



CASE REPORT

Management of extensive maxillofacial injury related to a Tyre Blast: A rare case report



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Abstract *Background:* Severe blast injuries of large tyres are similar to those resulting from explosions with neither thermal nor chemical effects. The literature related to the destructive nature of these blasts is very sparse. This case aims to report the clinical management of a patient involved in large tyre blasts who presented with a severe soft tissue injury, comminuted mandible and associated multiple facial fractures due to a tyre blast injury.

Results: Excellent results were obtained following reduction and fixation of fractures with primary suturing, as these types of injuries are prone to infection secondarily.

Conclusion: Due to the etiology and severity of injury, these injuries are challenging to operate and are more prone to infection following surgery. These require careful management skills.

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1. Introduction

Blast injuries have become more common in the past few decades resulting in extensive casualties. These include bomb explosions, terrorist blasts, and industrial and home-related explosions. One of the rare causes of blast injuries is related to tyre explosion and reports related to this important area are sparse (Hayda et al., 2004). Most tyre explosions occur during servicing by the road side or in service stations. The

severity of the injuries depends on the size of the tyre, the contained air pressure, and the distance between the tyre and the victim. Head and upper limb injuries are most likely to happen while inflating the tyre. The dominant hand is prone to be injured in most of the cases where the upper limb was involved which can cause a significant loss of function and disability to those young mechanics. Primary effects are caused by the initial pressure wave (blast shock wave) that can shatter rigid bones and tear off soft tissues as well as the skin and vessels. Secondary effects are caused by the fragments and materials propelled by the blast force as they strike, the victim at a high speed. Tertiary effects occur as a result from the body being thrown against the ground, wall, or other objects causing deceleration injuries with serious fractures and countercoup injuries (Pyper and Graham, 1983). Herein, we present our recent experience in the management of extensive tyre blast injury.

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2. Case report

A 30-year-old man was brought to our emergency department with severe facial injury following a tyre blast, in his working place. Patient was semi-conscious and uncooperative. Patient's relatives provided the history of the tyre blast injury on his face and left hand region. The patient was trying to change the tyre of a truck when the blast incident occurred, was not under the influence of alcohol. One could visualize entire right side of the patients face involving the hard and soft tissue totally avulsed and hanging (Fig. 1A and B). His Vitals recorded were within normal limits. Patient had severe degloving injury to Right side of the face causing a contused lacerated wound 5 * 5 cm extending from lateral half of the upper lip to the ear region exposing the entire mandible on the right side that was comminuted into multiple segments. Patient had a fracture over the right side dentoalveolar segment involving the maxillary anterior and posterior region also. Vision in both eyes was intact.

Patient had a routine CT (computed tomography) scan done that revealed no neurological abnormality. CT revealed multiple comminuted fracture of the mandible involving right side and parasymphysis fracture of the left side mandible, dentoalveolar fracture involving the maxillary anterior and right maxillary posterior teeth region (Fig. 2A–D).

Prophylactic antibiotics (Inj Cefotaxim and Inj Metronidazole) was started and open reduction, internal fixation with primary closure was planned under general anesthesia. Patient was shifted to Operation Theater immediately, intubated nasally and wound was irrigated thoroughly with normal saline and betadine solution with minimal debridement of the exposed tissue. The injured site contained multiple pieces of foreign body such as wood and sand. After thorough debridement and removal of the foreign bodies, bleeding was controlled over the lacerated wound margins. Fractured mandibular bone over right side was examined to assess the extent and severity of injury. After carefully releasing the soft tissues entrapped within the bone fragments, inferior alveolar nerve was found to be intact (Fig. 3A). The mandible on the right side was fractured into three small segments near the angle region, had a body fracture in-between 44 and 45 region,



Fig. 1 Photograph taken at the accident site following large truck tyre blast (A). Intraoperative photograph demonstrating the extensive soft tissue laceration and comminution of the mandible (B).

parasymphysis fracture on the left side of mandible. IMF (intermaxillary fixation) using screws was secured prior to plating of the fractured segments on the left side as the molars over right side posterior maxilla were mobile with the alveolus. Interdental wiring was done between 44–45 and 32–33 regions to secure the fractured segments (Fig. 3B). The angle region had a fracture with three segments (proximal, middle and distal). Fragments over the right side mandibular angle region were approximated to aid in reduction. The fractured fragments were aligned and plated using 2 mm miniplates (5-hole 4 screws, two 3-hole 3screws and 4-hole 4 screws) respectively (Fig. 3C). In the right side mandibular body region, careful subperiosteal dissection of soft tissues was done to expose the fractured fragments. The mental nerve was identified exiting from the mental foramen and fractured segment were aligned properly. On examination there was a triangular piece of fractured fragment in the inferior border and was plated using 2 mm miniplate system (5-hole 5 screws) at the lower border and with 5-hole 4 screws at the upper border. On the left side of mandible, parasymphysis fracture was treated using 2 mm miniplates (5-hole 4 screws) at the lower border and (4-hole 3 screws) at the upper border. Fractured maxillary segments on the right side were approximated using interosseous wiring as plating was not possible owing to the severe comminution of the fractured segments (Fig. 3D). Stability of the plated segments was assessed and IMF released to check for occlusion. Thorough irrigation of the site was done prior to suturing using povidone iodine solution and copious amount of normal saline. Primary suturing of the wound was done over plated fracture segments using Polyglactin (Vicryl). Once the suturing over the fracture segments was done, suturing of the soft tissue avulsion was planned. Injury to the parotid duct was assessed and was found to be atraumatic. The laceration did not involve the parotid gland and hence facial nerve involvement was also ruled out. Suturing was done in layers starting from the mucosa intraorally to the extra oral skin layer. An initial approximation suture was placed at the upper lip junction for proper orientation of the soft tissue injury. Suturing was done in layers using resorbable Polyglactin (Vicryl) for deeper layers and Nylon (Ethilon) for superficial skin region. An additional cut lacerated wound (CLW) was found extending from the angle of mouth to the chin measuring 2 * 1 cm deep. Similarly suturing was done using Polyglactin (Vicryl) and Nylon (Ethilon). An antibiotic ointment was applied over the sutured wound margin and a pressure dressing was applied. The surgery took around 6 h to complete and postoperative radiographs demonstrated satisfactory approximation (Fig. 4A and B).

The patient had an associated fracture of metacarpal bones of his right hand, tendon injury with severe soft tissue lacerations and was operated under plastic surgery for the same. Regular dressing was done over the sutured wounds after cleaning with povidone iodine solution daily. Pus Discharge was evident on the 10th postoperative day over the sutured wound near the angle of mandible (Fig. 5A). Intra orally, sutured Polyglactin material became loose without exposing the fracture site even after thorough and regular irrigation using povidone iodine solution and mouth wash (Fig. 5B). Salivary leak was ruled out as the culture report and antibiotic sensitivity revealed gram negative organism namely *E. coli* that might have been hospital acquired. The organisms were managed effectively using Ciprofloxacin Intravenous injections.

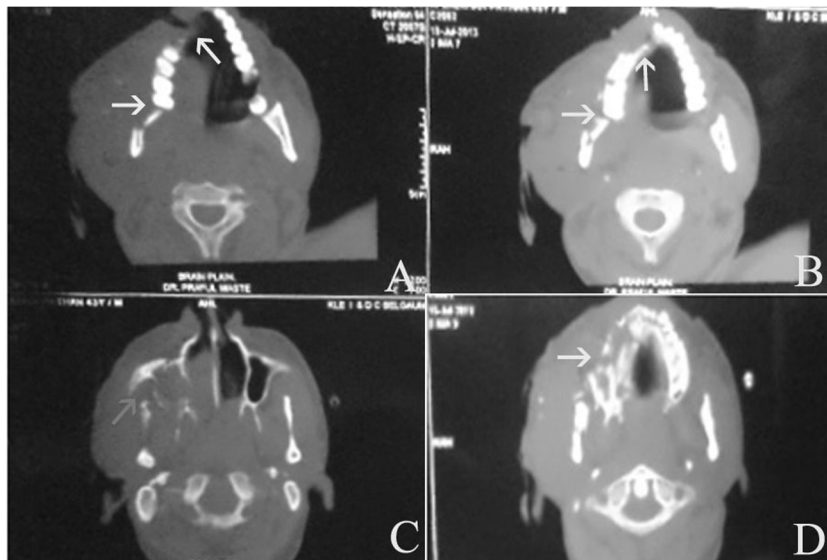


Fig. 2 CT scan pictures depicting the mandibular fractures (A and B), Maxillary fracture (C) and the zygomatic one fracture (D).



Fig. 3 Intraoperative views showing approximation of the soft tissue (A), fixation of the mandibular fracture (B), maxillary interosseous wiring (C) and final closure (D).

Post operative healing after 1 month revealed satisfactory healing without wound dehiscence and adequate occlusion (Fig. 5C and D).

3. Discussion

The high energy produced by large tyre blasts may cause severe injuries. This type of severe work-related injury is underreported. The injuries caused in this case were probably caused by the 'blast' of the exploding tyre filling the patient's mouth that forced his cheek away from the gums, leading to associated fracture of the facial bones. Injuries secondary to exploding tyres are classified as barotraumas; as they are a result of high pressures causing tissue damage and lead to direct injuries

by metal rim fragments. Barotrauma has been known to cause severe injuries like tympanic perforation, eye injury, oesophageal rupture and pneumomediastinum (Bautista et al., 1971). Such severe injuries may necessitate multiple surgical reconstructive procedures to restore the form and function. Blast pressure waves may either directly injure the patient, or the projectiles may be the source of penetrating trauma (Motamedi and Behnia, 1999). Head and face are commonly involved as the injured victims usually face the wheel. The head then becomes the target for the flying objects of the explosion (Lau, 1995).

In the management of blast injuries, irrigation is an essential component; to prevent infection since it aids in removal of debris and microorganisms. Thus, visible dirt and foreign



Fig. 4 Postoperative radiographs demonstrate the fixation plates for the multiple mandibular and maxillary fractures along with interosseous wiring (A and B).

bodies have to be removed using saline followed by rigorously washing the wound with high pressure saline irrigation. Facial wound debridement must be kept to a minimum as the blood supply to face is excellent providing an optimal healing

environment (Red book, 2007). Puncture wounds have deep inoculation of pathogens and high infection rate, so require extensive debridement. Crush injuries with tissue ischemia have infection with lower bacterial counts (Kesting et al., 2006). High-pressure saline irrigation can change the contaminated (or even dirty) wound into a clean-contaminated environment, making it suitable for subsequent primary closure. Saline usage is emphasized for the mechanical effect rather than any antibacterial activity (Baliga et al., 2012). Hydrogen peroxide can also be used for its effervescent and presumed antimicrobial effects. The effervescence is the result of oxygen bubbles created by the breakdown of hydrogen peroxide to water and oxygen by tissue catalase. This “bubbling” action enhances mechanical cleansing of necrotic debris from wounds. Methicillin-resistant *S. Aureus* are shown to be susceptible to 3% hydrogen peroxide in vitro. Further, 1% povidone-iodine solution is recommended for irrigation as it provides an optimal therapeutic balance between bactericidal capacity and tissue toxicity (Tatnall et al., 1990).

Due to the shock effect, some of the tissues that look vital at the time of primary surgery later become necrotic and shed off. Attempt must be made to leave any bone fragment that is attached to periosteum in situ. These bone fragments may act as a good recipient site during the time of secondary reconstruction. Periosteal stripping should be kept to as minimum as possible to preserve the remaining blood supply. Fracture fragments should be mobilized and stabilized with mini plates/micro plates and screws. Adequate care is mandated for identification and preservation of vital soft tissue structures including parotid duct, branches of facial nerve etc. Several sequential surgeries may be required to get an acceptable result (Gibbons and Breeze, 2011).

Wounds are most susceptible to infection especially in the first two days and an increased nosocomial infection rate has been observed in wounds older than 6–12 h (Red book, 2007). Nosocomial infections (NI) also known as hospital associated/acquired infections (HAI) are those infections that develop in a patient during his/her stay in a hospital or other



Fig. 5 Pus discharge developed as a complication (A) and loosening of the intraoral polygalactin suture (B). At discharge, occlusion was satisfactory (C) as well as the healing was satisfactory (D).

type of clinical facilities which were not present at the time of admission. Common organisms causing nosocomial infections include *Staphylococcus (S.) aureus*, *Streptococcus* sp, enterococci, *Pseudomonas (P.) aeruginosa*, *Acinetobacter* spp., coagulase negative staphylococci and members of the Enterobacteriaceae family such as *Escherichia (E.) coli*, *Proteus mirabilis*, and *Klebsiella pneumoniae*. But the most frequent nosocomial pathogens are *E. coli*, *S. aureus*, enterococci and *P. Aeruginosa* (Bereket et al., 2012). In the present case, our patient had acquired *E. coli* infection as revealed by the pus culture method. Pus culture aids in identification of the organism causing the infection and also to choose the appropriate antibiotic for especially if the infection is resistant to the antibiotics being used. In our case, the *E. coli* organisms were sensitive to ciprofloxacin rather than the routinely used Cefotaxim. After the change of antibiotics and routine meticulous local wound management with povidone iodine irrigation, the infection subsided and wound healing was satisfactory.

Winter's landmark article established that the formation of a dry scab on the superficial surface of a wound impairs epithelization and he determined that a moist environment without scab formation enhances wound healing (Winter, 1962). The patient was under the hospital environment for a period of over 20 days even after being operated for facial fractures and plastic surgical procedures of hand. Patient was not ambulatory for a long time as he was not co-operative and not obeying to orders. Patient had urinary SRC (self retaining catheter) in place since the day of admission. All these could have precipitated for the *E. coli* infection (gram negative organism) that he developed during his postoperative stay in hospital. Hence to reduce/prevent the infection, postoperative stay in the hospital should be kept to a necessary minimum, make the patient ambulatory, SRC should be removed as soon as possible, and obviously the patient has to be made clear about the self oral prophylaxis measures to keep the operative site clean.

4. Conclusion

Blast injuries even though causes severe damage, due to abundant blood supply of the facial region; healing is usually satisfactory and does not necessitate the need for removal of any soft/hard tissue unless it is nonvital. Due to postoperative soft tissue fibrosis, operated cases might need a secondary correction surgery which needs to be informed to the patient's relatives during the time of primary surgery.

Conflict of interest

The authors declared that there is no conflict of interest.

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Ethical approval

Permission has been obtained from the patient for the publication of this report.

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