

# Postoperative Complications in Primary Definitive Management of Hard and Soft Tissues in Mandibular Gunshot Injuries; A Review of 47 Cases

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## ABSTRACT

**Background:** Firearm injuries cause significant morbidity and mortality among its victims. The type and extent of tissue damage vary from simple small size wound to a large soft tissue or skeletal defect. The selection of the appropriate surgical technique is as important as the timing because incorrect selection or improper application of surgical techniques may also lead to infection, sequestration, wound dehiscence, graft rejection, facial deformity and subsequent re-visional operations. **Objective:** The present study, carried out at Oral and Maxillofacial Surgery department, King Edward Medical University/ Mayo Hospital, Lahore, was aimed at highlighting the frequency of Postoperative complications in primary definitive management of hard and soft tissues in mandibular gunshot injuries. **Study design:** Descriptive case series. **Setting:** Department of Oral and Maxillofacial Surgery, King Edward Medical University/ Mayo Hospital, Lahore, from November 2010 to November 2012; including 6 months follow up. **Patients and methods:** The study was conducted on 47 patients. All patients suffered gunshot injuries to the mandible and had soft and hard tissue defects at a single site. Patients ranged in age from 17 to 54 years with a mean age of 32.31 years. Males dominated in the study and were n=37 and females n=10. All patients were treated definitively in the first

operation by addressing the hard and soft tissue defects. **Results:** All had single site fracture with angle of the mandible being most common 27 (57.44%). For reconstruction of soft tissue defect local advancement by undermining and primary closure was carried out in 35 (74.47%) patients, buccal pad of fat in 4 (8.51%) patient, deltopectoral flap in 5 (10.64%) patients and skin graft in 3 (6.38%) patient. For hard tissue reconstruction, nonvascularized bone graft was given in all cases i.e. n=47 (100%). Iliac crest bone graft was given in 34 (72.34%) patients, rib graft in 6 (12.77%) patients and symphyseal outer cortex bone graft in 7 (14.89%) patients. Post-operative complications were noted in terms of infection, plate exposure, plate fracture and malocclusion which appeared to be 9 (19.1%), 5 (10.6%), 2 (4.3%), 5 (10.6%) respectively. **Conclusion:** All patients in this series required surgical intervention for treatment of their facial gunshot wounds. Primary definitive hard and soft tissue management can be considered in patients suffering from gunshot injuries to the mandible. Although post-operative complications can result at higher rates in such injuries yet properly selected surgical techniques and post-operative infection control can produce excellent desired esthetic and functional results. **Keywords:** Gunshot injuries; hard and soft tissue defects; primary treatment; postoperative complications.

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## INTRODUCTION

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Trauma to maxillofacial region is commonly caused by road traffic accident, assaults, gunshots, falls and blast injury. Firearm injury contributes to 10% of all maxillofacial traumas. Gunshot injuries have increased in the recent years due to terrorism and interpersonal violence.<sup>1, 2, 3</sup>

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The causes differ in developing countries from those in 3<sup>rd</sup> world countries.<sup>4</sup> Socioeconomic issues, social behavior, type of industry, transportation, driving skills, consumption of alcohol and legislation, all play their part in establishing the prevalence of the various causes.<sup>5</sup> Penetrating injuries of the maxillofacial region and the neck result from assault are being seen with increasing frequency in towns usually during fights in clubs, pubs and on streets. Materials commonly retained within the orofacial regions include pieces of glass, wooden fragments, knife blades and bullets.<sup>6,7</sup>

Although the frequency of firearm-related injuries and the number of deaths associated with them decreased markedly during the 1990s, firearm-related injuries are still the second leading cause of death in the United States. Moreover, more than 50% of all gunshot-related suicide attempts and approximately 14% of gunshot-related assaults result in head and neck injuries.<sup>8</sup> The last thorough review of firearm-related injuries appeared in the *Journal of Oral and Maxillofacial Surgery* more than 10 years ago.<sup>9</sup>

The incidence of head and neck injuries in the 21<sup>st</sup> century has been reported as 20%, 21% and 40%<sup>10, 11,12</sup> for the conflicts in Afghanistan and Iraq. This is a marked increase in the comparison with the 16% quoted for most of the 20<sup>th</sup> century.<sup>13</sup>

The type and extent of tissue damage vary from simple small size wound to a large soft tissue or skeletal defect. It depends upon the type of weapon used, distance from which it is fired, mass of bullet, velocity of bullet, shape and movement of bullet.<sup>14, 15</sup>

Although close-range, high velocity gunshot wounds can result in devastating functional and aesthetic consequences, shrapnel and mortar shell projections may be just as destructive depending on the size, irregular shape, high velocity and jagged edges of the fragments.<sup>16</sup>

Firearm injury is most common in males; male to female ratio is 9.6:1<sup>17</sup> in another study male to female ratio was 5.3:1<sup>1</sup> the male dominant pattern is almost universal and is comparable in various studies.

Many gunshot wounds are low-velocity injuries (less than 1,200 ft/sec) with minimal potential for severe soft tissue damage or for evolving tissue

necrosis. The fractures show comminution at the point where the bullet penetrates the bone, but is not extensive.<sup>18</sup>

Projectile injuries to the face can have minor or, more often, devastating consequences. The timing, sequence and application of appropriate surgical procedures and techniques used for reconstruction and rehabilitation of maxillofacial warfare injuries have proved to be influential on the final outcome and aesthetic results.<sup>19, 20, 21</sup>

The staged sequence of treatment stresses the importance of the timing hard and soft tissue treatment, which depends on surgical judgment, extent of injury and the general conditions of the patients. The selection of the appropriate surgical technique is as important as the timing because incorrect selection or improper application of surgical techniques may also lead to infection, sequestration, wound dehiscence, graft rejection, facial deformity and subsequent revisional operations. Such complications will prolong hospital stay and postoperative morbidity and increase in treatment costs.<sup>22, 23</sup>

Definitive management of gunshot injuries remains controversial in terms of surgery and reconstruction.<sup>24</sup> Gunshot injuries to the face are not known to cause life-threatening problems, but they can have serious esthetic, functional, and psychological consequences.<sup>16, 25, 26</sup> However, there is a scarcity of reports related to the management of gunshot injuries in the facial region.<sup>27, 28</sup> Management of facial gunshot wounds has been classified in 2 categories: the conventional, multistage approach, or the immediate, 1-stage approach.<sup>29, 30</sup> There is no consensus on the timing of hard and soft tissue reconstruction related to facial gunshot injuries.<sup>24</sup> The immediate, 1-stage method involves judicious debridement of the wound followed by immediate reconstruction with composite-free tissue transfers.<sup>29, 30</sup> The conservative, multistage method is reported to be popular; the first stage involves the stabilization of existing bone fragments in the anatomic position, temporary closure of soft tissues, and debridement at 48-hour intervals when necessary.<sup>30</sup> Definitive reconstruction is performed in a delayed second-stage approach after stability of the patient is confirmed.

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Surgical reconstruction of discontinuity defects in the mandible often involves the use of large grafts dictated by the size of the defect and the surgeon's preference. Nonvascularized bone graft harvested from the anterior iliac crest offers numerous advantages, such as providing adequate volume of bone, reliable shape, low donor morbidity, and a distant location from the mandible to facilitate a multiteam approach. Some of the accepted disadvantages are hernia, hemorrhage, seroma, and thigh pain. Long-term complications may include sensory deficits, gait disturbance, and intraperitoneal communication.<sup>31</sup> The literature is clear that a grafting procedure using bone harvested from the anterior iliac crest is less invasive than a free-flap technique, has a well-documented success rate and provides good quality bone that affords successful osseointegration of dental implants.<sup>32, 33, 34, 35</sup>

## **MATERIALS & METHODS**

The results of 47 patients with gunshot injury to the mandible, in the Department of Oral and Maxillofacial Surgery, from November 2010 to November 2012 were presented.

47 patients with gunshot injury fulfilling the inclusion criteria were selected. The diagnosis was on clinical basis selected from OPD/ emergency of Maxillofacial Surgery Department, Mayo Hospital Lahore. An informed consent was obtained from them or their parents/ guardian for including in either surgical procedure or for using their data in research. The demographic information like name, age, sex and address was recorded. Routine investigations and radiographs like Orthopantomogram (OPG) and or Posteroanterior (PA) view of mandible were undertaken.

In all the patients with mandibular defects, reconstruction was undertaken with the autogenous bone grafts from the site that suited best to a particular patient. All reconstructions were carried out under general anesthesia (GA) with nasotracheal intubations.

Before intervention, patient's record was entered on the proforma. Postoperatively outcomes, infection, rediodensity, resorption and failure of bone graft were checked clinically and by taking

radiographs like Orthopantomogram and Posteroanterior view of mandible.

Patients were checked post operatively for follow up on 7<sup>th</sup> day, 3rd month and 6<sup>th</sup> month, respectively. On every follow up visit postoperative outcome variables were assessed and noted in the proforma.

## **RESULTS**

Patients ranged in age from 17 to 54 years with a mean age of 32.31 years. Males dominated in the study and were n=37 and females n=10.

All these patients had soft and hard tissue defects fulfilling the inclusion criteria, for which they underwent single stage surgical reconstruction. All the patients were admitted in the ward and debridement was done initially and antibiotics were prescribed as to keep the patient infection free. All had single site fracture with angle of the mandible being most common 27 (57.44%).

For reconstruction of soft tissue defect local advancement by undermining and primary closure was carried out in 35 (74.47%) patients, buccal pad of fat in 4 (8.51%) patient, deltopectoral flap in 5 (10.64%) patients and skin graft in 3 (6.38%) patient. For hard tissue reconstruction, nonvascularized bone graft was given in all cases i.e. n=47 (100%). Iliac crest bone graft was given in 34 (72.34%) patients, rib graft in 6 (12.77%) patients and symphyseal outer cortex bone graft in 7 (14.89%) patients. The patients were kept on maxillomandibular fixation for 7-10 days postoperatively.

Infection was checked whether present or not. On 7<sup>th</sup> day postoperatively, only 12(25.53%) patients developed mild infection. On 3rd month follow up visit, 10(21.27%) patients developed infection with pus discharge but 37(78.72%) patients had no sign of infection. On 6<sup>th</sup> month follow up visits, there was improvement in the infection rate and 9(19.1%) patients presented with the infection while in the rest of 38(80.85%) patients, no infection was noted.

Plate exposure was checked whether present or not. On 7<sup>th</sup> day postoperatively, only 8(17.02%) patients presented with plate exposure intraorally. Margins were refreshed and primary closure was achieved. On 3rd month follow up visit, 6(12.76%) patients had plate exposure but 41(87.24%)

patients had no sign of exposure. On 6<sup>th</sup> month follow up visits, there was improvement in the plate exposure rate and 5(10.6%) patients presented with it while in the rest of 42(89.36%) patients, no plate exposure was noted.

Plate fracture was checked whether present or not. On 7<sup>th</sup> day postoperatively, none of the patients had any fracture of the reconstruction plate. On 3<sup>rd</sup> month follow up visit, 1(2.12%) patient had plate fracture but 46(97.87%) patients had no sign of fracture. On 6<sup>th</sup> month follow up visits, one more case of plate fracture reported making the total of 2(4.3%). The fractured plates were removed in 2<sup>nd</sup> surgery and again new plates were adapted and once again the patients were advised to take precautions while eating, not to overload or bite heavily. Also they were advised to limit the mandibular movements and avoid any trauma.

Malocclusion was checked whether present or not. On 7<sup>th</sup> day postoperatively, 9(19.1%) of the patients presented with malocclusion. On 3<sup>rd</sup> month follow up visit, 6(12.76) patients had not restored their pretrauma occlusion. On 6<sup>th</sup> month follow up visits, 5(10.63%) patients reported with persistent malocclusion.

**Table 1: Distribution of Cases by Age and Sex, n=47**

Sex	No of Patients	Percentage	Mean Age
Male	37	78.7%	31.05yrs
Female	10	21.3%	37.00yrs
Total	47	100%	

**Table 2: Distribution of Cases by Post-Operative Wound Infection on 6<sup>th</sup> Month Follow-up, n=47**

Wound Infection	Frequency	Percentage
No	38	80.9%
Yes	9	19.1%
Total	47	100%

**Table 3: Distribution of Cases by Post-Operative Plate Exposure on 6<sup>th</sup> Month follow-up, n=47**

Plate Exposure	Frequency	Percentage
No	42	89.4%
Yes	5	10.6%
Total	47	100%

**Table 3: Distribution of Cases by Post-Operative Plate Fracture on 6<sup>th</sup> Month Follow-up, n=47**

Plate Fracture	Frequency	Percentage
No	45	95.7%
Yes	2	4.3%
Total	47	100%

**Table 3: Distribution of Cases by Post-Operative Malocclusion on 6<sup>th</sup> Month Follow-up, n=47**

Malocclusion	Frequency	Percentage
No	42	89.4%
Yes	5	10.6%
Total	47	100

## DISCUSSION

Most of the studies about the treatment of gunshot injuries remain controversial and have not been designed adequately to provide meaningful comparison. Also statistics available related to management of gunshot injuries have mostly been surveyed in developed countries and much of the demographic information on maxillofacial injuries that appears in English language journal comes from USA, England, Netherlands and Scandinavian countries. However, with in light of limited work in the literature and this study, relatively satisfactory results regarding definitive

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primary management of mandibular hard and soft tissue gunshot injuries were achieved.

As in other studies, our study had the same limitations like limited sample size, uncontrolled variables, inconsistent data accumulation and lack of availability of records and consequently it does not answer all questions concerning management of gunshot injuries, still we have tried to provide some valuable information about the treatment planning and different treatment options.

As with any debate in the practice of surgery, there must be no absolutes. Each patient deserves the attention of directed thought and treatment his or her individual problem demands. Adhering blindly to algorithms and approaching treatment options closed-mindedly produces only average results the majority of the time and poor results too frequently. Creative thinking based on sound surgical principles along with good clinical judgment drives excellent patient care outcomes and the discovery and advancement of new techniques.

The management principles for the treatment of ballistic injuries were established long ago to include serial debridement, sequential dressing changes, and secondary reconstruction. Periodically, attempts at immediate definitive primary reconstruction were undertaken but failed as a result of inadequate structural and soft-tissue support. The incidence of complications and sepsis after primary reconstruction convinced most surgeons that delayed management was the appropriate surgical philosophy. The goal of achieving maximal functional and aesthetic restoration was consistently placed into a secondary consideration to avoid wound complications.<sup>36</sup>

In the past 20 years, the treatment of blunt facial injuries has undergone considerable evolution with the introduction of craniofacial surgical approaches, direct open reduction of fracture sites, and early or immediate repair with plate and screw fixation,<sup>37</sup> In particular, the advent of computed tomography (CT) scanning has brought a new accuracy to preoperative fracture identification and postoperative evaluation of reduction accuracy.<sup>38</sup> These techniques have revolutionized the aesthetic and functional results of facial reconstruction. The combination of definitive

open reduction of bone with early replacement of soft tissue into its primary position is the key to achieving such aesthetic results. These principles, however, when applied to ballistic or avulsive facial injuries, will succeed in low-energy injuries but when applied to high-energy or avulsive facial injuries, devascularization of bone and soft tissue leads to a high incidence of necrosis, hematoma, and sepsis.

This protocol of injury management emphasizes the advantages of definitive initial anatomic reconstruction of facial skeletal buttresses to provide maximal preservation of the skeletal structures. Complications are minimized by serial "second look" explorations, where any necrotic-tissue loss is identified and infection prevented by serial irrigation, debridement, and evacuation of hematoma. Excellent soft-tissue vascularity is the critical requirement for bone survival when extensive open reduction has essentially converted bone fragments to bone grafts. The initial anatomic reconstructions of the existing bony skeleton and the maximal use of regional tissue for cutaneous reconstruction provide an aesthetic appearance that cannot be duplicated by secondary reconstructions.

It should not be troubling that every patient has minor areas of wound sepsis, separation, or breakdown with small areas of exposed bone. These minor wound problems are not of sufficient magnitude that the primary reconstruction is threatened, and, therefore, they do not represent a significant treatment error as far as the conceptual plan is concerned.<sup>18</sup>

The most important consideration when treating any major facial injury is the adequacy of vascularized soft tissue for both lining and cutaneous reconstruction. This well-vascularized soft tissue will support reconstruction of devascularized bone.<sup>18</sup>

In our study the mean average age of patients was and the 32.31 years, most of the patients were in third and fourth decade of life. This was consistent with the study conducted by Mian Mujahid Shah et al 2008 in which most of the patients were of age group ranging from 15-35years.<sup>17</sup> In a study conducted by Motamedi MHK 2003 the mean age of the patients was 25 years.<sup>39</sup> In another study, conducted by A.B van As et al 2002, the mean age

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of the patients suffering from gunshot injuries to head and neck was 27 years.<sup>40</sup> In a study conducted by Constantinou Sofianos et al 1996 mean age of patients was 27 years.<sup>41</sup> In a study conducted by Shawn.D et al 2003 mean age of the patients was 30 years.<sup>42</sup>

In our study male gender predominated over female. This was consistent with a study conducted by Motamehdi MHK 2003.<sup>39</sup> In another study conducted by Mian Mujahid Shah et al 2008 males were 90% and females 7%.<sup>17</sup> males dominated in a study conducted by Shawn.D et al 2003.<sup>42</sup>

In our study local advancement and primary closure was undertaken in 35 (74.47%) patients. In a study conducted by Motamedi et al local advancement and primary closure was done in most of the cases as well. The local flaps yielded excellent results in his study.<sup>39</sup> Primary closure was undertaken in our study for most of the cases because the defect size in all the cases was  $\leq 5$ cm. The results were good as far as flap healing is concerned. The soft tissue injury may even mandate coverage with distant tissue, including microvascular tissue transfer, which may be performed at the time of bone repair. In our study distant flaps were used i.e. deltopectoral flap in 5 (10.64%) patients and skin graft in 3 (6.38%). In our study postoperative complications were assessed and documented on 6<sup>th</sup> month postoperative day. Over all 9(19.1%) patients had complications in the form of wound infection, plate fracture, plate exposure or malocclusion. This was consistent with a study conducted by Shawn.D et al 2003 in which thirty-nine percent of patients with rigid internal fixation had complications including 3 exposed plates (which were removed), 3 wound infections (1 infected bone graft), and 1 loose reconstruction plate (which was also removed).<sup>42</sup> In this study the sample size was very small and the variables were uncontrolled so the author could not conclude whether primary definitive treatment is better or second look procedure should be considered in gunshot injuries.

In another study by Bradley et al 35% failure was documented with the use of primary bone grafting for the mandible. He used nonvascularized bone grafts in all cases which is consistent with our

study.<sup>18</sup> He stated that the failure rate was principally a result of deficient mucosal lining.

In a study conducted by Leon A et al, 17 patients presented with fracture mandible out of which 4 resulted due to gunshot. There were numerous bony fragments and single site was involved. As in our study all the patients underwent open reduction and internal fixation with reconstruction plate and bone grafting with iliac crest. All 17 of the patients had reconstruction plated placed with a mean of .33 (range 2-4) 2.7mm screws placed in the proximal segment, and a mean of 3.8 (range 2-5), 2.7mm screws placed in the distal segment. A mean of 1.1 (range 0-3), 2.7mm screws were placed through the plate and into the comminuted segment. All 17 were placed into immediate function. In 2 of the 17 patients (12%), a post-operative malocclusion was observed. 3 out of 17 patients (17%) had post-operative infection which lead to non-union of the bony fragments. In our study 5(10.6%) of the patients had post-operative malocclusion which is consistent with the above mentioned study. Post-operative infection was 19.1% in our study which is consistent with this study.<sup>43</sup>

The most relevant complications of MRP (mandibular reconstruction plate) are immediate orocervical fistula, hardware problems (plate fracture and/or screw loosening) and late plate exposure. The high incidence of screw loosening reported in the literature can be reduced by employing as many screws as possible, at least four in each stump. A study was conducted by Peter et al (2010) on reconstruction of mandibular continuity defects. The most common complications were extraoral exposure (16%), intraoral exposure (10%), loose osteosynthesis screws (5%), fractures of the reconstruction plate (5%), and extra/intraoral exposure (1%).<sup>44</sup> In our study plate exposure was 5(10.6%) and plate fracture in 2(4.3%) cases.

## CONCLUSION

Definitive primary management of hard and soft tissues in mandibular gunshot wound can be considered in selected cases. If the degree of comminution and contamination is low and there is single site involvement, early treatment will bring desired functional and esthetic results.

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Single site hard and soft tissue defects come with less morbidity in terms of infection and contamination and definitive management can be considered in a single stage. This minimizes the number of admissions and does not bear a higher complication rate than other reported series that advocate multiple staged operations to treat such injuries.

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