Mine Blast Injuries – Our Experience

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Abstract

Background: The sudden increase in incidence and magnitude of mine blast injuries prompted us to highlight the problem and its management.

Methods: The cases of mine blast injuries occurring during mining and demining in a particular geographical area were analysed. Total 27 cases of mine blast injuries occurred during mining or demining operations in a period of 13 months.

Results: Various body regions were involved in the mine blast injuries but the main brunt was borne by feet and legs followed by multiple body regions due to splinters. 14 patients underwent below knee (BK) amputation while 4 patients required through knee (TK) amputations. The effect of blast was so severe that most of the cases required 2 to 5 times wound debridements. The initial aggressive debridement / open stump amputation saved the limb and life of all patients.

Conclusion: A mine blast causes extensive injuries and psychological trauma. Management is needed urgently, surgery is difficult, and amputation is often inevitable. Maximum lives and limbs can be saved with aggressive debridement, repeated inspections and dressings under anaesthesia and definitive closure at optimum time.

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Key Words: Amputation; Antipersonnel mine; Crush syndrome; Debridements; Mine blast injury; Secondary missiles; Shrapnel

Introduction

Incidence of fatalities with mine blast injuries are very high. They usually occur while handling a device, stepping on a device or falling onto a device. Incidents with anti tank mines are rare, but have invariably killed the deminer initiating the mine [1]. The most common activity at the time of an incident is “excavation of mines” “handling” or “victim inattention”. The missed-mine risk is real and generally results in a severe injury. We share our experience of managing 27 mine blast injuries in the northern sector of the country.

Material and Methods

We received 27 cases of mine blast injuries while mining or demining land mines in a period of 13 months. Out of these injuries, only 3 cases occurred during demining operations. All anatomical details were lost in most of the cases. The tissues were deeply impregnated with dust, cloth pieces, shrapnel's, splinters and were grossly contaminated. The wounds were ghastly looking with traumatic amputation in certain cases. In one of our patients who sustained injuries due to explosion of antitank mine Mark 5HC, resulted in severe life threatening injuries. The limb or their parts were blown off, the bone was pulverized with soft tissue loss and the demarcation of dead from living tissue was difficult. He required above elbow amputation of left arm, excision of little and ring fingers of right hand, through knee amputation on

right side, evisceration of right eye and primary suturing of multiple wounds all over the body (Fig 1 & 2). He was almost exsanguinated when he reached this hospital. This patient required multiple redebridements before definitive closure. The management of these injuries was a formidable challenge. The surgical treatment consisted of thorough wound debridement and irrigation or open stump amputation. The post-operative regimen consisted of frequent wound inspection and dressing / debridement under anaesthesia only. Comprehensive broad-spectrum systemic antibiotics were started from beginning. It consisted of third generation cephalosporin, aminoglycoside and an agent against anaerobic organisms. Pain control was provided with Baxter pump infusion, epidural or intravenous. To prevent thrombo-embolic complications prophylactic anticoagulant (low molecular weight heparin) was given in each case and psychological support was offered in the form of regular counseling. There was no fatality and average hospitalization was 3 weeks. Patients with well-healed and matured stumps were sent to Artificial limb center (ALC) Pune for application of prosthesis.

Results

The youngest victim in our series was son of a serving soldier, 14 year old who accidentally picked up the mine while playing and sustained mine blast injury of right eye and left hand. The oldest patient was an ex-serviceman, 48 years old who lost his lower limb due to stepping over drifted anti

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Fig. 1 : Shows amputation of left forearm due to explosion of antitank mine Mark 5HC.

Fig. 3 : Shows ghastly, severely crippling mine blast injury of the foot with missing bone and flesh from the foot and ankle.

personnel mine while ploughing his field (Fig 3). The mean age was 30.37 years (SD 6.021). Young men suffered the

Fig. 2 : Shows grossly contaminated and shattered right leg due to mine blast injury. The tissues were deeply impregnated with dust, cloth pieces, sharpnells, and grass fibers.

Fig. 4 : Shows involvement of multiple body regions in mine blast injuries.

highest rate of injuries (Table 1). Various body regions were involved in the mine blast injuries (Table 2) but the main

Table 1**Age distribution**

Age in years	Number of cases
0-20	1
20-30	15
30-40	7
40-50	4

Table 2**Various body regions involved**

Area of body involved	Number of cases*	%	Probability
Multiple	12	21.42	0.44
Foot	17	30.36	0.63
Leg	12	21.43	0.44
Thigh	5	8.93	0.19
Upper limbs	5	8.93	0.19
Eyes	3	5.36	0.11
Abdomen	1	1.79	0.04
Chest	1	1.79	0.04

*The occurrence of multisystem trauma accounts for the percentage distribution of > 100%

brunt was borne by feet and legs followed by multiple body regions due to splinters (Fig 4). 14 patients underwent BK amputation while 4 patients required TK amputations. The effect of blast was so severe that most of the cases required 2 to 5 times wound debridement under anaesthesia before definitive closure. 3 cases of eye injuries were also there requiring evisceration of eyes in 2 cases and repair of cornea in one case (Table 3). We had complications in few cases. The revision of stumps to higher level was required in 4 cases due to ascending myonecrosis in spite of repeated wound debridements and excision. One Symes amputation was converted to BK amputation, a BK amputation to high BK amputation and two BK amputations to TK amputations were carried out (Table 4). There was no mortality in the series.

Discussion

When the foot of the victim is directly on top of the exploding mine, the blast force exceeds the structural integrity threshold of the majority of wearable materials and footwear. Furthermore, the blast waves generate a strong vertical force that accelerates the foot and lower leg mutilation. If the victim does not have adequate foot protection, there is a high probability of amputation. For the larger blast anti personnel mines, shattering of the lower leg bones and joints located axially over the mine occurs. Stripping of soft tissues also occur, allowing debris from the compromised footwear, mine casing or surrounding dirt to be driven into the lower leg due to blast waves and mass wind movement effect. This contamination and effects of invisible strong blast waves leads to an escalation of the level of injury and the need for amputation of the limb further up the leg [2]. In our series also, legs were affected (direct or indirect injuries) in 12 cases only; however 18 BK or TK amputations

Table 3**Operative procedures**

Operative procedure	Number of cases*	%	Probability
Wound debridements	42	44.69	1.56
Delayed primary suturing	18	19.15	0.67
Conservative amputation of fore foot	2	2.13	00.7
Symes amputation	1	1.06	00.4
BK amputation	14	14.89	0.52
TK amputation	4	4.26	0.15
Above elbow amputation	1	1.06	0.04
Skeletal traction	2	2.13	0.07
External fixators	2	2.13	0.07
Skin grafting	4	4.26	0.15
Exploratory laparotomy	1	1.06	0.04
Evisceration of eye	2	2.13	0.07
Repair of corneal perforation	1	1.06	0.04

*The occurrence of multisystem trauma accounts for the percentage distribution of > 100%

Table 4**Complications**

Complication	Number of cases	%	Probability
Revision of stump	4	36.36	0.15
Wound infection	4	36.36	0.15
Wound dehiscence	2	18.18	0.07
Discharging sinus	1	9.09	0.04

were carried out due to problem of ascending myonecrosis.

Due to their small size and the relative closeness of their vital organs to the mine blast, children are more prone to death and serious injury from landmines than adults. They are more likely than adults to die immediately or shortly after being injured, because they are not able to compensate the extensive blood loss during the time it takes to get them to a hospital for emergency treatment.

The blast mines rely upon the energy released by the explosive charge to harm their target, and are normally buried by hand or placed on the ground. The injuries they produce result primarily from the explosion, but secondary fragmentation injuries are possible as the mine casing or surrounding dirt or gravel is blasted at the victim. A fragmented bone piece of the victim also acts as secondary missile. Most depend on blast alone for their effectiveness, since the target generally needs to come in contact with the mine to set it off.

There are various types of mines. (i) Anti-personnel mines have been stigmatized internationally because they claim civilian lives and create impoverishment to an extent vastly disproportionate to their military utility. They can be further divided into two main categories: blast and fragmentation. (a) Blast mines are typically exploded by the pressure of a footstep. They can be put in place

by hand but many are also 'scatterable'. Scatterable mines can be launched from ground-based systems or dropped from fixed wing aircraft or helicopter. When detonated, the blast waves of the mine pushes upwards deep into the tissue of the leg, driving with it 'secondary fragmentation'. Fragments of the mine casing, earth, grass, parts of the casualty's footwear, bone and flesh from the foot and ankle are all driven high into the wound. Traumatic amputation of the lower leg is common. Subsequent surgical amputation is normally required from a higher site in the limb to ensure that blast and fragmentation-affected tissue and bone are excised. Secondary injuries can be very severe. Blindness and serious facial, chest or abdominal injuries are common with blast mines. (b) Fragmentation mines are typically exploded when a trip-wire is pulled or when the mine is disturbed directly. The mine contains a packing of fragments; usually metal, or a segmented outer casing that breaks into fragments on detonation. When dispersed by the explosive force of the mine, these fragments acting as missiles are the prime cause of injuries sustained by the victim. The fragmentation effect drives metal fragments into the mine victim. These fragments rip through tissue, organs, bone and where velocity is sufficiently maintained, they can cause large lacerated exit wounds. Survivors may suffer multiple amputations, blindness, and secondary effects caused by damage to internal organs. Fragmentation mines can kill and injure multiple victims in a single incident. (ii) Anti-tank mines contain enough explosives to stop or destroy an armoured vehicle. An anti-tank mine usually requires a substantial amount of pressure to be applied in order to explode. It requires about 180 Kg of the weight for its detonation. This means that anti-tank mines are not normally capable of being detonated by a person standing on them. However, civilian vehicles or people ploughing fields can activate an old anti-tank mine [3]. In our series, except in one case that sustained injuries due to explosion of antitank mine Mark 5HC, rest of the injuries were due to explosion of anti personnel mines of Non Metallic Mine (NMM) 14 and M 16 only. These mines require a pressure of 9 Kg and 3.6 Kg respectively to detonate them and M 16 mine can also be triggered of by pull strength of 1.3 Kg only. The old mines due to prolonged environment exposure become sensitive to even less weight than specified for their explosion and are dangerous for the farmers ploughing their fields near the border.

In a large series from Sri Lanka, Meade and Mirocha found a definite and identifiable landmine injury pattern. Patients were most often wounded in the lower extremities, had multiple wounds, and were injured together in groups. Victims were most often male, but

there were unusually high numbers of women, children and elderly who were also injured. The higher incidence of mine injuries were associated with two important activities: returning home and agriculture [4].

Landmine explosions bring a formidable challenge to both patients and treating surgeons. Initially the main decision to be made is to amputate or to salvage the limb. Amputation is a radical and irreversible intervention, and indications for amputation must be determined by those with great surgical experience and good knowledge of military surgical doctrine. Repeated wound debridements and stabilization by plaster of Paris or external fixator can save a large number of feet and limbs [5,6]. Free tissue transfer is the other method of repairing extensive soft tissue defects of the foot after serial debridements. Early wound coverage is important because if the wound coverage is delayed, wound infection develops and healing is impaired. By providing skin coverage in 4 cases and external fixation in 2 cases in our series we prevented a significant disability in these patients. In a series from Gulhane Military Medical Academy, Turkey 65 consecutive free muscle flap transfers were performed in 54 patients who had foot defects involving soft tissue and bone due to mine explosions and in them the overall flap survival rate was 83% [7].

The complications and the mortality rate from accidents involving land mines are high. Half of the mine victims die within minutes of the blast and 85% of child victims die before they reach hospital. The main cause of death is infection and crush syndrome in patients who survive the initial shock blast wave. We prevented this morbidity and mortality by maintaining good hydration and repeated extensive wound debridements. We also use low molecular weight heparin routinely in all cases to prevent thrombo-embolic complications. Nearly one third of mine victims lose at least one limb after a landmine blast while in our series of 27 patients of mine blast injury, two third of our patients lost their limbs as most of the victims were not wearing protective boots. In an international series from Russia, frequency of complications was reported as high as 70% with total lethality going up to 5.2% [4,8]. In our series of 27 patients, only 7 patients (26%) had complications with no fatality. In Iran, most fatalities (36%) occurred in the prehospital settings during a study for a period from 1989-1999 [9].

To summarize mine blast injuries are common while deploying or disarming land mines during tactical operations. During these operations army provides maps of minefields and their notification and markings, but due to rain fall, winds, melting of the snow and soil erosion, some mines drift ending up, years later, in places

far from the minefields and resulting in severe fatal injuries to victims – whether civilians or military personnel. Nature does not respect national boundaries and these mines can be found anywhere. A mine blast causes extensive injuries and psychological trauma. Management is needed urgently, surgery is difficult, and amputation is often inevitable. People injured by mines require a multitude of things; evacuation, first aid, resuscitation, surgical care, rehabilitation including, if need be, an artificial limb, physiotherapy, vocational training and social reintegration.

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