

Case Report

Death due to Accidental Explosion of a Balloon Filling Cylinder: A Case Report

¹Faraz Ahamed, ²Ramesh C., ³V. T. Venkatesha, ⁴Ameena Ahamed

Abstract

An explosion is a process where any substance or device capable of creating a sudden gas expansion, releasing potential energy and thus creating a pressure wave. Blast injury is becoming more common in non-military population due to terrorist acts and unsafe use of domestic gases, but it is still rare to see such injuries and deaths. Explosive related deaths fall into three categories: accidental, homicidal and suicidal. Accidental deaths normally occur either at the work place or when untrained, unlicensed individuals handle legal or illegal fireworks or explosive/inflammable material. Physicians and surgeons need to have a basic understanding of the patho-physiology of such injuries, because the major prognostic factor for favourable outcome is accessible and timely medical and surgical treatment along with implementations of preventable occupational measures for safety.

We report a case where a 33 year old male succumbed to an accidental explosion of a balloon filling gas cylinder.

Key Words: Cylinder, Traumatic amputation, Explosion, Blast lung, Tympanic membrane rupture

Introduction:

An explosion is a process where any substance or device capable of creating a sudden gas expansion, releasing potential energy and thus creating a pressure wave.

Compression of the air in front of the pressure wave, which heats and accelerates air molecules, leads to sudden increase in atmospheric pressure and temperature transmitted to the surrounding environment as a radially propagating shock wave, known as the 'Blast wave'. [1]

Injuries directly inflicted by this sudden increase in air pressure after an explosion are referred to as 'primary blast injuries', and mainly affect primary gas containing structures (lungs, middle ears and gastrointestinal tract). [1-3]

A minimum pressure of about 700 kPa (100 lbs/sq inch) is necessary for severe tissue damage in humans. [4]

Secondary blast injuries result from blast-energised bomb fragments and other displaced objects causing penetrating trauma. Tertiary blast injuries occur when the body is accelerated away from the blast wave at first and is then abruptly decelerated on rigid objects resulting in blunt force trauma. [1]

Quaternary injuries (Miscellaneous blast related injuries) encompass injuries caused by collisions, falling masonry, buildings, beams, etc. [5] Explosive force is highly directional. The parts of the body directly exposed to the explosive force only are injured. An explosion at ground level mainly injures legs and feet.

When a person is in front of a bomb when it blows up, the face, chest, forearms, hands, inner thighs and legs below knees are injured, but the back of the body, the lower legs and face escape. If a person is bending down over the bomb, the face, chest, legs and hands are severely damaged. [4]

Orthopaedic trauma resulting from an explosion is manifested as a primary, secondary, tertiary or quaternary (miscellaneous) blast injury in isolation or in combination.

Although uncommon in survivors, the direct effects of changes in atmospheric pressure caused by the blast wave (primary blast injury) can fracture bones and it is probably responsible for limb avulsions in victims exposed to stress waves of sufficiently high intensity. [6, 7]

Corresponding Author:

¹Postgraduate Student cum Tutor
Department of Forensic Medicine
Kempegowda Institute of Medical Sciences
Bangalore, India.

E-Mail: far.raaz@gmail.com

²Assist. Prof,

³Professor

⁴Postgraduate student cum Tutor

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Case History:

On 28-03-2014 at around 12:25 PM, a 33 year old man who used to sell gas-balloons for a living met with an accidental explosion of the gas cylinder with which he was filling the balloons. He sustained severe damage to both the lower limbs and was admitted to a nearby accident and trauma centre where he was being treated. But he eventually succumbed to the injuries on 29-03-2014 at 08:35 PM. Body was preserved in the cold storage and autopsy was conducted on 30-03-2014 at 01:30 PM.

Autopsy Findings:

The victim was found to be a 33 year old male, with amputated lower limbs. He measured 133cm in length from the stump of amputated left lower limb to the vertex. He was moderately built and nourished, of brown complexion. Cold stiffening was present throughout the body.

Faint livor mortis was present over the back of the body. Dried blood stains were present at nostrils, over left cheek and both ears. Injection marks were present over the upper part of right side of chest, left cubital fossa and lower 1/3rd of the right forearm.

Hospital bandages were present over the lower limbs and left forearm. On removing the dressing, both lower limbs were amputated. (Fig. 1) Left lower limb was amputated below knee, stump length measuring 60cm from the left antero-superior iliac spine. Blood stained fluid is seen oozing out from left stump. (Fig. 2)

Right lower limb was amputated at the junction of middle and lower 1/3rd of thigh (above knee) and stump length measuring 30cm from the right antero-superior iliac spine. (Fig. 3)

Tympanic membranes were ruptured irregularly on both sides. The external auditory meatus was blood stained on both sides. An abrasion measuring 5x3cm was present over inner aspect of right forearm in the middle 1/3rd.

Another abrasion measuring 6x3cm was present over the front of left knee. Multiple punctuate abrasions of varying shapes and sizes ranging from 0.1x0.1cm to 1x1cm with bluish-black discoloration were present over the right side of face, inner aspect of left forearm and over the front of abdomen in the right lateral and umbilical regions, inner aspect of right arm and right forearm. (Fig. 4-6)

Internal examination revealed a scalp contusion of size 10 x 6 cm over the left fronto-parietal region. There were no skull fractures, the meninges were intact and the brain appeared to be oedematous without any intracranial haemorrhages.

There were no injuries to the chest wall and ribs. Both lungs showed patchy haemorrhages. Heart and pericardium were intact. Abdominal walls and intra-abdominal viscera were intact. Both kidneys were congested.

Histopathology of lung tissue revealed enlargement of alveolar spaces, rupture and thinning of alveolar septae, interstitial perivascular haemorrhages (showing a cuff-like pattern around the pulmonary vessels) but no evidence of air or fat embolism.

Death was due to the **blast lung injury and traumatic amputation of limbs.**

Fig. 1: Both Lower limbs Amputated



Fig. 2: Blood oozing from Left Stump



Fig. 3: Right Stump



Fig. 4: Multiple Punctate Abrasions on Right side of Face

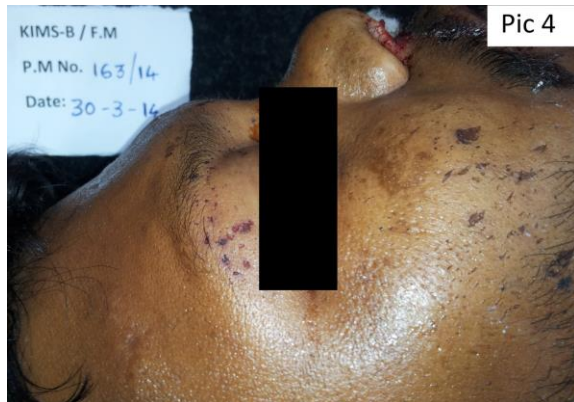


Fig. 5: Abrasions on Right Arm



Fig. 6: Multiple Abrasions around Umbilical Region



Discussion:

In the non- military population, blast injuries caused by things other than terrorist acts are rare. Explosive related deaths fall into three categories - accidental, homicidal and suicidal.

Accidental deaths normally occur either at the work place or when untrained, unlicensed individuals handle legal or illegal fireworks or explosive/inflammable material. Accidental

explosions at workplace typically involve mines, road construction and demolition sites. [8]

The characteristic injury patterns resulting from explosions have been thoroughly discussed in literature. Blast injuries mediated by different mechanisms; victims usually suffer from a combination of primary blast effects to gas containing organs, blunt force injuries, penetrating trauma and burns. Lungs, middle ear and gastrointestinal tract are most vulnerable to extreme pressure. [1]

Blast lung injuries are caused by pressure wave. The pressure front causes wall displacement towards the spinal column leading to transient high intra-thoracic pressure.

The elevated intra-thoracic pressure leads to tearing of alveolar septae, stripping of airway epithelium, and rupture of alveolar spaces with consequent alveolar haemorrhage, oedema and alveolar- venous fistulae. [1]

Blast lung injuries are most common after closed space explosions (e.g., in a bus) as compared with open spaced explosions (e.g., an open market). [9, 10] Eardrums may rupture at pressure as low as 2psi, whereas pulmonary damage should be expected in 50% of cases exposed to 70psi. [11]

A review of literature of cited cases of explosive related deaths found perforated ear drums in the majority of cases (76-86%). [10, 11]

The lung injury is considered an important parameter defining mortality in those who survive the explosion. [1] Limb amputation can carry a grave prognosis: according to a report by Mellor in 1989, only 9 out of 52 servicemen who had sustained traumatic amputations from explosions survived. [12]

The post-mortem examination is critical to the investigation of explosive related deaths. In our autopsy based study, we found a significant blast lung injury without co-existing blunt or penetrating chest trauma supported by histopathological findings expected after an open- space explosion.

Conclusion:

The blast injury, ear drum perforations along with the traumatic amputation of limbs were considered to be the primary blast injuries. The multiple abrasions were considered to be the secondary blast injuries due to fragments or shrapnel or missiles. The scalp contusion was considered to be the tertiary blast injury.

We have presented this autopsy based investigation to provide further insight into blast injuries, which are rare events. Physicians and surgeons need to have a basic understanding of the patho-physiology of such injuries, because

the major prognostic factor for favourable outcome is accessible and timely medical and surgical treatment along with implementations of preventable occupational measures for safety.

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