Surg* 1987;79:33-8.
  37. Schortinghuis J, Bos RR, Vissink A. Complications of internal fixation of maxillofacial fractures with microplates. *J Oral Maxillofac Surg* 1999;57:130-4.
  38. Lee BM, Park DH, Chung JH, Park MC, Kim KS. Use of microplate on fixation of orbital rim fracture. *J Korean Soc Plastic Reconstructive Surg* 1998;25:607-12.
  39. Sayed AI. Comparison of three-dimensional microplate versus miniplate fixation on the stability of zygomatic complex fractures. *Int Journal of Maxillofacial Surgery* 2009;38:480-1. Doi:10.1016/j.ijom.2009.03.299.
  40. Ozkan A, Cil Y. Reduction of zygomatic complex fracture using combination of microplate and miniplate osteosynthesis. *Int J Dent Sci Res* 2016;4:35-7.
  41. Sadove AM, Eppley BL. Microfixation techniques in pediatric craniofacial surgery. *Ann plast Surg* 1991;7:36-43.
  42. Gupta A, Singh V, Mohammad S. Bite force evaluation of mandibular fractures treated with microplates and miniplates. *J Oral Maxillofac Surg* 2012;70:1903-8.
  43. Xie ST, Singhal D, Chen CT, Chen YR. Functional and radiologic outcome of open reduction and internal fixation of condylar head and neck fractures using miniplate or microplate system. *Ann Plast Surg* 2013;71 Suppl 1:S61-6.
  44. Huston M, Stassen L. Microplates making a macro impact on mandibular osteosynthesis. *IJOM* 2017;83:297.
  45. Anand D, Prasad K, Lalitha RM, Krishnappa R, Rajnikanth BR, Munoyath SK, *et al.* Bite force assessment of mandibular interforaminal fractures treated with combination of microplate and miniplate – A randomized control study. *Craniomaxillofac Trauma Reconstr Open* 2018;2:e1-8.
  46. Jin Sik Burm MD, Juliana E, Hansen MD. The use of microplates for internal fixation of mandibular fractures. *Plast Reconstr Surg* 2010;125:1485.
  47. Jack JM, Stewart DH, Rinker BD, Vasconez HC, Pu LL. Modern surgical treatment of complex facial fractures: A 6-year review. *J Craniofac Surg* 2005;16:726-31.
  48. Abdullah WA. The use of a single titanium microplate in displaced pediatric parasymphysial mandibular fractures. *Saudi Dent J* 2009;21:95-100.
  49. Ahmed SS, Bhardwaj S, Ansari MK, Farooq O, Khan AA. Role of 1.5 mm microplates in treatment of symphyseal fracture of mandible: A stress analysis based comparative study. *J Oral Biol Craniofac Res* 2017;7:119-22.
  50. Choi TJ, Chung YH, Cho JY, Burm JS. The Use of Microplates for Internal Fixation of Comminuted Mandibular Fractures; *Ann Plast Surg* 2018;82:55-61. doi: 10.1097/SAP.0000000000001623.
  51. Haug RH, Morgan JP 3<sup>rd</sup>. A microplate and screw technique for intraoral open reduction of mandibular angle fractures. *J Oral Maxillofac Surg* 1995;53:218-9.
  52. Tate GS, Ellis E 3<sup>rd</sup>, Throckmorton G. Bite forces in patients treated for mandibular angle fractures: Implications for fixation recommendations. *J Oral Maxillofac Surg* 1994;52:734-6.
  53. Feller KU, Richter G, Schneider M, Eckelt U. Combination of microplate and miniplate for osteosynthesis of mandibular fractures: An experimental study. *Int J Oral Maxillofac Surg* 2002;31:78-83.
  54. Cawood JI. Small plate osteosynthesis of mandibular fractures. *Br J Oral Maxillofac Surg* 1985;23:77-91.