Traumatology

Annals of Oral & Maxillofacial Surgery
Open Access

Critical review

Current trends in the management of maxillofacial gunshot injuries: a critical review

MHK Motamedi[1]*, A Ebrahimi[1], A Shams[2]

Abstract

Introduction

Firearm injuries continue to be a major public health problem. Herein, we review and evaluate the current trends in the management of maxillofacial gunshot injuries.

Conclusion

Ease of reduction and fixation of fractures, easier restoration of occlusion, prevention of contracture and displacement, ability to reduce displaced or avulsed teeth, early mandibular mobilization, less scarring, less anxiety and shorter hospital stay are among the many benefits associated with comprehensive definitive management of maxillofacial gunshot injuries.

Introduction

Firearm injuries continue to be a major public health problem. The management of patients with facial gunshot wounds varies and involves four main steps namely securing an airway, control of haemorrhage, identifying concomitant injuries and finally definitive repair of the facial deformity[1–3].

The emergency care of warfare-injured patients focuses first on the basics of resuscitation and status of the airway, as bleeding and subsequent swelling can compromise breathing. Also, similar to other trauma victims, advanced trauma life support must be provided when necessary. Airway control with an endotracheal tube or tracheostomy should be considered early, although, surprisingly, it is not always necessary. Haemodynamic resuscitation, followed by thorough patient evaluation, is done to rule out concomitant injuries often associated with warfare injuries. They may go unnoticed when attention is directed primarily to an extensive facial injury[4–7]. After early resuscitation, careful history and physical examination and paraclinical diagnostics are necessary for correct management. Surgical management of facial gunshot wounds is basically divided into three stages:(1) debridement, fracture stabilisa-tion, and primary closure; (2) reconstruction of hard tissues, provided soft tissue coverage is adequate; and (3) rehabilitation of the oral vestibule, alveolar ridge, and secondary correction of residual deformities and dental implants[6,8]. Herein, we review and evaluate the current trends in the management of maxillofacial gunshot injuries.

Discussion

The authors have referenced some of their own studies in this review. These referenced studies have been conducted in accordance with the Declaration of Helsinki (1964) and the protocols of these studies have been approved by the relevant ethics committees related to the institution in which they were performed. All human subjects, in these referenced studies, gave informed consent to participate in these studies.

Debridement

Today, modern weaponry demands a modern approach to wound management. There are many concepts regarding wound debridement. The oldest belongs to Pirogov, who states that debridement is done to 'convert a crushed wound into an incised wound'. Regularly, contused, crushed, dead and dying wound edges must be excised to the point of active capillary bleeding so that the traumatic wound becomes an incised wound. The wound can then be sutured, allowing wound closure without suppuration, disintegration and suture breakdown. Struchkov and Berkutov recommended excising wound edges and the removal of all damaged and contaminated tissues. After debridement, wound edges should be well perfused and resistant to bacterial invasion to ensure rapid healing.

In military maxillofacial surgery, the basic principles of maxillofacial gunshot wound debridement formulated in the 1940s still hold. These principles require sparing of damaged tissues. Also, soft tissues of wound margins should be excised removing only the obvious non-viable tissues[9].

Shvyrkov and Yanushevich[9] stated that in high-velocity projectile wounds the sparing of soft tissue in gunshot wound debridement may result in disability, multiple surgical interventions and prolonged duration of treatment. They recommended radical primary surgical debridement of gunshot wounds, and excision of soft tissue wound margins to the point of active capillary bleeding (indicative of normally functioning microcirculation system in the remaining viable soft tissues which heal rapidly). They excised 3.5 mm or more of skin and mucosa from wound margins. They assessed muscle viability by the strength of

* Corresponding author
Email: motamedical@yahoo.com

[1] Trauma Research Center, Baqiyatallah Medical Sciences University, Tehran, Iran
[2] Trauma Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.

Competing interests: none declared. Conflict of Interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

Annals of Oral & Maxillofacial Surgery
Open Access

capillary bleeding and muscle jerk under the scalpel. However, the current trend in facial gunshot injuries comprises early conservative debridement, removal of traumatic tattoos, all non-viable tissues and attention to aesthetic result of the face in all steps using primary closure when possible and antibiotics[6,7].

Fracture stabilisation

With regard to stabilisation, facial fractures resulting from gunshot injuries have been treated by many different methods including closed reduction, external pin fixation, internal wire fixation and open reduction and internal stable fixation (ORIF) using titanium plates and screws[6,7]. Before the development of reliable implants and instrumentation for rigid fixation, most facial fractures as a result of gunshot injuries were treated by closed reduction. The goal is correct reduction and stabilisation of facial bone fractures and minimal morbidity for patients. In most gunshot fractures, ORIF is necessary for optimal results.

Before rigid fixation, closed techniques were preferred because of poor treatment outcomes with open reduction, which primarily involved internal wire fixation. These cases frequently developed infection and non-union. Conservative methods for the treatment of gunshot wound fractures have been recommended by many authors to avoid periosteal stripping of small, partially devitalised segments[10,11].

Li and Li[11] recommended ORIF (reconstruction plate) treatment modality with adjunct maxillomandibular fixation (MMF) for multiple-site comminuted mandible fractures.

Rana et al.[1] found MMF to be less time-consuming, technically easier to perform with a lower incidence of post-operative pain and less post-operative care was required along with shorter hospitalisation.

Other authors have recommended open reduction of comminuted mandibular fractures using K-wires as an internal splint, or removing the comminuted segments, crushing them and replacing them as a free graft[12]. In their study on facial fracture surgery, Dingman and Natvig[13] described the ORIF method for treating 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[14]. 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 devitalised bone and teeth. Effective use of ORIF using the Association for the Study of Internal Fixation approach with large mandibular reconstruction plates has been reported by some investigators and stated that infection was caused mainly by loosening of hardware[15].

In Rana's findings, infection did not occur in any of his patients treated via MMF; and 6.6% of infection occurred in patients treated with ORIF. This corresponds with the findings of Dingman and Natvig and others, who found infection rates around 13% in patients treated with ORIF. Newlands et al.[16] reported this complication in closed reduction in 10% of his cases. However, Neupert and Boyd reported an infection rate of 27% with ORIF treatment, which is a high rate. Motamedi[18,19] reported a 20% infection rate.

Occlusion

In a study on 30 patients treated with osteosynthesis, Okoturo et al.[17] reported malocclusion as the most frequent complication with 23.3% in ORIF. Smith and Johnson[15] reported 4.1% malocclusion in their retrospective study. All cases were of ORIF group. In another study, Baurmash[10] reported no malocclusion when closed reduction was used. Motamedi states that ORIF must be accompanied by arch bars, as arch bars remain to be the "mainstay" of management in gunshot patients even when ORIF is used[6,7,18,19].

If arch bars and MMF are not used primarily, the occlusion may never be the same afterwards.

Primary closure

The soft tissue injuries in gunshot wounds are generally treated primarily along with fracture treatment via debridement and primary closure or combining, modifying and tailoring, useful local or regional flap techniques to fit the location of the injury, and to close the wound according to region. Reconstruction of soft tissue defects must be in accord with the reconstructive ladder, that is, simple primary closure in small wounds without tension and more complex reconstructive procedures including local flap, regional flap or free flaps in difficult wounds. Local undermining and use of regional soft tissue advancement rotation flaps for primary closure of maxillofacial soft tissue defects during the same operation has proved beneficial from both an aesthetic and functional point of view in gunshot injuries[4,6,7,18–20]. Leaving the defects open results in extensive scarring of the facial tissues, complicating subsequent surgical procedures, and should be avoided even in contaminated penetrating wounds[4,7,18–21].

Reconstruction

Facial gunshot wounds frequently represent a complex set of challenges for the surgeon. Often as a result of assault, accident or suicide attempt, facial gunshot injuries cause significant soft tissue and bone defects[22,23]. Whereas past management favoured delayed reconstruction, contemporary trends more frequently favour immediate, definitive reconstruction[5,6,18,24,25]. After skeletal fixation,

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.

Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

Annals of Oral & Maxillofacial Surgery
Open Access

soft tissue coverage is crucial. In the acute and sub-acute setting, tissue coverage depends on (1) wound dimension, (2) overall patient status, and (3) the surgeon's prerogative. Shortly after injury, it is generally preferred to attain more conservative wound coverage. Although some surgeons advocate free flaps, others prefer "temporary" coverage and defer lengthy definite procedures to a time when the patient has stabilised. Examples of this coverage include use of galeal flaps and scalp flaps, back-grafting any defects created temporarily with xenografts or allografts[26,27].

Timing reconstruction

Timing of definitive reconstruction is an area of continuing debate[28]. Although traditional approaches advised delayed reconstruction, the contemporary paradigm demonstrates success with more immediate definitive reconstruction within 24–48 h.

Proponents of delayed reconstruction have typically maintained that the prolonged period decreased infection rates, reduced necrotic debris, and allowed the surgeon to obtain a better idea of the extent of irreversible injury. Additionally, by allowing adequate time for oedema resolution, the decrease in inflammation provides for a better assessment of the pre-traumatic facial structure. However, in a review of 33 facial reconstructions, Vasconez et al.[29] observed similar infection rates between delayed and immediate post-gunshot wound reconstruction. The delayed group also demonstrated an increased incidence of wound contracture, which resulted in significantly more structural and functional deformity. In two other comparative reviews, Gruss et al.[30] and Vayvada et al.[31] also present improved results over traditional delayed approaches. Motamedi advocates early management of facial gunshot defects after primary stabilisation and assessment of all injuries; after meticulous conservative debridement of non-viable tissues and freshening of the wound, early primary reconstruction of bone defects was done using the fractured segments; the soft tissue was repaired with similar adjacent tissues (local or regional flaps) because he states these tissues have the same texture, colour and consistency as well as good blood circulation and less morbidity as compared with distant flaps[6,7,18,19].

Hard tissue reconstruction

Correct positioning of the arch helps establish the proper facial width and frames the face. Improper reconstruction of the arch may result in incorrect framing for the remainder of the reconstruction. When a mandibular fracture is a component of gunshot wounds, re-establishing mandibular continuity[19] and thus restoring occlusion first is advisable[5,24,32,33]. This demands placement of arch bars to aid restoration of occlusion and facilitate the reconstruction of the remaining facial skeleton by creating a useful anatomic platform[19,32–34]. External fixation may be prudent in the event of extensive bone comminution with minimal soft tissue damage[8,30,35]. While maintaining vital soft tissue coverage, external fixation allows bone regeneration and advancement without devascularising the underlying bone stock. This also stabilises the severely comminuted bone fragments and tends to promote the osteogenic character of fragments, facilitating bone healing and restoration of bone structure[8,30]. Internal plating should be used in the majority of the remaining instances in which bone fragments are large enough to accept screws. Although miniplates typically suffice for the cranium and midface, large (2.4 mm) locking plates are sometimes used in the mandible[5,30]. More often than not, the shattered and scattered bone can be found and secured to a reconstruction plate to obtain mandible continuity[18]. Midface and mandibular bone defects may need to be bone grafted[8,30,35]. Iliac crest bone graft is preferred for the mandible, as grafts similar in height and thickness to the mandible can be easily harvested[6,7,18,19]. Depending on the nature of these defects, iliac crest, cranium and rib are all reasonable options. In most cases, vascularised bone is not critical for reconstruction.

Definitive closure

Optimally, simple re-approximation of adjacent tissue can achieve definitive closure. Surprisingly, seemingly massive injuries can sometimes be closed primarily after treatment of hard tissues[18,22,23,30]. However, it is critical to avoid placing undue tension on local tissues. Undermining of skin edges, usually a significant facilitator of primary closure, should be done very conservatively. Some massive soft tissue defects secondary to gunshot wounds require free tissue transfer[36]. Over the past decade, advances in microvascular technique have established free flap transfer as the gold standard in the reconstruction of severe facial trauma[18,22–24,27]; however, they are not used primarily[6,7,18,19].

Colour and texture matching is best done with local flaps. Providing enough tissue may require the use of a tissue expander secondarily. In the case where tissue expansion is desired, the wound should be maintained by dressing changes or vacuum-assisted therapy or covering with temporary skin graft until tissue expansion is complete. This approach accomplishes both wound conditioning providing adequate amount of local tissue needed for transfer without adversely affecting the donor site.

In cases that require multiple stage reconstruction, the free flap option is often best delayed until the exact nature of the defect is diagnosed and the patient is best prepared for this intervention.

For complex composite defects in the partially dentate patient, distraction osteogenesis is a promising technique that has been very useful for the reconstruction of these defects. To facilitate distraction, soft tissue

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.

Competing interests: none declared. Conflict of Interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

Annals of Oral & Maxillofacial Surgery
Open Access

reconstruction and healing should be complete to ensure integrity of the wound. By using distraction, the overall shape and amount of regenerate provides superior bone and soft tissue relationships and contour. Another well-observed benefit of distraction is the increase in native soft tissue.

Primary versus delayed reconstruction

The terms primary and delayed treatment are somewhat ambiguous and can be defined differently depending on the context[2,37–39]. For our purpose, primary treatment will be defined as initial treatment of a wound within 48 h (or the first major operation) with the intent to definitively manage all aspects of the injury. The goal of primary treatment is to repair the wound in such a way that both hard and soft tissues are restored and all wounds primarily closed. Delayed treatment will include all other forms of treatment later on, which are numerous. Classically, surgeons selecting delayed treatment have advocated debridement of soft tissue injuries and stabilising bony injuries. After oedema has resolved and the soft tissues have healed to cover the wounds, the final reconstruction is attempted. Staged repair of wounds also will be classified as a form of delayed treatment.

Without a doubt, the majority of penetrating wounds to the maxillofacial area are lacerations that are generally cleaned easily and closed primarily. Little controversy exists regarding this current standard of practice. For more complex penetrating wounds, however, the debate continues regarding which wounds should be treated primarily versus delayed. Proponents that favour primary treatment claim superior aesthetic and functional outcomes, whereas those of the delayed approach claim fewer complications due to infection. There is no soft tissue contracture or deformity in primary treatment, in addition coverage of soft tissue defects is easier and more anatomic; however, all surgeons must note that the need for secondary revisions in primary or secondary interventions of gunshot injuries of the face is the rule not the exception.

An obvious reason for delayed treatment is the inability for the patient to tolerate an operative intervention. Generally, one thinks in terms of the patient being medically stable, and once cleared by the trauma critical care team, operative intervention for the facial injuries can commence. Uncertain neurological or cervical spine status is an example. Even though the patient may be stable for surgery, unexpected or adverse outcomes of these injuries may result in questioning the decision for early facial surgery. A common reason for delaying treatment is to allow for resolution of oedema; however, after oedema subsides comprehensive treatment can be rendered in the first operation[18,19]. In cases of open fractures, the overlying soft tissue wounds can be closed primarily or in an interval fashion. Once the oedema has resolved in 7–10 days, bony defects can be repaired more easily. This technique not only allows for subtle deformities to be appreciated, but also prevents the undo retraction of the soft tissue that can produce poor outcomes in sites such as the peri-orbital region. Furthermore, properly identifying all deformities allows a single intervention rather than multiple insults to the soft tissue that produce fibrosis and decreased vascularity ultimately leading to thick stiff tissue and displacement of fractured segments.

Finally, there are times when a multidisciplinary approach is needed. Temporising wounds allows time for the team to be assembled, diagnostic imaging and models can be attained, and input from the various disciplines to be discussed. Patient/family input can be sought and informed consent secured. Once the patient is stable and optimally tuned for surgery, the best intervention can be delivered with hopes for the ideal outcome in the first major operation.

The general condition of the patient, timing and sequence of the operations, extent of damage, and proper application of appropriate surgical hardware for reconstruction and rehabilitation of patients with penetrating maxillofacial warfare injuries have proved to be influential to the final outcome and aesthetic result. These criteria dictate whether or not to use primary repair for the maxillofacial injury. The staged sequence of treatment has been described by Behnia, Motamedi, Clark, and others[4,7,18–20,40].

Even with a comprehensive primary management approach, penetrating maxillofacial warfare injuries are associated with a significant number of residual problems. The majority of these can be addressed on an outpatient basis. Nonetheless, treatment options necessitate clinical judgement and are based on similar experiences. No strict protocol can be uniformly applied to all patients. With the antibiotics and surgical hardware at hand, however, the majority of maxillofacial penetrating injuries can be treated definitively at the time of debridement when the general status of the patient permits and when this is in the best interest of the patient as the benefits are numerous[19].

Conclusion

Based on this review, the current trend is to do as much as is practically possible for the gunshot patient with regard to hard and soft tissue reconstruction of the face and jaws in the first major operation even after 1 or 2 days. Even patients referred with wounds temporarily closed (to control haemorrhage) at the fronts or field hospital and then triaged and transferred to local hospitals can be treated comprehensively in the first stage. Treatment in such cases may be done upon arrival with the intent to debride and reconstruct the hard and soft tissues and to restore mandibular continuity (with

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.

Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

Annals of Oral & Maxillofacial Surgery
Open Access

the segments and fragments available) and occlusion in addition to closure of the soft tissues; because then subsequent procedures may be performed in minor operations. If arch bars and MMF are not used primarily, the occlusion may never be the same afterwards. Additionally, if only debridement, closed reduction and MMF are done and mandibular continuity is not obtained at the first operation, arch bars and MMF will again be needed in the next operation when bone grafting is done; this is most inconvenient for the patient.

Ease of reduction and fixation of fractures, easier restoration of occlusion, prevention of contracture and displacement, ability to reduce displaced or avulsed teeth, early mandibular mobilisation, less scarring, less anxiety and shorter hospital stay are among the many benefits associated with comprehensive definitive management of maxillofacial gunshot injuries in the first surgical intervention.

Abbreviations list

MMF, maxillomandibular fixation; ORIF, open reduction and internal stable fixation.

References

1. Rana M, Warraich R, Rashad A, von See C, Channar KA, Stoetzer M, et al. Management of comminuted but continuous mandible defects after gunshot injuries. Injury. 2012 Oct.
2. Kaufman Y, Cole P, Hollier LH Jr. Facial gunshot wounds: trends in management. Craniomaxillofac Trauma Reconstr. 2009 May;2(2):85–90.
3. Breeze J, Bryant D. Current concepts in the epidemiology and management of battlefield head, face and neck trauma. J R Army Med Corps. 2009 Dec;155(4):274–8.
4. Behnia H, Motamedi MH. Reconstruction and rehabilitation of short-range, high-velocity gunshot injury to the lower face: a case report. J Craniomaxillofac Surg. 1997 Aug;25(4):220–7.
5. Hollier L, Grantcharova EP, Kattash M. Facial gunshot wounds: a 4-year experience. J Oral Maxillofac Surg. 2001 Mar;59(3):277–82.
6. Motamedi MH. Primary management of maxillofacial hard and soft tissue gunshot and shrapnel injuries. J Oral Maxillofac Surg. 2003 Dec;61(12):1390–8.
7. Motamedi MH, Behnia H. Experience with regional flaps in the comprehensive treatment of maxillofacial soft-tissue injuries in war victims. J Craniomaxillofac Surg. 1999 Aug;27(4):256–65.
8. Ellis E, 3rd, Muniz O, Anand K. Treatment considerations for comminuted mandibular fractures. J Oral Maxillofac Surg. 2003 Aug;61(8):861–70.
9. Shvyrkov MB, Yanushevich OO. Facial gunshot wound debridement: debridement of facial soft tissue gunshot wounds. J Craniomaxillofac Surg. 2013 Jan;41(1):e8–16.
10. Baurmash HD. Closed reduction, an effective alternative for comminuted. J Oral Maxillofac Surg. 2004 Jan;62(1):115–6.
11. Li Z, Li ZB. Clinical characteristics and treatment of multiple site comminuted mandible fractures. J Craniomaxillofac Surg. 2011 Jun;39(4):296–9.
12. Coniglio JU, Norante JD. Augmented fixation of mandibular fractures with a threaded Kirschner wire. Arch Otolaryngol Head Neck Surg. 1989 Jun;115(6):699–704.
13. Dingman RO, Natvig P. Surgery of facial fractures. Philadelphia: W.B. Saunders; 1964.
14. Neupert EA 3rd, Boyd SB. Retrospective analysis of low-velocity gunshot wounds to the mandible. Oral Surg Oral Med Oral Pathol. 1991 Oct;72(4):383–7.
15. Smith BR, Johnson JV. Rigid fixation of comminuted mandibular fractures. J Oral Maxillofac Surg. 1993 Dec;51(12):1320–6.
16. Newlands SD, Samudrala S, Katzenmeyer WK. Surgical treatment of gunshot injuries to the mandible. Otolaryngol Head Neck Surg. 2003 Sep;129(3):239–44.
17. Okoturo EM, Arotiba GT, Akinwande JA, Ogunlewe MO, Gbotolorun OM, Obiechina AE. Miniplate osteosynthesis of mandibular fractures at the Lagos University Teaching Hospital. Nig Q J Hosp Med. 2008 Jan–Mar;18(1):45–9.
18. Motamedi MH. Primary treatment of penetrating injuries to the face. J Oral Maxillofac Surg. 2007 Jun;65(6):1215–8.
19. Motamedi MH. Management of firearm injuries to the facial skeleton: Outcomes from early primary intervention. J Emerg Trauma Shock. 2011 Apr;4(2):212–6.
20. Motamedi MH, Hashemi HM, Shams MG, Nejad AN. Rehabilitation of war-injured patients with implants: analysis of 442 implants placed during a 6-year period. J Oral Maxillofac Surg. 1999 Aug;57(8):907–13.
21. Mladick RA, Georgiade NG, Royer J. Immediate flap reconstruction for massive shotgun wound of face. Case report. Plast Reconstr Surg. 1970 Feb;45(2):186–8.
22. Doctor VS, Farwell DG. Gunshot wounds to the head and neck. Curr Opin Otolaryngol Head Neck Surg. 2007 Aug;15(4):213–8.
23. Yuksel F, Celikoz B, Ergun O, Peker F, Acikel C, Ebrinc S. Management of maxillofacial problems in self-inflicted rifle wounds. Ann Plast Surg. 2004 Aug;53(2):111–7.
24. McLean JN, Moore CE, Yellin SA. Gunshot wounds to the face-acute management. Facial Plast Surg. 2005 Aug;21(3):191–8.
25. Thorne CH. Gunshot wounds to the face. Current concepts. Clin Plast Surg. 1992 Jan;19(1):233–44.
26. Antonyshyn OM, Paletz JL, Wilson KL. Reconstruction of composite facial defects: the combined application of multiple reconstructive modalities. Can J Surg. 1993 Oct;36(5):441–52.
27. Long V, Lo LJ, Chen YR. Facial reconstruction after a complicated gunshot injury. Chang Gung Med J. 2002 Aug;25(8):557–62.
28. Williams CN, Cohen M, Schultz RC. Immediate and long-term management of gunshot wounds to the lower face. Plast Reconstr Surg. 1988 Sep;82(3):433–9.
29. Vasconez HC, Shockley ME, Luce EA. High-energy gunshot wounds to the face. Ann Plast Surg. 1996 Jan;36(1):18–25.
30. Gruss JS, Antonyshyn O, Phillips JH. Early definitive bone and soft-tissue reconstruction of major gunshot wounds of the face. Plast Reconstr Surg. 1991 Mar;87(3):436–50.
31. Vayvada H, Menderes A, Yilmaz M, Mola F, Kzlkaya A, Atabey A. Management of close-range, high-energy shotgun and rifle wounds to the face. J Craniofac Surg. 2005 Sep;16(5):794–804.
32. Calhoun KH, Li S, Clark WD, Stiernberg CM, Quinn FB Jr. Surgical care of submental gunshot wounds. Arch Otolaryngol Head Neck Surg. 1988 May;114(5):513–9.
33. Gravvanis A, Iconomou T, Tsoutsos D, Katsikeris N. Aesthetic and anatomic

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.

Competing interests: none declared. Conflict of Interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

Annals of Oral & Maxillofacial Surgery
Open Access

subunit reconstruction of composite mandibular gunshot wound. J Craniofac Surg. 2012 Mar;23(2):e95–8.
34. Labbe D, Nicolas J, Kaluzinski E, Soubeyrand E, Sabin P, Compere JF, et al. Gunshot wounds: reconstruction of the lower face by osteogenic distraction. Plast Reconstr Surg. 2005 Nov;116(6): 1596–603.
35. Manson PN, Crawley WA, Yaremchuk MJ, Rochman GM, Hoopes JE, French JH Jr. Midface fractures: advantages of immediate extended open reduction and bone grafting. Plast Reconstr Surg. 1985 Jul;76(1):1–12.
36. Waheeb AM. Closure of large oroantronasal fistula residual after gunshot injuries with temporalis muscle flap. J Craniofac Surg. 2012 Jul;23(4):e297–9.
37. Sali Bukhari SG, Khan I, Pasha B, Ahmad W. Management of facial gunshot wounds. J Coll Physicians Surg Pak. 2010 Jun;20(6):382–5.
38. Peleg M, Sawatari Y. Management of gunshot wounds to the mandible. J Craniofac Surg. 2010 Jul;21(4):1252–6.
39. Ueeck BA. Penetrating injuries to the face: delayed versus primary treatment – considerations for delayed treatment. J Oral Maxillofac Surg. 2007 Jun;65(6):1209–14.
40. Clark N, Birely B, Manson PN, Slezak S, Kolk CV, Robertson B, et al. High-energy ballistic and avulsive facial injuries: classification, patterns, and an algorithm for primary reconstruction. Plast Reconstr Surg. 1996 Sep;98(4):583–601.

Competing interests: none declared. Conflict of interests: none declared.
All authors contributed to the conception, design, and preparation of the manuscript, as well as read and approved the final manuscript.
All authors abide by the Association for Medical Ethics (AME) ethical rules of disclosure.

FOR CITATION PURPOSES: *Motamedi MHK, Ebrahimi A, Shams A.* Current trends in the management of maxillofacial gunshot injuries: a critical review. Annals of Oral & Maxillofacial Surgery 2013 Feb 01;1(1):8.