

# Blast Injury: Brief Review Article

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## Abstract

Blast injuries are encountered frequently in this modern era. These are multisystem damage-causing injuries. A clinician should be familiar with mode and pattern of injuries. There should be a judicious and keen approach to manage blast victims.

## INTRODUCTION

The spectrum of injuries inflicted in blast injury is unique and variable. They range from simple pellet to multiple organ system injury with fatal consequences. There are multitude of factors governing the type and pattern of injuries inflicted in blasts. Victims are of any age, sex, caste and color and can be single or many.

## EPIDEMIOLOGY

Frequency depends on political stability.

## LOCATION

Blasts occurring in enclosed spaces lead to more serious injuries<sub>1</sub>. In open spaces damage depends on vicinity to site of explosion

## TYPES OF BLAST INJURIES

Injuries caused by explosive devices were classified by Zuckermann during World War II according to physical effects on the body caused by released energy<sub>2</sub>;

Blast injuries are primarily classified into four types:

1. Primary blast injury
2. Secondary blast injury
3. Tertiary blast injury
4. Quaternary blast injury<sub>3</sub>
5. Quinary blast injury

## PRIMARY BLAST INJURY

This type of injury is uncommonly diagnosed. The

mechanism of injury is direct interaction of primary blast wave with the organ. This blast wave can get reflected from solid objects accounting for accessory tissue damage. A single blast wave can inflict multiple persons in its radius of curvature. A person with no apparent mark of blast injury is to mandatorily observe. Sometimes primary blast wave manifests with delay. Intensity of primary pressure wave in blast injury declines with the cube root of the distance of explosion. Any viscera in abdomen are affected. Spelling impulsions, inertia and extreme differentials at the body surface causes stress waves that reproduce in underlying tissues, with spelling leading microscopic and macroscopic tear at site of interaction of body medium with the pressure wave. Gas filled organs, mesentery and solid viscera are prone to damage.

## SECONDARY BLAST INJURY

This is an apparent injury. In this type, there is direct collision of impulsive and energized fragment strike with the body. Striking materials are bomb fragments and debris. This pattern of blast injury alerts the clinician. It can coexist with primary blast injury. The more proximal the person is to site of blast, the bigger the injury.

## TERTIARY BLAST INJURY

Sometimes in high energy explosive devices, there can be blast energy mediated directional throwing or structural collapse. The displacement involves whole body or body parts, rolling of the body and getting struck with the surrounding. Results are seen in form of any visceral injury. There can be traumatic amputations.

## QUATERNARY BLAST INJURY

Quaternary blast injury encompasses other blast injury not

described in above type, burns and asphyxia type and exacerbation of underlying chronic illness. Burns are mainly occurring in victims close to detonation site. Temperatures of 3000 centigrade can be reached in explosions.

### **QUINARY BLAST INJURY**

There is hemodynamic instability unexplained by typical pattern of blast. Toxic material released from explosives absorption has been proposed. Patients can exhibit hyperpyrexia, a low central venous pressure and positive fluid balance.

### **GASTROINTESTINAL INJURIES**

There is a myriad of abdominal insults of blast injuries. Clinicians managing blast injury victims have to be aware of the spectrum of injuries inflicted. This valuable awareness and dedicated care will save precious human life. Each type of blast injury produces unique pattern of injury. A misdiagnosis can add iatrogenic surgical trauma. Patient usually presents with features of peritonitis. Gas containing viscera, intestine and stomach are most commonly affected by blasts. Liver and spleen damage are somewhat less. Mesenteric vessel damage presents as haematoma. In addition, direct trauma can account for many injuries due to deceleration.<sup>4</sup> Blast effects on intestine are by primary, secondary and tertiary wave. Most of the patients present with unexplained tachycardia, falling blood pressure and signs of increasing peritonism. Diagnostic laparotomy findings in intestinal injury is perforation. Perforation is ragged and with ecchymosis of the surroundings. Gastric perforation is not uncommon. Sometimes if the primary blast wave is strong traversing solid visceral organ can tear tissue and present with hemoperitoneum, among solid organs liver is more susceptible. In tertiary and secondary injuries, the direct traumatic contact can present with any abdominal injury, gastric and intestinal perforation, splenic and liver tear, diaphragmatic injury mesenteric tears and retroperitoneal hematoma. Renal injuries are not commonly encountered. Sometimes pellets can go deep and patients present with haematuria. Pellets can penetrate deep into bladder. Genitals can be hit by pellets. Sometimes visceral perforation may develop up to 24-48 hours later; however delays of up to 14 days have been reported.<sup>4</sup> Victims having abdominal penetrating blast injury create diagnostic dilemma for clinician. Track follow from superficial or deep inside, sometime getting lodged in viscera. Multiplicity is often noticed with other body parts. Gastrointestinal blast injury more commonly occurs after blast wave propagation in water. Gastrointestinal hemorrhage and perforation is most

common in the lower small intestine or caecum where gas accumulates

### **ASSOCIATED INJURIES**

The lung is characterized by contusion in blast and is hall mark of blast injury.<sup>5</sup>(Pizov). Contusions are often multiple and bilateral. Clinical manifestation is hypoxia, severity consistent with grade of contusion. Sometimes in lung contusion inadequate response to mechanical ventilation is attributed to be by pneumothorax and thoracostomy is indicated. Urgent thoractomy should be done in patients with excessive bleeding in the thoracotomy tube. There is risk of developing ARDS after blast injury. This occurs with multiple assaults with combined blast injury inhalational injury, significant soft tissue injury multiple long bone fractures prominent soft tissue injury and those requiring massive transfusions.<sup>5</sup> Similar to gastrointestinal injury, heart and blood vessels are prone to injury by wave effect and direct effect. Cardiac ischemia and coronary vessel embolization are manifestations of cardiac involvement. Blast wave induced micro thrombi formation in blood vessels may contribute to DIC. Rarely cardiac blast injury present with features of hemorrhage in the epicardium, myocardium, or papillary muscle. Tympanic membrane damage is most sensitive to blast injuries but is rarely looked for. It is easily ruptured in a blast.<sup>6</sup> But hearing loss can occur without tympanic membrane rupture.<sup>7</sup> A victim having less than 80% of membrane perforation heals of its own with 10% of perforation per month. Previously eardrum perforation was considered marker of delayed onset of pulmonary and gastrointestinal injuries but has been refuted.<sup>8</sup> Ossicular bone disruption can add further to hearing loss. Traumatic amputations are seldom seen in blast victims. An additive of primary blast wave, secondary and tertiary blast wave has been proposed.<sup>9</sup>

### **MANAGEMENT**

Management starts at the site of scene but one has to be keen observer and aware of specific features of blast injuries.<sup>10</sup> Any time any moment one can have to manage blast casualties single or multiple. It is the need of time to be aware, trained and be able to apply care and management of blast victims. Trauma care should be given according to advanced trauma life support guidelines.<sup>11</sup> An effective triage system should be applied. A reverse triage system can swamp the emergency services and add to morbidity and mortality. Understanding the mechanism of injury and treatment issues and the potential long-term morbidity of

primary blast injuries will enhance survival<sub>1,2</sub>

In a country where modern emergency facility is lacking the tradition can be put in use. A bleeding should be stopped by piece of cloth, a fractured limb can be splinted by card board or duppata, and a cart can be used to move victim in nearby emergency service.

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