

CASE REPORT

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Two deaths due to explosion of cylinders of liquid petroleum gas

Nagendra Singh Sonwani¹, Navneet Ateriya^{2*} , Arvind Kumar¹ and Anil Kohli¹

Abstract

Background: Cylinder blasts can inflict multi-system life-threatening injuries to one or many persons simultaneously if they are nearby. The explosion in high-pressure equipment produces injuries due to its varied effects. Cases have been reported where the blast occurred in balloon gas cylinder, oxyacetylene gas cylinder, oxygen cylinder, coffee machine, and compressor of a split air conditioner (AC). Most of the cases are accidental. The investigation into the blast circumstances is of utmost importance to find out the manner and device involved.

Case presentation: Here, we present a report of two cases where victims suffered blast injuries at the same location due to the explosion of two different capacity liquefied petroleum gas (LPG) domestic cylinder and died on the spot.

Conclusion: The investigation into the blast circumstances is of utmost importance to find out the manner and device involved. Malpractice involving use of cylinder to fill another one might be dangerous for the person involved and present in the vicinity. This practice should be discouraged by lay person.

Keywords: Forensic pathology, Liquefied petroleum gas (LPG), Accidental death, Autopsy, Blast injury

Background

Blasts can produce unique patterns of injury over the body with great potential to inflict multi-system life-threatening injuries to one or many persons at the same time if they are nearby. Injuries due to explosion in high-pressure equipment produce injuries due to its varied effects. It causes primary blast injuries due to blast waves produced by rapid change in the explosion's surrounding pressure. Secondary blast injuries are produced by flying fragments or other missiles, while tertiary blast injuries are caused by the victim's body striking against stationary objects or collapsing structures. Thermal and chemical injuries are also associated with blast injuries (Dogra and Rudra 2005).

Cases have been reported where the explosion occurred in balloon gas cylinder, oxyacetylene gas cylinder, oxygen cylinder, coffee machine, and compressor of a split air conditioner (AC) (Chandulal 1974; Rani et al.

2005; Gupta and Jani 2009; Kashiwagi et al. 2009; Gupta et al. 2010; Behera et al. 2017). All these cases were accidental, except when the acetylene cylinder was exploded by the victim himself to commit suicide (Kashiwagi et al. 2009). Here, we present a series of two cases where victims suffered blast injuries due to the explosion of two different capacity liquefied petroleum gas (LPG) domestic cylinder and died on the spot.

Case presentation

A 60-year-old woman (case 1) and her 36-year-old daughter-in-law (case 2) were killed in a cylinder blast. The incident took place when the duo was trying to refill a 5-kg cylinder from a regular size (16 kg, domestic supply) LPG cylinder through connecting pipe with pressure controller. Suddenly, it caught fire probably due to the fact that they were cooking food nearby, and the smaller tank exploded. Another cylinder, which was lying nearby, also caught fire and exploded. Following the blast, the fire spread across the house, and both the victims suffered burn injuries. The event was witnessed by the husband of case 1. According to his narration, when small cylinder

* Correspondence: dr.navneet06@gmail.com

²Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Gorakhpur 273008, India
Full list of author information is available at the end of the article

caught fire, they got alerted but it was too late to escape from sustaining burn injuries. They witnessed bursting of small cylinder and in mean time moved out of the area. Few moments later, they heard another blast probably due to bursting of larger cylinder. Both the deceased's sustained fatal burn injuries in the process while the husband of case 1 sustained non-fatal injuries in the form of burns. All three victims were shifted to hospital, where cases 1 and 2 were declared dead on arrival. The dead bodies were moved to the mortuary for medico-legal autopsies.

The dead bodies of both the females were subjected to radiological examination before the autopsy. No identifiable foreign material was observed on X-rays. On autopsy, the deceased were of average build. No clothing was seen on the body. The body was charred and blackish discoloration was present at places. The singeing of scalp, eyelashes, and pubic hairs was present; no hair was present on the scalp of 60-year-old female due to burning. Multiple heat ruptures were present over the bilateral upper limb, bilateral thigh, chest, and abdomen with soft-tissue involvement at variable depth and exposing muscles and underlying bone at places. Intestinal loops were seen protruding out of the abdominal cavity on the right lateral aspect (Figs. 1 and 2 respectively for cases 1 and 2). Intestinal loops were seen protruding out of the anterior abdominal cavity on the right side. The small intestine exposed loop showed multiple tears and reddish and erythematous areas at places (Figs. 3 and 4, respectively for cases 1 and 2). Blackish soot particles were present all over the body, including exposed parts of the intestine's loops. On further dissection (case 1), multiple reddish contusions and tears of varying size were present over mesentery at places. The right lower limb was missing below the knee joint level while the left lower limb was transected at the level of about 15 cm below the knee joint. Underlying bones of lower limbs

were exposed, and evidence of burn injury was present. In case 2, the right hand and adjoining part of forearm was transected below the elbow joint. Underlying bones were exposed, with burn injury.

Internal examination in both the cases revealed soot particles inside the nasal and oral cavity extending till terminal bronchioles in both the lungs. Blackish soot particles were grossly visible in the respiratory tract and same was confirmed by observing soot particles on glass slide under light microscope. Multiple contusions were observed on the external surface of both the lungs. A soft, brittle, and chocolate color, extradural heat hematoma was present in the bilateral parietal, temporal, and occipital areas. Other internal organs were congested. No drugs were detected on the chemical analysis report of viscera.

Discussion

Pollution in India is greatly increasing, mostly caused by burning biomass fuel. Traditionally, woods and dung are used as a cooking fuel across the country. However, India has improved access to a cleaner source of cooking, such as liquefied petroleum gas (LPG) in recent years. The number of registered LPG consumers had increased from 106 million in 2008/09 to 263 million in the year 2017/2018. This has contributed to reducing mortalities due to pollution. Still, an LPG cylinder in the household also increases the chance of fatal injury due to the blast effect (Support for Clean Cooking in India 2020).

Liquid petroleum gas (LPG) is a group of flammable hydrocarbon gases which are liquefied through pressurization. It is a blend of butane and propane gas mainly. The LPG can be stored in a larger tank as well as in the gas cylinder. In India, the domestic supply of LPG is provided in 14.2 and 5.0 kg cylinder. LPG has a faint smell because of deliberately added mercaptan to help its



Fig. 1 Burnt and charred body with traumatic amputation of parts of lower limbs (case 1)



Fig. 2 Showing burnt and charred body in a pugilistic attitude (case 2)

detection. The vapor of LPG is heavier than air; thus, it normally settles down in lower space in the event of a leak. It also condenses the water vapor in it to form a whitish fog, which is easy to identify (Indane Gas 2020).

In India, a few cases of LPG cylinder blast have been reported in the lay press (Gupta 2019; Gururaja 2020; Madhya Pradesh 2020; Jaipur Cylinder Blast 2020). However, no such case of death due to the LPG cylinder blast is reported in the scientific literature. There was an explosion in the smaller cylinder (5 kg) followed by, the larger cylinder (14.2 kg) while the victims were refilling the 5 kg cylinder from the 14.2 cylinders. Both the victims died on the spot from the cylinder blast.

The injuries over the body of victims were in the form of burns, lacerations, and limbs' dismemberment. The injury patterns on both the victims were typical of

explosion injury. There was a combination of blast effect, burn injury over the bodies produced by cylinder blast. The deceased's were close to the cylinder, which proved fatal. After the explosion, several factors contribute to death, such as the blast wave, the impact of projectiles, burns from hot gases, and other secondary injuries (Saukko and Knight 2004).

The blast effect may cause severe damage to various body parts. The shock wave is mainly responsible for producing injury to air containing parts of the body. It may cause tear/laceration, contusions, hemorrhage in the lungs and the intestine. Flying missiles may cause a combination of abrasions, bruises, and lacerations (Reddy and Murty 2017). This typical phenomenon was not observed in the present series, mainly due to severe burns all over the body but evidence of laceration was



Fig. 3 Intestinal loops protruding out of the abdominal cavity (case 1)



Fig. 4 Intestinal loops protruding out of the abdominal cavity (case 2)

present over body at multiple sites. The force produced by the explosion is highly directional, and the body parts directly in contact with such force are damaged severely (Reddy and Murty 2017). Large penetrating lacerated wounds observed over the abdomen in both the victims can be related to this fact. These facts clearly explained the patterns of injuries seen in the present series concerning the blast effect.

Another possible mechanism contributing to death could be related asphyxiation caused by the smoke. This mechanism is supported by the fact that the soot particles were seen in the respiratory passages of the victims in present case.

Various cases of cylinder blast are reported in the literature. A balloon gas cylinder exploded due to excessive production of gas under pressure claiming lives of seller and two people present in surroundings. All the victims suffered fatal injuries over the body externally as well as internally (Chandulal 1974). One victim suffered fatal injuries to head, neck, and chest when cylinder exploded while filling up the oxyacetylene gas cylinder with an excess of calcium carbide (Rani et al. 2005). Accidental explosion of an oxygen cylinder claimed lives of three victims. They were dealing with the refilling of the oxygen cylinder when the cylinders exploded. The victims suffered blast injuries in the form of severe burns, dismemberment of body parts, multiple lacerations, contusions, and abrasions (Gupta and Jani 2009).

In a case reported by Kashiwagi M et al. (Kashiwagi et al. 2009), the victim committed suicide using an oxygen-acetylene cylinder. The victim was found burnt and skeletonized due to flame produced during the explosion. Gupta M et al. (Gupta et al. 2010) reported two cases of accidental coffee machine explosion who sustained injuries ranging from blunt injuries to severe burns including injuries caused by flying objects. A series of three case reported deaths due to blast in

compressor of split type air conditioner (AC) during repair process. A split air conditioner consists of two main parts—an inside air outlet unit and a compressor located outside which are connected to each other by set of pipes. Multiple lacerations, contusions, and abrasions were present over the body of victims. Associated internal injuries mainly involving the lungs and brain were also found in the dead bodies (Behera et al. 2017).

A woman attempted to murder her husband with Calor gas which is simply a brand name for LPG (and limited to the UK). Cylinder was hid in the bedroom; she closed the windows and door after turning on cylinder. Room was left closed for sufficient time so that the asphyxiating effect of gas could kill the husband (Baldock 1970). Two autopsy cases had been reported in the past where direct toxic effects of propane poisoning were suggested as the cause of death (Fukunaga et al. 1996). Victims also used butane and propane for recreational purpose, and death was suggested as combination of the direct toxicity of the compound and oxygen replacement (Sironi et al. 2016). Mass casualties had also been reported in past literature. A large butane and propane tank exploded in Mexico City claiming 550 lives and about 23,000 sustained minor injuries (Arturson 1987). A fire disaster following LPG tanker explosion occurred in Kannur (India) after colliding with a road divider. At least 20 victims died in various hospitals who were in the vicinity of explosion and many more were left injured (Kumar 2013).

In the present series, the investigation revealed that the victims were refilling the 5 kg cylinder from 14.2 kg cylinder, and at the same time, they were also preparing food in the kitchen. The moment gas started leaking from the connecting pipe, the 5 kg cylinder caught fire and blasted. This blast further led to an explosion of a 14.2 kg cylinder causing various injury patterns akin to blast effect to both the victims.

Conclusions

The investigation into the blast circumstances is of utmost importance to find out the manner and device involved. Malpractice involving use of cylinder to fill another one might be dangerous for the person involved and present in the vicinity. This practice should be discouraged by lay person.

Abbreviations

LPG: Liquefied petroleum gas; AC: Air conditioner

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Authors' contributions

Medicolegal autopsy was conducted by Dr. NS. This article was conceptualized and designed by Dr. NA, Dr. AKr, and Dr. AK. Relevant literature was searched by Dr. NA and NS. Dr. NA, and NS drafted the manuscript which was further edited and reviewed by Dr. AKr and Dr. AK. All authors read and approved the final manuscript.

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Competing interests

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Author details

¹Department of Forensic Medicine, University College of Medical Sciences & GTB Hospital, Delhi 110095, India. ²Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, Gorakhpur 273008, India.

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