Case Report -Trauma

Management challenges in a short-range low-velocity gunshot injury

Access this article online
Website: www.amsjournal.com
DOI: 10.4103/2231-0746.101367
Quick Response Code:

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ABSTRACT

The use of firearms is becoming more prevalent in the society and hence the number of homicidal and suicidal cases. The severity of gunshot wounds varies depending on the weapons caliber and the distance of firing. Close-range, high-velocity gunshot wounds in the head and neck region can result in devastating esthetic and functional impairment. The complexity in facial skeletal anatomy cause multiple medical and surgical challenges to an operating surgeon, demanding elaborate soft and hard tissue reconstructions. Here we present the successful management of a patient shot by a low-velocity short-range pistol with basic life support measures, wound management, reconstruction, and rehabilitation.

Keywords: Ballistic injury, gunshot injury, blast injuries, penetrating injuries, wound management, missile wounds

INTRODUCTION

Gunshot injuries are always known to cause severe morbidity and mortality when head and neck are involved. They vary in morbidity and significance, forming a spectrum from trivial to life-threatening conditions which can occur in both military and civilian surroundings.[1]

The wound thus created largely depends on the type of weapon, mass and velocity of the bullet, and the distance from where it has been shot. These injuries in the head and neck may cause airway obstruction or serious blood loss leading to hypovolemic shock and death. Therefore, the primary treatment goal includes establishing airway, control of bleeding, and restoring hemodynamic status. Controversy regarding managing such cases exists between proponents for one-stage aggressive treatment with respect to hard and soft tissue facial reconstruction and those who prefer conservative and/or staged management, which includes angiographic management of facial bleeding.[2-6] The case presented here discusses about the medical challenges and a successful staged management from emergency to functional and esthetic rehabilitation in a patient who sustained low-velocity gunshot injury fired from a short range.

CASE REPORT

A 25-year-old male patient was brought to the emergency at 11 am with a history of being shot with 0.32 bore 9 mm pistol from a distance of about 10-15 m. An initial attempt to arrest bleeding was made by applying pressure dressing and intravenous fluid (iv) resuscitation at a primary care center and referred to our hospital situated 60 km from the site of accident. Day 1: At the time of presentation, the Glasgow coma score (GCS) was 6 (E1V1M4), tachycardia (100 beats/min), tachypnea (24/min), and hypotension (90/60 mm of Hg). The patient was in a state of confusion with profuse bleeding from oral cavity, left cheek and nasopharynx with evidence of difficulty in maintaining airway. The left eye was normal but the right eye was blind with limbus perforation, and uveal prolapse. He had sustained penetrating injuries to the head, neck, upper and lower limbs. The bullet entry wounds [Figure 1a] were found in the right cheek, right post auricular, right neck, right upper limb, and left thigh region. The only exit wound was seen in the left cheek [Figure 1b].

Oral and nasal route of intubation was not possible due to continuous bleeding into the mouth and nasopharynx; edema obscured the anatomy of neck and therefore, a percutaneous

needle tracheostomy was performed and airway secured. The blood investigation revealed hemoglobin of 8 g/dl and blood group AB positive. Two peripheral cannula were secured using 18 gauze needles and fluid infusions started initially with crystalloids 2 RL (ringers lactate) and 2 DNS (dextrose 5%+ normal saline 0.9%), Expan 6% (hydroxyethyl starch, plasma expander) and one fresh cross matched whole blood. The patient was catheterized using Foley's catheter to monitor urine output. Drugs that were started intravenously (iv) included Mannitol 100 ml/8 hourly, inj.Melpred (Methyl prednisolone) -- 500 mg/100 ml normal saline 12 hourly, Epsolin (phenytoin sodium) 100 mg/8 hourly, Inj.Aciloc 50 mg (Ranitidine) 8 hourly. The antibiotics included Inj.Lactaguard -- 1 g (Cefaperazone -- 0.5 g+Salbactam -- 0.5 g) iv 12 hourly, Inj.Linox (Linezolid) 200 mg/100 ml iv 12 hourly, Inj.Metrox -- 100 ml (metronidazole 500 mg) iv 8 hourly.

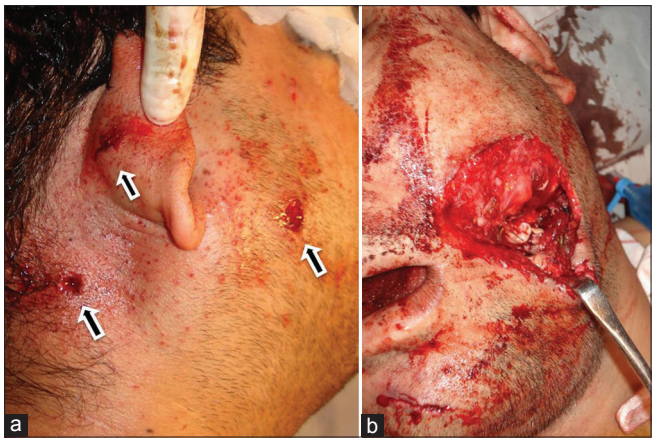

Figure 1: (a) Bullet entry through right ear, neck and cheek region. (b) Exit wound with large cavitation and shattered left mandible

Once the patient was stabilized, conventional lateral and antero-posterior skull, upper and lower limb radiographs [Figures 2a-d] and CT scan [Figures 2e-g] were obtained. Under general anesthesia thorough wound debridement was performed using isotonic saline and diluted povidine iodine solution. Intraoral debridement included broken teeth and alveolar bone in the left maxilla and mandible. The bullets were retrieved from left posterior maxilla, right infratemporal fossa, medial to right ramus region, right forearm and left thigh region with the help of C-arm guide [Figures 3a and b]. Multiple small metal pieces in the right posterior orbital cavity, temporal lobe of brain, and right neck region were left untouched. Upper and lower eyelets were placed and intraoral and extraoral lacerations closed. The cheek wound was undermined and closed primarily. A nasogastric tube was placed and the patient was put on maxilla-mandibular fixation (MMF).

Day 3: The patient went through a hemodynamic instability as he developed fever of 102–104°C and tested positive for malaria parasite Plasmodium Vivax. This was successfully managed with antimalarial drug (chloroquine 25 mg/kg/day) for 3 days. The methyl prednisolone and linezolid were discontinued at the end of 3 days.

Day 8: The tracheostomy tube was replaced as the mucous secretions caused airway obstruction and discomfort to the patient. The patient complained of hearing impairment from the right ear and examination revealed stenosis of the auditory canal which was corrected surgically by recanalization by the ENT surgeon. At the same time since the right eye vision was lost, a complete evisceration was carried out by an ophthalmologist. Day 14: The tracheostomy tube was removed and discharged with MMF and oral antibiotics for 1 week.

9 weeks: The patient was kept under observation for a total of 9 weeks for a complete recovery from the physical and psychological

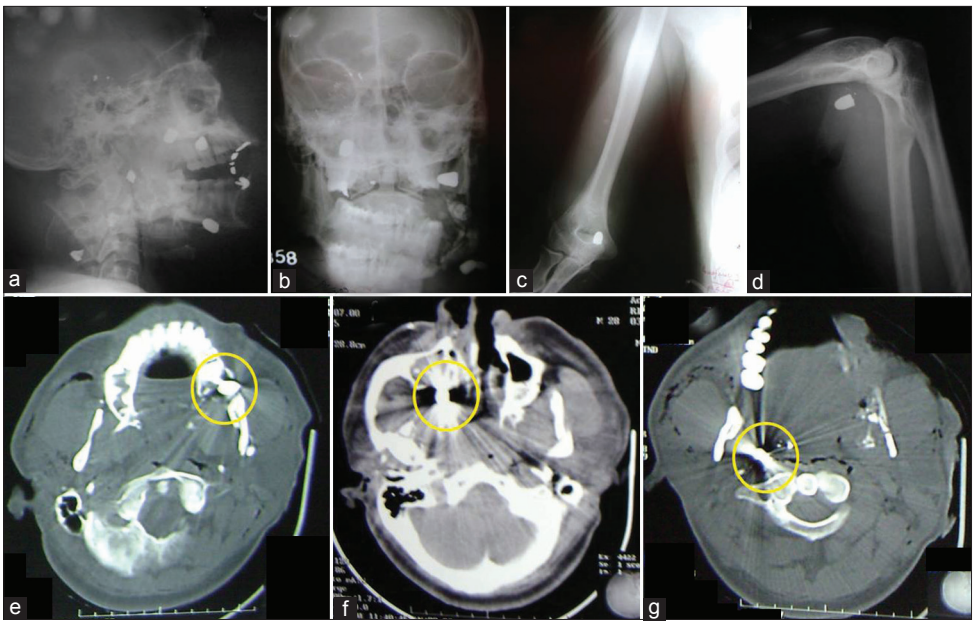

Figure 2: (a, b) Lateral skull and postero-anterior radiographs showing three bullets in face and scattered metal pieces. (c, d) Elbow and thigh radiographs with bullets. (e-g) Axial CT scans showing bullet in left posterior maxilla, right infratemporal fossa and medial to right ramus region

shock. At the second stage left iliac crest bone graft was used to reconstruct the segmental mandibular defect and stabilized with reconstruction plate [Figure 4a]. 9 weeks 3 days: During his stay eye prosthesis was made. He had quite reasonably restored facial contour [Figure 4b] with satisfactory mouth opening and occlusion [Figure 4c]. The patient refused to undergo any more surgical procedures and therefore the left marginal mandibular weakness and dental rehabilitation remained untreated.

DISCUSSION

Bullets at first, crushes structures along its track, causing temporary cavitation, shearing and compression, sometimes tearing structures (as with solid abdominal viscera) or stretching inelastic tissue (the brain). As tissues recoil and hot gases dissipate, soft tissue collapses inwards, and hence, a permanent cavity is formed. Secondly, kinetic energy transfer occurs during retardation of the bullet and this may cause damage outside the tract. Factors influencing the efficiency of kinetic energy transfer include the kinetic energy of a body (e), proportional to mass and velocity (mv^2), projectile's deformation and fragmentation, entrance profile and path traveled through the body and biological characteristics of the transit tissues.[7]

The Maxillo-facial gunshot injuries are associated with a very high mortality rate. The severity of these injuries varies depending on the caliber of the weapon used, distance, the mass and velocity of bullet (low velocity, less than 1000 feet/sec and high velocity, more than 2000 feet/sec). Based on the range the gunshot injuries are classified into three types. Type 1 (long range, over 7 yards) penetrates subcutaneous tissue and fascia, type 2 (3–7 yards) penetrates abdominal cavities, type 3 (blast injuries, less than 3 yards). Type 2 and 3 injuries cause extensive tissue damage, contusions, and fracture of bones. Based on the tract that is formed by the bullet in gunshot victims, they are classified into four categories: (1) through and through (2) graze (i.e., tangential without any entry or exit wound). (3)retained in body with bullet palpable under skin. (4) Retained in body with bullet not palpable under skin.[8-10] According to this classification our patient belonged to categories 1 (cheek wound) and 4 (neck and maxilla). High-velocity injuries have traditionally been assumed to cause more damage than low-velocity ones, an assumption that is still under dispute. A close range, high-velocity gunshot wound can result in devastating facial disfigurement and disability in those who survive. Management of the airway is a major concern in patients with maxillofacial ballistic injuries because a compromised airway can lead to death. Although there are many options to secure airway, each one has specific indications, and the choice will ultimately depend on the patient's situation and the expertise of the trauma team.[11,12]

In general, endotracheal intubation is usually not a viable option in cases of profuse bleeding from oro-nasal cavity. Cricothyroidotomy, tracheostomy or percutaneous needle tracheostomy are preferred methods to secure airway in emergencies. Other procedures for consideration are the submental or submandibular intubation techniques which can provide a clear field for facial surgeries. Hollier *et al.* had shown 21% of patients requiring tracheostomy, had lower third facial injury.[12,13] This may be because of intraoral bleeding preventing endotracheal intubation, distortion of oropharyngeal anatomy, and the fear of edema compromising airway. An early and comprehensive surgical management of the soft tissue at the first stage with less aggressive debridement has shown minimal morbidity. A primary closure or local flaps are preferred over secondary healing as it may cause excessive scarring. Fractured bone pieces should be aligned if attached with muscle and periosteum and plating is done according to the AO/ASIF principles of rigid fixation. Immediate bone grafting should be considered provided soft tissue is adequate to achieve a watertight closure.[14,15]

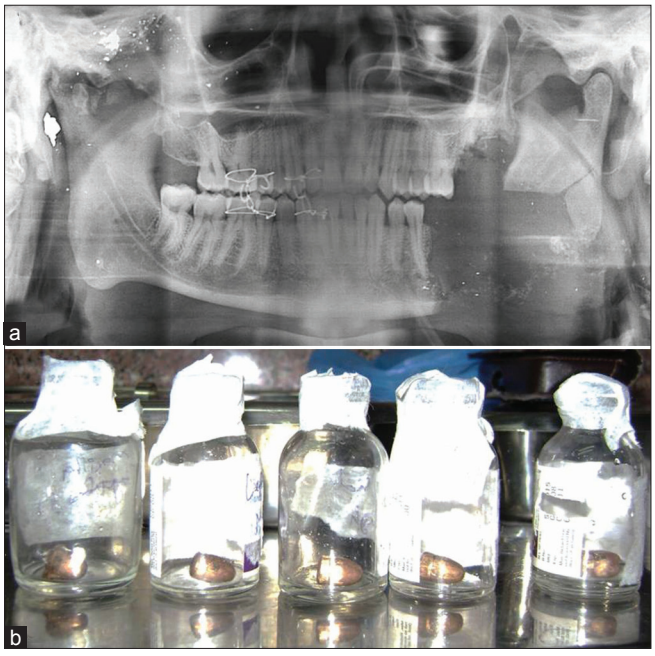

Figure 3: (a) Radiograph of postsurgical debridement and bone loss. (b) Retrieved bullets

Figure 4: (a) Iliac crest graft with reconstruction plate. (b) Reasonable restoration of facial contour and right eye prosthesis. (c) Postoperative occlusion

Our patient was treated in two stages. First wound debridement by removing nonviable tissue, loose bone fragments, loose and irrevocable teeth, and retrieval of bullets under general anesthesia followed by primary wound closure was done. Retrieval of bullets or metal debris is important, as the lead in them is soluble in serum and systemic lead toxicity has been reported as early as 2 days after injury.[16] Arch bars were placed and MMF was done. Mannitol plays a vital role in head injuries by reducing intracranial pressure through increasing sodium and water excretion thereby decreasing extracellular fluid volume. Methyl prednisolone is an anti-inflammatory drug given for spinal cord injuries at 30 mg/kg intravenous followed by drip at 5.4 mg/kg/h for 24 hours improves sensory and motor recovery if given within 8 hours of injury. Dexamethasone is another anti-inflammatory drug of choice which is 20–30 times more potent than naturally occurring human cortisol and 4–5 times potent than prednisone. Phenytoin sodium acts by increasing efflux or decreasing influx of sodium ions across cell membrane in the motor cortex, thus stabilizing neuronal membrane and decrease seizure activity. It also acts as an antiarrhythmic by extending effective refractory period and suppressing ventricular pacemaker automaticity, shortening action potential in the heart. At the second stage, the mandibular defect was reconstructed using the iliac crest graft through an extraoral approach. Free microvascular tissue transfer grafts are also preferred when needed as also implant placement several months later to reduce graft bone resorption.[15]

Antibiotics play a major role in the prevention of infection of both hard and soft tissues after primary closure of class IV wounds. Appropriate wound debridement, immobilization and fixation, detailed wound closure, drainage and maintenance of clean dressings, nutrition, and circulating fluid volume are equally important. The hemodynamics of the patient must be addressed as the oxygen-carrying capacity influences both wound healing and prevention of infection.[17,18] The penetrative injuries to the face can cause minor or major devastating consequences. The general condition of the patient, timing and treatment sequencing, extent of damage, and proper selection of reconstruction method and rehabilitation are helpful for the final functional and esthetic outcome.[15] Even with a comprehensive primary management approach, penetrating maxillofacial injuries are associated with a significant number of residual problems. The majority of these, however, can be addressed as an outpatient basis.[19] Treatment options necessitate clinical judgment and 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. Hollier reported 31% of ocular complications in gunshot injuries.[12] Our patient had sustained injury and a ruptured right globe with complete loss of vision. The bullet that penetrated breaking through the left mandibular body and cheek and damaged the marginal mandibular nerve. Although these deformities can be treated in stages, ethically we had to restrain ourselves from doing them as patient desired not to undergo any kind of surgeries but expressed satisfaction over the treatment so far.

CONCLUSION

The immediate basic life support measures with fluid resuscitation followed by appropriate management of soft and hard tissue damage stabilized the patient. Whenever possible most of the tissue loss should be addressed in first stage when the wound is fresh but if staged correction is inevitable, minimal procedures should be performed keeping in mind the psychological aspect of patient.

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Cite this article as: Arunkumar KV, Kumar S, Aggarwal R, Dubey P. Management challenges in a short-range low-velocity gunshot injury. Ann Maxillofac Surg 2012;2:200-3.

Source of Support: Nil, **Conflict of Interest**: None declared.