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BLAST INJURIES FROM A DIESEL TANK EXPLOSION – AN AUTOPSY CASE REPORT.

Forensic Medicine

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ABSTRACT

With the increased use of flammable gas and liquid-filled devices for domestic use and in vehicles there have been many deaths following the mechanical explosion of such devices, and it is important to know the pathomechanics and physiological effects of blast injuries from a gas explosion for effective treatment and a proper medico-legal autopsy with preservation of samples, which will be helpful for the investigation.
This is a report of an 18-year-old male who accidentally detonated a diesel tank and was brought dead to casualty. His autopsy findings showed features of a contact explosion with disruption of tissues of the right lower limb and the cause of death was found to be shock and hemorrhage due to blast injury, it provided useful information for the investigation.

KEYWORDS

Blast injury, Explosion, Diesel tank blast, Autopsy of blast case.

INTRODUCTION

A blast injury is a complex Mechanical Trauma and is most commonly seen in an explosive blast that is employed in warfare[2]. Blast injury can occur in civilian settings also like in domestic gas explosions and mechanical explosions.

An explosive is any substance or device capable of creating a sudden gas expansion, releasing potential energy and thus creating a pressure wave, which rapidly propagates in the surrounding media called a "Blast Wave".[1] Interpretation of pathomechanism of blast injuries aids in the investigation and management.

Case Study

An 18-year-old male was brought dead to casualty, with a history of burns and injuries sustained by the accidental blast of a diesel tank that he was repairing.

A medicolegal postmortem was conducted in the Department of Forensic Medicine and Toxicology GMCH Nagpur. All peculiarities of contact blast injury, with disruption of the right lower leg, were present in the autopsy.

Autopsy Findings

External Examination

- Blackening of skin and singeing of hairs are present.
- Superficial flash burns of uniform depth over the exposed skin of the face upper and lower limbs, abdomen, and trunk amounting to 40% surface area (Rule of Nine). [Figure 1]
- Terry cotton cloth brunt dripping over both thighs.
- Laceration of the posterior part of the right thigh of size 40 cm x 20cm x bone deep, which is reddish in colour. [Figure 2]
- Avulsion laceration of left-hand 2nd to 4th digits from knuckles down of size 8 cm x 4 cm x bone deep which is reddish in colour.

Internal Findings

- Under scalp hematoma is present over the occipital region.
- Both lungs' lower lobes collapsed and petechial haemorrhages over subpleural space.
- All other organs are pale.

Investigation

- Viscera for chemical analysis – Negative for any intoxication or asphyxiants.
- Viscera for histopathology – lungs revealed enlargement of the alveolar spaces and interstitial perivascular haemorrhages. [Figure4]
- For ballistics – Cloths, skin swabs, pieces of skin, and foreign material over the body for the detection of inflammable substances– Petroleum Hydrocarbon flammable content detected.

Cause of death

- Shock and haemorrhage due to blast injury.

Figure 1 – Flash Burns over the body due to the blast.

Figure 2: Laceration of the right posterior thigh.

Figure 3: Avulsion laceration of the left hand.

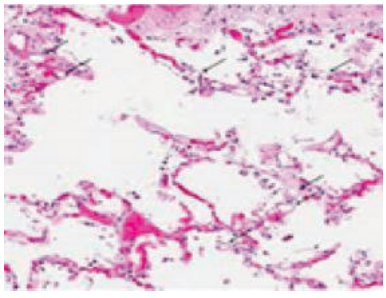

Figure 4 – Subpleural alveolar thinning and haemorrhages

Sources: www.googleimages .com/ blast lung

DISCUSSION

An explosion is a process that rapidly liberated vast amounts of energy, which is released when the chemical bonds within the explosive break down, resulting in rapid conversion of solid or liquid to a gas and generating high amounts of heat, kinetic energy, and high-pressure shock wave.[3,5]

The blast wave is defined as a combination of the shock wave and the dynamic overpressure (Blast Wind/Wind), which travel supersonically up to 8000m/s.[3,5]

Blast wave generated by the bomb causes extensive damage, especially to air-containing organs such as lungs, ears, and intestines; as most of the blast energy is dissipated at the gas-solid interface.[7]

Injuries seen in explosions are as follows

1. Primary Blast Injuries

This occurs due to the direct pressure effects of the blast wave on the victim, especially inside a confined space due to the reflection of the wave.

The organs most likely to suffer damage are the air-filled organs like the auditory apparatus and the respiratory and gastrointestinal systems.[7]

The blast wave with high velocity when passing through the organ will result in microscopic damage rather than visible lacerations, as they pass across the interface between substances of different densities, resulting in a break up of the tissue-air border, by a phenomenon called "**spallation**".[5]

When the blast wave passes through delicate air-filled structures such as the tympanic membrane, these will undergo "**implosion**" due to the pressure differentials across the boundaries and cause them to rupture.[5]

The shear waves will cause gross movement of tissues, but tissues of different densities will move at different rates causing the tearing of delicate attachments, such as bowel mesentery, solid organs, and its capsule, retinal detachment, etc. are common by this phenomenon of "**inertial effect**".[5]

The ear is the most sensitive organ to the blast effect.[7] Blast lung is the most common fatal injury among initial survivors.[10] Blast-induced neurotrauma, also known as traumatic brain injury (TBI) is common as well as a major medical concern.[3]

Primary Blast Lung Injury is defined as "Radiological and clinical evidence of acute lung injury occurring within 12 hours of exposure and not due to secondary or tertiary injury".[4]

2. Secondary blast injury

They are produced when the ejected missiles from the explosive (usually that used in warfare) causes the classic triad of punctate lacerations, Abrasion, and Bruises known as Marshall's Triad.[7]

3. Tertiary blast injuries

They are produced either when the victims are actually lifted up and thrown around by the effect of blast wind or when some heavy piece of masonry breaks and falls upon the victim.[7]

4. Burns

Sometimes known as Quaternary injuries. The characteristic burns seen in the explosion are flash burns which are due to the radiant heat of high intensity and not the actual flame. Since the duration of exposure is infinitesimally small, these injuries are superficial in nature and since the heat applied is the same, they are of uniform depth. Areas protected by clothing are safe and cast a shadow of the substance between the skin and the flames.[7]

5. Fumes

If a bomb explodes in a confined area, carbon monoxide and other non-respirable gases will be formed which cause asphyxiation.[7]

6. Explosive injuries

Dust tattooing is seen when the projected dust and other small particles get embedded in the subcutaneous tissue.[7]

7. Complete Disruption

If the victim is almost in contact with a large bomb he may be blown to pieces. A bomb exploding on the ground may cause severe damage or traumatic amputation of the lower legs.[8]

Investigation of bombing incidents.

- Physical evidence to be collected from the site of the explosion includes any material related to the explosive device like batteries, timers, wires, etc.[7]
- Collection of explosive residues by mechanical vacuuming from the site and from the skin by hand swabs and fingernail scrapings and clothing of the deceased and suspects.[7]
- Identification of bodies by facial identification, clothing, and other standard identification protocols. DNA profiling techniques aid in the correct identification.[7]
- Radiological examination to identify and retrieve any parts of the explosive device which may have got lodged in the body.[7]
- Collection of internal samples including viscera, blood, and urine for toxicology and blood or bone marrow for DNA profiling.[7]

Scoring Systems used to assess blast injury

The Trauma and Injury Severity Score (TRISS) has been adopted by UK and US military to monitor their trauma care programs as it calculates a probability of survival (PS). This scoring system incorporates both anatomical (Injury Severity Score) and physiological (Revised Trauma Score) and age thus increasing its accuracy. The TRISS classifies a PS score of <0.5, as an expected death, and >0.5, as an expected survival.[9]

CONCLUSIONS

Based on the injuries and circumstances provided we could interpret the victim's posture during the incident as sitting over the tank leaning forward and facing straight or down with the posterior part of the right leg near the explosion site.

Internal injuries show the effects of the blast wind suggesting that the explosion could have happened in an enclosed space. Blood investigation did not reveal any features of inhalation of irrespirable gases, suggesting that he was removed from the place of the blast as soon as the explosion happened or that the patient expired soon after the blast.

Autopsy study of blast-related death is very significant as it will be helpful for physicians and surgeons to understand the pathophysiology of blast injuries and will be able to provide timely and effective medical treatment and it also aids in the police investigation.

In this autopsy study, we found significant haemorrhage following the disruption of tissues, and features of blast lung injury were the leading factors that led to the death of the patient.

By our findings, we were able to picture a virtual scene of the incident which matched with the findings of police investigation and we were able to label the manner of death as an accident.

The main cause of preventable cause of death as a result of the explosion is hemorrhage and it should be dealt with the same way as any other traumatic hemorrhage, by control of bleeding and the initiation of hemostatic resuscitation.[5]

Two factors that make the deduction of the position of explosion and victim are, firstly, that the explosive force declines exponentially with distance and secondly the explosive force is very directional[7], but in reality, explosions in urban and transport environments lead to complex waveforms, due to additional reflections and confinement and can typically amplify blast overpressures[6].

By proper documentation of injuries and understanding the physics behind an explosion we will deduct the cause and manner of death and also the relative position of the victim and the explosion site.

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