

Comparison of Open Reduction and Internal Fixation Versus Closed Reduction and Maxillomandibular Fixation for the Treatment of Gunshot Injuries of Mandible

Kashif Ali Channar, Abdul Qadir Dal, Safia, Riaz Ahamed Warriach

ABSTRACT

OBJECTIVES: To determine the early and late outcome of two treatment options by open reduction and internal fixation versus closed reduction and Maxillomandibular fixation (MMF) in treatment of gunshot injuries of Mandible.

STUDY DESIGN: Prospective descriptive study.

PLACE AND DURATION: Department of Oral and Maxillofacial Surgery King Edward Medical University/ Mayo hospital Lahore from November 2008 to November 2009.

METHODOLOGY: Sixty patients of gunshot injury were randomly allocated in two groups. In group A, 30 patients were treated by open reduction and internal fixation and in group B, 30 patients were treated by closed reduction and Maxillomandibular fixation. Postoperative complications were evaluated fortnightly and the outcome between two group were assessed Postoperatively infection, malocclusion, nonunion/ malunion of fracture fragments, facial asymmetry, exposed plate and sequestration of devitalized bone were checked. Patients were discharged as the treatment completed and recalled for post operative follow up.

RESULTS: Patients treated by open reduction were having fewer complications as compared to closed reduction i.e. 36.6%, and 50%. P-value ($P > 0.05$) is significant in nonunion, mal union and facial asymmetry.

CONCLUSION: Based on this study open reduction and internal fixation is the best available method for the treatment of gunshot injuries to the mandibular fractures after gunshot injuries.

KEY WORDS: Comminuted mandible fracture, Gunshot injuries, Maxillomandibular fixation, Plating, Air way management, Open reduction internal fixation.

INTRODUCTION

Since last decade the incidence of violent crimes are on rise in our society. Gunshot injuries in particular have become increasingly more frequent in the civilian population¹⁻³. Due to instability & increase in violence in our region, the number of deaths has also increased mainly due to firearm weapons.^{4, 5} Main causes of the gunshot injuries in this part of the world are violent crimes, domestic violence, accidental discharge of bullet, suicidal attempts and air shooting^{4, 5}. Surgical management of facial gunshot wounds is generally divided into 3 stages include debridement, fracture stabilization, and primary closure; reconstruction of hard tissues, provided soft tissue coverage is adequate; and rehabilitation of the oral vestibule, alveolar ridge, and secondary correction of residual deformities^{6, 7}. Comminuted fractures of the mandible as a result Gunshot injuries have been treated by a number of methods, including closed reduction, external pin fixation, internal wire fixation and more recently, open reduction and internal stable fixation using plates and/or screws⁷. Before the development of reliable implants and instrumentation for rigid fixation, most comminuted mandibular fractures as a result of

gunshot injuries were treated by closed reduction. This was done to avoid periosteal stripping and devascularization of comminuted bony segments. Closed techniques were preferred because of poor treatment outcomes with open reduction that primarily involved internal wire fixation. These cases frequently developed infection and nonunion. In particular, conservative methods for the treatment of gunshot wound fractures have been recommended by many authors to avoid periosteal stripping of small, partially devitalized segments⁸⁻¹⁰.

Kazanjian, during 2nd world war, nearly half century ago, challenged this theory. He stated that "the majority of non-united fractures are due to inadequate immobilization of comminuted fragments of bone, and subsequent infection, rather than to initial loss of bone." To him, it was clear stabilization that of the fragments was the most important requirement to obtain osseous union of comminuted fragments^{7, 11}. Previously, these wounds were managed with conservative debridement, serial dressing changes, external fixation, and delayed reconstruction. This management protocol required social isolation of the patient for months, bacterial colonization of the wound, and

scar contracture.¹

Recently, open reduction and stable internal fixation using plates and/or screws has been advocated for comminuted fractures. Open reduction and internal fixation of comminuted fractures goes against the most basic of maxillofacial surgery dogma that states comminuted fractures should be treated by closed method to prevent stripping the blood supply from the fragments.¹²

In the management of gunshot wound the opinions are divided regarding management by close or open method. This study was designed to compare the above mentioned two techniques, which have better clinical result and fewer complications, consequently contributing towards the goals of a better treatment option and in due process benefit the concerned patients.

Hence this study was conducted to determine the early and late outcome of two treatment options by open reduction and internal fixation versus closed reduction and Maxillomandibular fixation in treatment of Gunshot injuries of Mandible.

METHODOLOGY

A prospective descriptive study was carried out in the department of Oral and Maxillofacial Surgery Mayo Hospital Lahore from November 2008 to November 2009. Sixty cases with single gunshot injury to the mandible (angle, body, symphysis and parasymphysis), continuity defect less than 1-cm and no intra oral communication or soft tissue cover available intra-orally and extra orally for primary closure were included in this study. All infected cases of gunshot injuries to mandible and case presenting in hospital after three days of injury and displaced fractures were excluded. Diagnosis were made clinically and radiographically. Radiograph used for conformation and extent of fracture includes Orthopantomogram (OPG) and Postero-anterior (PA) view of mandible. Written informed consents were obtained from all patients or their parents/ attendants, for including in either surgical procedure or for using their data in this research study. The confounding variables like age, sex, duration of injury and site of fracture were adjusted by paired sampling. The demographic information like name, age, sex and address were recorded. Patients were divided in two groups by using random number table. In Group A, there were 30 patients treated by open reduction and internal fixation with reconstruction plates or/ and miniplates and in Group B, 30 patients were treated by closed reduction of Maxillomandibular fixation. Before intervention, patient's record was documented on the Proforma.

Postoperatively infection, malocclusion, nonunion/malunion of fracture fragments, facial asymmetry, ex-

posed plate and sequestration of devitalized bone were checked. SPSS 16.0 was used for data analysis. P-values were obtained by applying Chi-square test and t-test. Patients were discharged as the treatment completed and recalled for post operative follow up.

RESULTS

A total number of 70 patients reported during the study period and these were treated for the same. Out of these, 4 patients were associated with continuity defect greater than 1cm and 2 were associated with mid face fractures, one patient have multiple gunshot injuries to mandible and soft tissue deficient cover and three patients lost their follow up thus were excluded from the sample. 60 patients were selected.

The mean age of the patients in the study was 27.36 years SD \pm 10.7. The most common age group was 16-30 years followed by 31-45 years. The children under 15 years and elderly age group 45-60 years showed the least involvement with gunshot injuries of mandible (**Table I**). Male female ratio was 7.5:1 (**Table II**).

(**Table III**) shows post operative complication, total 11 patient encountered complications in both groups. The complication was higher in close reduction and MMF group, the number of patients with complications were seven. Five of the total 60 patients experienced at least one treatment complication, and 6 of these patients had multiple complications.

Details about postoperative complications related to two treatment modalities are given in figure I and II. Sixteen early complications were encountered in a total of sixty patients; 23.3% of these complications occurred in open reduction and internal fixation group, 30% in closed reduction with MMF group. The most common complication was infection, occurred in 16.6% of the patients treated with ORIF, 10% of patient treated with close reduction and Maxillomandibular fixation. The infection was slightly higher in ORIF, but it was not statistically significant. Facial asymmetry occurred in 20 % of patient treated with close reduction and MMF, and 3.3% of patient treated with ORIF. Patient with close reduction and MMF develop more facial asymmetry. Here P value for facial asymmetry is statistically significant ($P < 0.05$).

Twenty six late complications were encountered in a total of sixty patients; 36.6% of these complications occurred in open reduction and internal fixation group, 50% in closed reduction with MMF group. The most common complication was facial asymmetry occurred in 13.3% of the total patients, followed by nonunion/mal union, occurred in 11.6% of the patients. Here P values for facial asymmetry and non union, mal union are statistical significant ($P < 0.05$).

TABLE I: DISTRIBUTION BY AGE OF PATIENTS WITH GUNSHOT INJURIES TO MANDIBLE (n=60)

Age years	No. of patients	Percentage
15 ≤	05	8.3
16-30	36	60
31-45	15	25
46-60	04	6.7
Total	60	100

Mean(±SD) age of the patients 27.3 years (±10.7)

TABLE II: DISTRIBUTION BY SEX OF PATIENTS WITH GUNSHOT INJURIES TO MANDIBLE (n=60)

Sex	No. of patients	Percentage
Male	53	88.3
Female	07	11.7
Total	60	100

Male female ratio 7.5:1

TABLE III: COMPLICATIONS IN PATIENTS

Groups	Pt without complication n(%)	Pt with complication n(%)	Total
Open reduction and internal fixation (A)	26 (86%)	04 (13%)	30
Close reduction and MMF(B)	23 (76.6%)	07 (23.3%)	30
Total	49 (81.6%)	11 (18.3%)	60

FIGURE I: EARLY COMPLICATION

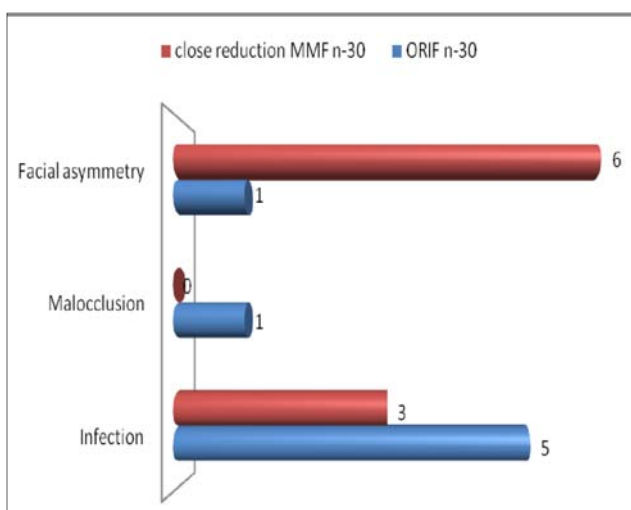
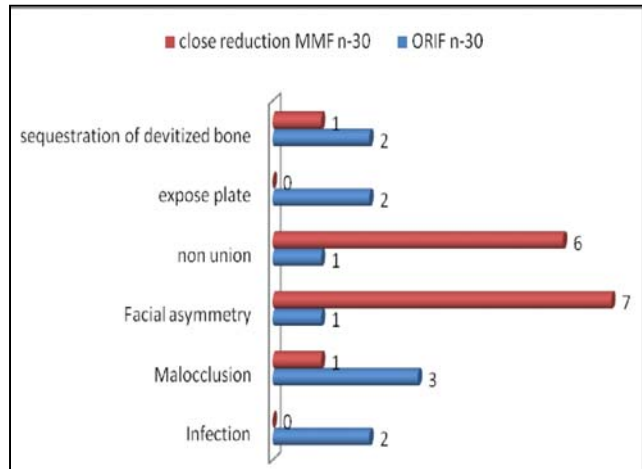


FIGURE II: LATE COMPLICATIONS



DISCUSSION

Gunshot wounds to the maxillofacial region are not uncommon in Pakistan. Despite this there is relatively little literature discussing treatment and outcome of these injuries.

The predominant age group in this study was 16 to 30 years. 2nd and 3rd decade constituted the major group in this study, which is the same as mentioned in previous studies by Ellis et al 2003⁷, Hussain Z 2006¹³, Larry Holier 2001¹⁴, Finn R.A 1996¹⁵, Newland SD 2003¹⁶, Hussain T, Tajammul N 2005¹⁷. In this study the majority of patients presenting with gunshot injuries to mandible were males and a considerably small proportion of patients were females. The male to female ratio was 7.5:1. This ratio matches with the conclusions of other researchers like Ellis et al 2003⁷, Hussain Z 2006¹³, Larry Hollier 200¹⁴, Finn R.A 1996¹⁵, Newlands SD 2003¹⁶, Hussain T & Tajammul N 2005¹⁷. There is a general increased predilection for males to be victims of firearm injuries throughout the country.

We found MMF method less time consuming, technically easier to perform with low incidence of postoperative pain and edema. Less post operative care and short hospitalization period reduce the cost of treatment. ORIF yields better outcome because of improved fracture exposure and bone stabilization. The use of rigid internal fixation for treatment of maxillofacial trauma has become very popular during the past decade. Large and small bone plating systems have been developed for treatment of mandibular fractures, and both have their advocates. Many authors have recommended open reduction of mandibular fractures using K-wires as an internal splint, or remov-

ing the comminuted segments, crushing them and replacing them as a free graft.^{11, 19} Dingman and Natvig²⁰ in their text on facial fracture surgery advocated ORIF of comminuted mandibular fractures using intraosseous wires or bone plates. A series of 32 low-velocity gunshot wounds to the mandible were reported by Neupert and Boyd.²³ Although they stated a preference for conservative management, 19 of 32 cases required open reduction with wire fixation or external pin fixation. They reported an infection rate of 27% with this treatment, whereas 18% developed continuity defects that required subsequent bone grafting. They attributed approximately half of the continuity defects to overly aggressive debridement and recommended conservative debridement of devitalized bone and teeth.

Effective use of ORIF using the ASIF approach with large mandibular reconstruction plates has been reported by some investigators that infection caused by loosening of hardware.^{21, 22} We also found that infection was the most common complication, and less common complications were malocclusion, sequestration, exposed palate.

In our findings infection occurred in 10% of total patients treated via MMF and 16.6% occurred in total of the patients treated with ORIF, this is in accordance with the findings of Dingman and Natvig and others, who found infection rate around 13% with open reduction and internal fixation.^{20, 21, 22} Newlands reported the complication in closed reduction in 10% of cases.¹⁶

However, our results are in contrast with the results of Ellis et al and Newlands SD, who showed low rate infection.^{7, 16} Our results are also contradictory with the results of Neupert and Boyd.²³ As they reported an infection rate of 27% with ORIF treatment, which is a high rate.²³

Malocclusion was assessed in this study solely reliant on the patient complaints. Our results show that 3 malocclusions were in patients treated ORIF, although it appears that open reduction and stable internal fixation caused more malocclusions than the close reduction with MMF, when related to the number of fractures treated, only 10% of patients treated open reduction internal fixation developed malocclusion. There was no statistically significant relationship between the development of malocclusion and either the type of treatment rendered (closed reduction, open reduction, and internal fixation) in our study.

Our results are comparable with other studies as by Ellis et al⁷, Smith, Teenier²² reported 4.1% mal-

occlusion in their retrospective study, all cases were of ORIF group. In other study Baurmash¹² reported no occlusal complication in close reduction.

The adaptation of the reconstruction plate requires skill and time, and the contour is not always perfect this may be the reason of exposed plate. Infection at the site and the significant soft tissue cover is also an important factor. In this study two patients develop this complication, we can not compare with close reduction group. In a retrospective study by Ellis et al⁷ stated that exposed plate is a rare complication encountered because of inadequate adaptation of reconstruction plates. Newlands SD¹⁶ reported that this complication occurs because of infection at hardware site, or loose reconstruction plates.

Much of the past literature concerning ORIF of comminuted mandible fractures cited devascularization of the comminuted segments as the reason for selection of closed treatment. The sequelae of devascularization mentioned include bony sequestra, infection, and non-union.

Two patients of ORIF develop sequestration in this study. This was removed surgically. Post surgical infection was the reason of sequestra and inability to cover wound primarily. Our results for sequestration of devitalized bone are not in the favor of Newlands SD¹⁶. He found only a single case of sequestration in close reduction with MMF group. We can assume that sequestration is independent complication that may occur in both groups. Important is if soft tissue is deficient present than reconstruction of soft tissue must be planned.

The most frequent complication was nonunion/ malunion developed in 7 cases out of the total sixty cases. Six patients (20%) were of close reduction and MMF group and one patient (3.3%) with open reduction. Out of 6 patients, three develop non union, of whom 2 required bone grafting to effect osseous union. The other patient was initially treated closed for an angle fracture and had postoperative rotation of the ramus. The patient was then planed for open reduction and reconstruction bone plate fixation. There was good bone contact so no bone graft was necessary, and the patient healed uneventfully. Three patients develop malunion and osteotomy done to re-contour the continuity. The cause was inability to obtain intimate bony contact of all the fragments by close reduction so that some were never accurately reduced. Malunion and non union was common in close reduction group. There was a statistically significant relationship be-

tween the development of mal union /nonunion and the type of treatment ($P < .05$)

This study favors the results of other authors as they suggested that nonunion is common in closed reduction with MMF or external pin fixation than ORIF.^{07,12}

We observed that the incidence of postoperative facial asymmetry was higher in the closed reduction group (23.33%) than ORIF (3.3%). A study by Finn¹⁵, established that closed reduction was followed by a higher incidence of postoperative facial deformity than were open reduction and fixation.

In our study 23.3 % of the patients treated close reduction was not satisfied esthetically where as patients treated via ORIF high degree of satisfaction has (3.3%). Our data regarding facial asymmetry in patient is statistically significant $P < 0.05$.

Although with a sample of 60 patients and a follow-up period of only 2 months is not enough to draw any statistically significant conclusion in search for an ideal treatment. It may however be deduced that ORIF is a better treatment option amongst the two procedures in the management of gunshot injuries to mandible.

CONCLUSION

Rigid internal fixation offer many advantages to the patient and is superior to more conventional techniques in spite of minor infection rates. The infection can, however, be reduced by careful selection of patients, meticulous debridement, use of antibiotics, skill and experience of the surgeon. The results show that majority of the patients were young adult males. It was also seen that open reduction and internal fixation was advantageous as it allow immediate or early mandibular mobility, with good functional and aesthetic results and a low rate of complications.

REFERENCES

1. Perry CW, Phillips BJ. Gunshot wounds sustained injuries to the face: a university experience. *J Surg* 2001; 2:2.
2. Cunningham LL, Haug RH. Firearm Injuries to the maxillofacial region .an overview of current thoughts Regarding Demographics Pathophysiology, and Management. *J Oral Maxillofac Surg* 2003; 61:932-942.
3. Cheema SA, Amin F. Incidence and causes of maxillofacial skeletal injuries at the Mayo Hospital in Lahore, Pakistan. *Br J Oral Maxillofac Surg* 2006; 44: 232-4.
4. Ambreen A, Shah R. Causes of maxillofacial injuries-a three years study. *J Surg Pak* 2001; 6:25-7.
5. Alper M, Totan S, Cankayali R, Songur E. Gunshot wounds of the face in attempted suicide patients. *J Oral Maxillofac Surg.* 1998; 56:930-3.
6. Motamedi MHK. Primary management of maxillofacial hard and soft tissue gunshot and shrapnel injuries. *J Oral Maxillofac Surg* 2003; 61: 1390-8.
7. Ellis E, Muniz O, Anand K. Treatment considerations for comminuted mandibular fractures. *J Oral Maxillofac Surg* 2003; 61:861-70.
8. Zide MF, Epker BN. Short-range shotgun wounds to the face. *I Oral Surg* 1979; 37:323.
9. Kendrick RW. Management of gunshot wounds. *Oral Maxillofac Clin North Am* 1990; 2:60.
10. Mainous EG, Sazima HJ, Stump TE, et al: in Kelly JF (ed):*Early Care in Management of War Injuries to the Jaws and Related Structures*, Washington, DC, US Government Printing Office, 1977, pp 74-78.
11. Kazanjian VH. Immobilization of wartime, compound, comminuted fractures of the mandible. *Am J Orthod Oral Surg* 1942; 28:551
12. Baurmash HD. Closed reduction, an effective alternative for comminuted mandible fractures. *J Oral Maxillofac surg* 2004; 62: 115-6.
13. Hussain Z, Mujahid M, Afridi H K, Arif .Homicidal deaths by firearms in Peshawar: an autopsy study. *J Ayub Med Coll Abbottabad* 2006; 18:1.
14. Hollier L, Grantcharova EP, Kattash M. Facial Gunshot Wounds: A 4-Year Experience. *J Oral Maxillofac Surg* 2001; 59:277-282.
15. Finn RA. Treatment of Comminuted Mandibular Fractures by Closed Reduction. *J Oral Maxillofac Surg* 1996; 54:320-327
16. Newlands SD, Samudrala S, Katzenmeyer WK. Surgical treatment of gunshot injuries to the mandible. *Otolaryngol Head Neck Surg* 2003; 129:239-44.
17. Hussain T , Tajammul N, Bhatti M A , Hanif S. Firearm injuries - a study of 110 cases. *Ann King Edward Med Coll* 2005; 11(4):499-502.
18. Kazanjian VH. An outline of the treatment of extensive comminuted fractures of the mandible (based chiefly on experience gained during the last war). *Am J Orthod Oral Surg* 1942; (28): 265.
19. Coniglio JU, Norante JD. Augmented fixation of mandibular fractures with a threaded Kirschner wire. *Arch Otolaryngol Head Neck Surg* 1989; 115:699.

20. Dingman RO, Natvig P. Surgery of Facial Fractures, Philadelphia PA: Saunders; 1964, pp 153-160.
21. Assael LA. Results in rigid internal fixation in highly comminuted fractures of the mandible. J Oral Maxillofac Surg 1989; 47:119.
22. Smith BR, Johnson JV. Rigid fixation of comminuted mandibular fractures. J Oral Maxillofac Surg 1993; 51:1320.
23. Neupert EA, Boyd SB. Retrospective analysis of low-velocity gunshot wounds to the mandible. Oral Surg Oral Med Oral Path 1991; 01 72:383.



AUTHOR AFFILIATION:

Dr. Kashif Ali Channar (*Corresponding Author*)

Assistant professor, Oral & maxillofacial surgery
Institute of Dentistry
Liaquat University of Medical and Health Sciences
(LUMHS), Jamshoro/Hyderabad, Sindh-Pakistan.
Email: kashif_omfs@yahoo.com

Dr. Abdul Qadir Dal

Assistant Professor, Institute of dentistry
LUMHS, Jamshoro/Hyderabad, Sindh-Pakistan.

Dr. Safia

Department of Oral & Maxillofacial Surgery
King Edward Medical University Lahore.

Prof. Riaz Ahamed Warriach

Department of Oral & Maxillofacial Surgery
King Edward Medical University Lahore.