Emergency Medicine

Clinical Features and Management of Blast Injuries

Col BM Nagpal VSM*, Maj Ajoy Menon+

MJAFI 2002; 58 : 335-337

Introduction

Today we have inherited a world in which spiralling violence has brought people from all walks of life closer to the dangers of blast injuries. On an average, 68-75% [1] of all injuries in war are blast injuries. A cursory look at any headline of a national daily reminds us that the civilian populace is no less immune, and considering this, it becomes imperative for all medical personnel to be aware of the manifestations and the correct line of management of these injuries. All this involves a good understanding of the biomechanics of the event of a blast.

Biomechanics of a Blast

A blast is caused by sudden increase in volume of the medium initiated by a detonation, which triggers a sudden shock wave. This leads to an instantaneous rise in temperature and pressure (the blast wave), which is followed by a massive negative suction effect (the blast wind) [2]. Contrary to popular perception, the blast wave can travel around objects, is faster in water and can penetrate body armour. The blast wind, on the other hand, is ineffective in water and cannot penetrate a wall. In its most intense form it can cause total disintegration of body parts and amputation of limbs. Injuries produced by the blast may be primary due to the blast wave or secondary due to flying debris or shrapnel. Tertiary injuries are caused by the blast wind either directly or indirectly. In addition burns, crush injuries and stampeding amount to massive casualties.

Clinical Features

1. *The Primary Injury*

Clinical manifestations of the primary injury [3] show a peculiar predilection for involvement of 'soft organ targets', namely the ear, the lungs, heart, gastrointestinal system, genitalia and the central nervous system (CNS).

The ear, which normally consists of a healthy tympanic diaphragmatic interface between air and tissue, can resist pressure differentials up to 100 kpa/sq cm, which a scarred tympanum cannot, thereby increasing the susceptibility of the latter to rupture.The ossicular chain, the organ of Corti and the vestibular apparatus can similarly get permanently damaged. Manifestations range from tinnitus, dizziness and otorrhea to frank permanent deafness.

The lungs [3] are particularly susceptible, being air filled spongy organs. Pressures upto 500 kpa/sec cause fatal damage in a radius of 10 metres. Pronounced stress wave reflection from the rib cage and the mediastinum causes massive extra cellular fluid leak into the alveoli resulting in acute respiratory distress syndrome (ARDS). Clinically, the patient may present with tachypnea, tachycardia or cyanosis. There may be diminished air entry and pneumo/haemothorax with concomitant bony cage injuries. The presentation may be insidious with mild effusions. Occasionally shear waves may cause tearing off of the lung tissues from the bronchial tree resulting in bronchopleural fistulae.

The heart, being closely invested by the lungs within the ribcage, may manifest injuries ranging from minor ECG abnormalities to more serious cardiac arrhythmias, or even coronary air embolism. Occasionally there may be cardiac tamponading or a frank myocardial tear, which is amenable to surgery if undertaken as an emergency.

The gastrointestinal tract (GIT) is vulnerable to shock and shear waves generated by a blast. There may be multiple ecchymoses, which can cause paralytic ileus and mesenteric disruption. Lung injury should alert the clinician to the presence of underlying GIT injury since the two almost always co-exist except in the rare event of partial underwater submersion.

The CNS disturbances may include transient concussion, conduction disorders, axonal degeneration and interruption of the blood brain barrier. This may manifest as drowsiness, neurological deficits, seizures, delayed tendon jerks or frank coma.

2. *The Secondary Injury*

Shrapnel missiles that emanate from the bomb itself act as high energy masses that cause injury much beyond the range of either the blast wave or the blast wind. Therefore secondary injuries [4] predominate in any blast. Each fragment acts as an individual missile, producing its own forms of cavitation and tissue dam-

*Professor & Head, +Clinical Tutor, Department of Surgery, Armed Forces Medical College, Pune - 411 040.

age. This 'force multiplier' effect is the true danger of blast injuries. Deformable organs like the lung, bowel wall and muscle resist the insult better as compared to the liver and the spleen. However, no part is immune from shrapnel injury.

3. *The Tertiary Injury*

The blast wind generates much less pressure, but for a longer duration, thereby causing purely mechanical effects with an extremely high mortality. If the wind is strong it can cause amputation of exposed parts or even total dismemberment of body parts.

Management of Blast Injuries

It is important to remember that all patients with blast injuries arrive with a combination of injuries without warning in large numbers. Therefore the importance of routine hospital drills of disaster management, pre-hospital triage and in the hospital, trauma care cannot be overemphasized [5]. Triage, rapid evacuation and basic or advance life support followed by definitive surgery is basically teamwork, in which every movement must be purposeful and documentation kept to a minimum. The patient is typically confused, anxious, breathless with minimal external signs of wounding and may have deafness, haemoptysis, colicky abdominal pain, haematemesis or melaena.

A brisk clinical examination should begin with the traditional ABCs i.e., monitoring of airway, breathing and circulation. Tetanus prophylaxis is mandatory at the level of first echelon, and broad spectrum antibiotics should be commenced. Haemorrhage must be promptly controlled with pressure, fractured segments must be stabilized with splintage.

Physical examination should then include recording the pupils, auscultation of the chest, abdominal examination as well as auriscopy to study the tympanic membrane. In the presence of life threatening haemorrhage or shock, no time should be lost in rapid transfusion of crystalloid before undertaking emergency surgery. Endotracheal intubation must be unhesitatingly offered to cyanosed dyspnoeic patients with airway compromise.

It is becoming routine to include a whole body computerised tomography if facilities are available, as an adjunct to routine radiographs in the initial evaluation for patients with blast injuries once stabilised. Prior to arrival of the casualty to the tertiary trauma care centre, valuable time can be saved if the medical officer at the site of the incident communicates his triaged casualties with the Control Centre set up at the hospital to prevent 'log jamming' of crucial departments.

Blast injuries of the lung present with pneumo-or haemothorax and subsequently with signs of ARDS. IV fluids may aggravate the pulmonary oedema and hence judicious administration of colloids, with propped up position, oxygen administration, micro dosing of morphine (0.01 mg%kg bw) must be done before the patient is transported. Asymptomatic patients with suspected lung injury need at least a 48 hour surveillance.

Management of abdominal injuries in a blast differs slightly from that of penetrating injuries. A high index of suspicion is essential. Evidence of intraperitoneal haemorrhage or perforation must be looked for. Clinically, one should be alert to notice presence of shock, coffee ground nasogastric aspirate, abdominal guarding or tenderness with blood on per rectal examination. These may guide the need for ultrasound or diagnostic peritoneal lavage [6]. Once indicated, no delay should occur in carrying out laparotomy, which could be life saving in the presence of continuing haemorrhage.

Early correction of acidosis, hyperkalemia and other electrolyte abnormalities is necessary. Secondary injuries due to shells may be treated with thorough meticulous wound debridement, followed by delayed primary or secondary closure. Debridement in the operation theatre involves preservation of viable structure and liberal incisions to prevent compartment syndrome. Wounds of the face, scalp, palm and those in communication with any joint are closed primarily. However, such wounds need to be monitored closely for any evidence of tension. Skeletal stability with external fixators must be employed if necessary. The long term management of these patients revolves around successful control of infection, good nursing care and management of skeletal and neurological deficits. Many patients need plastic reconstruction of deformities and planned staged repair of visceral injuries. The management of blast injuries is a complex subject into which numerous specialities are interwoven and eventually converge around the pivot who is the trauma surgeon. Nothing is more important than correct decision-making and prompt surgical intervention and this often tests the mettle of even the most experienced in the field of trauma care.

References

1. Spalding TJW. Penetrating missile injury in Gulf War. Br J Surg 1991;78:102-4.
Cooper GJ, Ryan JM. Interaction of penetrating missiles with tissues. Some common misapprehensions and implications for wound management. Br J Surg 1990;77:606-10.
2. Katz E, Oflex B, Adler J, et al. Primary blast injury after a bomb explosion in a civilian bus. Ann Surg 1989;209:494-8.
3. Zuckerman S. Experimental study of blast injury to lungs. Lancet 1940;11:219-24.

4. Rignault DP, Deligny MC. The 1986 terrorist bombing experience in Paris. Ann Surg 1989;209:368-73.
5. Chan RNW, Aniscow D, Sikoski JM. Diagnostic failures in the multiply injured. J Trauma 1980;20:684.
6. Bivens BA, Sachatello CR, Daughtery ME, et al. Diagnostic peritoneal lavage is superior to clinical evaluation in blunt abdominal trauma. Am J Surg 1978;44:637.