Title page

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Self-inflicted explosive death by intra-oral detonation of a firecracker: a case report

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Self-inflicted explosive death by intra-oral detonation of a firecracker: a case report

Abstract: Self-inflicted explosive deaths due to detonation of fireworks are rare. In this case report, a peculiar case of an elderly male who discharged a firecracker inside his mouth resulting in fatal blast induced craniofacial injuries is described. There is paucity of published data describing fireworks-related suicidal and/or non-suicidal deaths. Even scantier data is present specifically describing fireworks-related blast induced neurotrauma and the mechanism(s) of injury involved in such cases. This case report emphasizes the severe damage that a commercially available explosive, the so-called "Gorilla Bomb", can cause and raises questions about the relative ease of its acquisition.

Key Words: blast injury, fireworks, intra-cranial injuries, intra-oral injuries, suicide

Introduction

According to Temple, the first report of fireworks was in ancient China during the Tang dynasty where fireworks were used for festivals, and were believed to ward off bad spirits, in so doing forming part of the Chinese culture [1]. An explosion is a sudden and violent increase in volume accompanied by noise and release of energy, as from a chemical change, nuclear reaction, or escape of gases or vapors under pressure [2]. The Explosives Act 15 of 2003 in South Africa (SA) classifies fireworks into two broad categories: display and consumer fireworks. Display fireworks are pyrotechnic substances manufactured for the sole purpose of amusement or entertainment and are not sold to the general public. Selling of such fireworks and discharging them in a public place is illegal. Consumer fireworks, on the other hand, are pyrotechnic substances available to the general public and are defined as any small firework device designed to produce visible effects by combustion and which its construction, chemical composition and labeling must comply with the regulations from the Explosives Act. Despite legislation pertaining to fireworks, including the detonation thereof in neighborhoods, penalties which may be applicable and the awareness campaigns, fireworks can freely be obtained by any member of the public for any reason.

Deaths due to explosives are not uncommon and can be seen in different manners of deaths: suicide, accidental, unascertained or homicide. Deaths due to explosives occur in four broadly described categories: in acts of terrorism, military-war, industrial-work and rarely involving civilians [3]. Though, injuries secondary to explosives are seen more commonly in the theater of conflict, deaths due to explosives in the civilian contexts are not common and are seen in industries like the chemical, demolition and mining industries and these are rarely due to fireworks. The civilian population is commonly affected by accidental explosions in mines, road construction, demolition sites, during the use of fireworks, or in related industries [4]. The exact prevalence of deaths due to explosives in the SA population is unknown. In our experience, in the last 6 years 2010-2016 in our facility, Pretoria Medico-Legal Laboratory (MLL), only 1 death has been recorded. In the same period, 11 551 cases were admitted to the facility, thus these deaths are a statistical rarity.

There is no published data in the SA medical and/or medico-legal literature reflecting deaths of civilians from use of fireworks, and to our knowledge there have been no published reports of self-inflicted explosive deaths due to fireworks in SA. Herein we describe a peculiar case of an elderly male who died as a result of detonating a firecracker inside his mouth resulting in fatal blast induced craniofacial injuries.

Case report

A 76 year old Caucasian man was admitted to our facility for a medico-legal postmortem examination after suffering severe blast induced craniofacial injuries due to detonation of a firework inside his mouth. The event took place in a corridor inside the Tshwane municipal court. According to witness reports, the decedent retrieved an object from his bag, placed it in his mouth and proceeded to ignite it. The aforementioned object exploded almost immediately according to witness accounts and blew up inside the decedent's mouth resulting in death at the scene.

There were no resuscitative measures instituted on the decedent. At the scene, the decedent was found lying prone with the left side of his mutilated face flat against the floor **[Fig.1]**. A BIC™ lighter was found gripped in his right hand **[Fig.2]**. Dispersing caudally, fragments of skull bone, soft tissue, dentures and spectacles were identified at the scene. A fragment of an explosive (firework) **[Fig.3]** was found about 30cm from the decedent's head and small paper and cardboard fragments scattered around the body. The aforementioned fragments were

Fig.1 Scene photograph showing the decedent's posture in which he was found

Fig.2 Photograph showing a BIC™ lighter gripped on the decedent's right hand

Fig.3 Fragment of the "Gorilla Bomb" firecracker

later identified as being from the so-called “Gorilla Bomb” firecracker (according to personal communication with the bomb squad experts).

The body was referred to our facility (Pretoria MLL) for a medico-legal postmortem examination in accordance with the provisions of the Inquests Act No. 58 of 1959. The postmortem examination was performed approximately 19hrs after death and refrigeration of the body for storage.

At autopsy, there were blast induced injuries involving the middle and lower thirds of the face with lacerations and contusions of the lips, gums, tongue, palate, nose and orbits, and comminuted fractures of the mandible and maxilla. The mandible was traumatically bisected along the sagittal plane and the temporo-mandibular joints were disrupted **[Fig.4]**. The oro-pharyngeal mucosa was stained with soot and grey-black granules **[Fig.5]**. The ears showed no injuries and the tympanic membranes were intact. Fragments of glass were present inside the oro-pharynx (from the damaged spectacles). There were no fragments of paper or plastic recovered inside the oro-pharynx. Fragments of tissue; predominantly lips, nose, bone and an eye were recovered separate to the body. The left eye was protruding from the left orbit and there were lacerations around the borders of the left orbit. The right orbit showed peri-orbital hemorrhage and a laceration involving the medial border. The trachea was clear.

The anterior cranial fossa showed a fracture with a central cavity involving the cribriform plate and sella turcica. The brain showed diffuse acute subarachnoid hemorrhage, pin-point hemorrhages of variable sizes (involving the white matter of the frontal lobes and genu of the corpus callosum) and focal cerebral cortical contusions of the frontal lobes **[Fig.6 and Fig.7]**. Other organs were inconspicuous and showed no gross pathological changes or injuries. A postmortem blood sample was taken for ethyl alcohol and carboxyhemoglobin analyses. Pharyngeal swabs were also taken for analysis for priming agents.

Upon completion of the examination, the primary cause (and/or mechanism) of death was concluded as being blast-induced craniofacial injuries due to a firework. Although the manner of death in SA is pronounced by the presiding judicial officer as per the Inquests Act 58 of 1959, the opinion of the pathologist was in keeping with suicide.

Review of the scene photos, autopsy and case history (which included interviews with police investigating officers and a member of the bomb squad) revealed relationship problems. A review of the victim’s place of residence also showed a newly opened pack of “Gorilla Bombs” missing only a single firecracker.

Unfortunately, no postmortem CT-scan imaging was conducted on this case prior to commencement of the autopsy. The Lodox™ Statscan showed severe tissue distortion of the face. Identification was done with fingerprints and personal possessions.

Discussion

Deaths due to explosives generally attract immediate attention due to their inert characteristics which include creating a loud noise and their destructive nature. When an explosion occurs in a public space like a government building as in the case presented, added attention is attracted as fears of terror activity have become part of the social consciousness.

In the case presented, the unusual nature of the death and the devise used to cause the death presented many interesting aspects to the investigation. An investigation of a scene of death due to explosives requires particular attention to detail as many clues to the device used to cause the explosive might lie in the smallest of fragments of burnt or unburnt trace evidence. Personal communication with the head of the South African Police Service (SAPS) bomb squad unit reveals that forensic pathologists and forensic medical officers in SA have limited practical experience in bombs and explosives. As Blanco-Pampin stated in his paper, it is advantageous for the forensic pathologist to attend the scene of death, in order to gain valuable guidance in the investigation and to obtain a scientific perspective that will be integrated with other specialised teams including the police bomb squad [3]. Also of importance, is the opportunity for the pathologist to integrate the scene findings with the autopsy examination. In the case presented, the initial impression corroborated with the accounts from the witnesses, subsequent autopsy findings and findings at the home of the decedent.

Generally, the types of injuries described in suicidal deaths due to explosives include body disruption, explosive

Fig.4 Blast induced injuries with severe disruption of the face

Fig.5 In situ view of the oro-pharynx showing soot and grey-black granules

Fig.6 Base of skull showing a blow-out fracture involving chiefly the cribriform plate and sella turcica

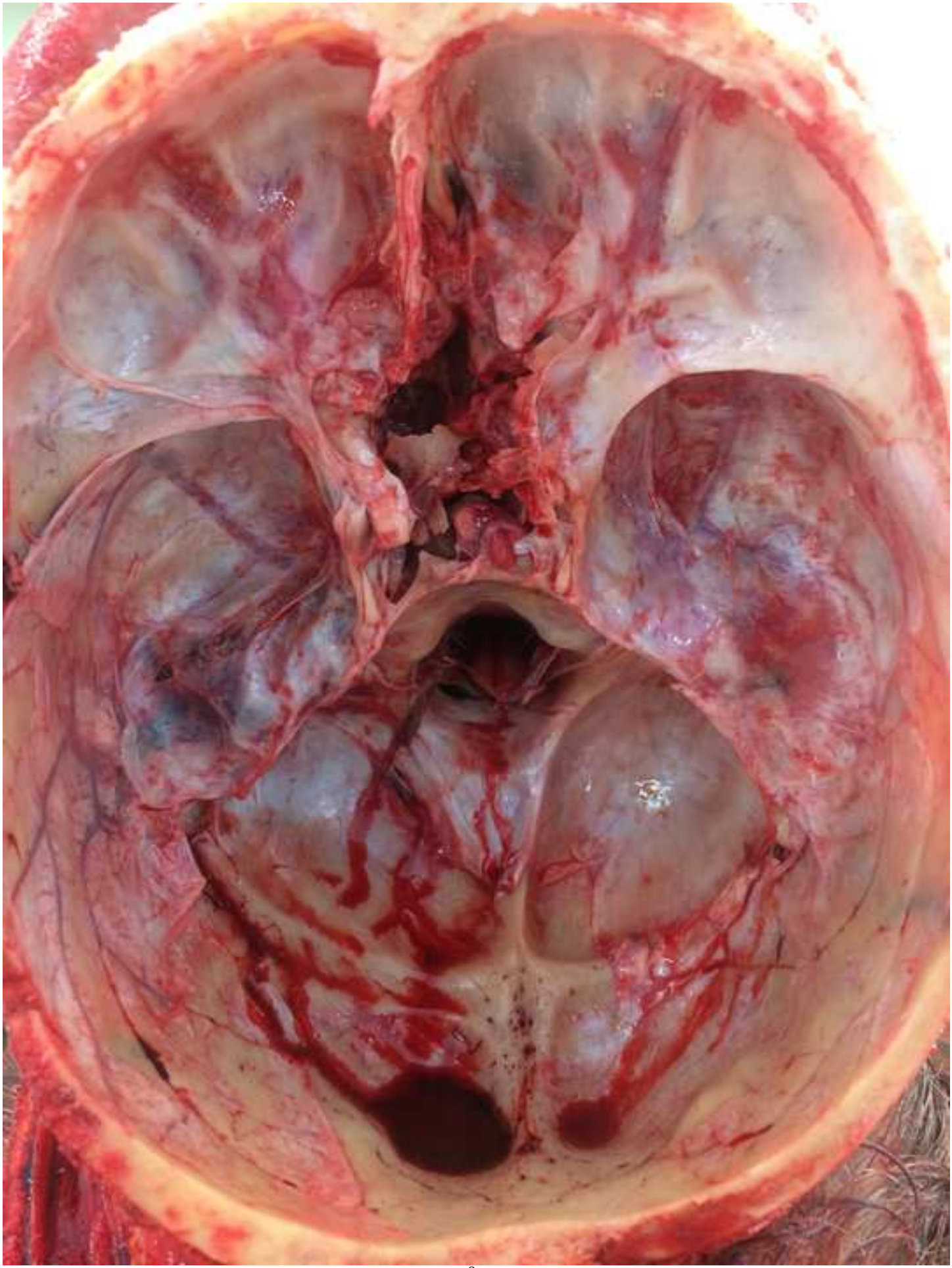

Fig.7 Cut surfaces of the brain showing pin-point hemorrhages of variable sizes (involving the white matter of the frontal lobes and and genu of the corpus callosum), and focal cerebral cortical contusions

injuries, flying missile injuries and blast injuries, and are directly proportional to the type of explosive used, with explosive devices generating bigger explosions resulting in more tissue damage [5, 6]. In the case presented, a "Gorilla Bomb" was used as an explosive device. There is no reported data on the pattern of fatal facial and head injuries caused by this type of firecracker. Gorilla bombs YT002 are commercially sold in a pack containing 6 pieces, each containing 8 - 9.5 grams of flash powder, and have the so-called *viso fuse*. Flash powder decomposes by deflagration at approximately 2000m/s depending on the mixture. Gunpowder, like flash powder, is a low order explosive which deflagrates rather than detonate at a velocity of 0.4 - 1.0km/s compared to a high order explosive like TNT (Trinitrotoluene) with detonation velocities of 6.9km/s (6900m/s) [5].

Traditionally traumatic brain injuries are classified into closed head injuries and penetrating head injuries. However, blast-induced traumatic brain injury (bTBI) is an entity typically used to describe traumatic brain injuries following blasts – especially in the military setting [6, 7].Blast-induced TBI involves disruption of brain function following exposure to an explosion, and the victim may have an intact calvarium. The pathophysiology and forces responsible for bTBI are not well understood and evidence shows that they are multi-factorial at the least involving an interplay of complex mechanisms of systemic, local, and cerebral responses to blast exposure due to overpressure, electromagnetic energy, acoustics and other still to be described etiologies [8]. The question of nomenclature can be perplexing as in literature the same phenomena of bTBI is also called blast induced neurotrauma (BINT). In the case presented, the two are used interchangeably. The injuries noted on the decedent are consistent with primary blast induced injuries to the head, with both the positive and negative pressure wave phases of the shockwave form, as depicted in the Friedländer waveform, being implicated [8, 9].

Zwirner at al conducted an experiment on the potential injuries sustained due to firecrackers and concluded that flash-powder based firecrackers (as used in our case) may indeed result in severe craniofacial injuries and destruction as opposed to black-powder based firecrackers [10]. Our case report support the findings of severe craniofacial injuries sustained as a result of the detonation of a flash-powder based firecracker. We propose that the resulting brain injuries should be classified as bTBI as their pathophysiology and/or mechanism(s) in causing damage will follow similar factors as described in other blasts-induced injuries such as those due to Improvised Explosive Devices (IDE's) and conventional explosives.

Conclusion

We describe an unusual method of suicide by means of intra-oral detonation of a firecracker. These cases occur rarely, but in the event that the pathologist do not attend the scene of death, it is important to recognize these injuries at autopsy. Fortunately, identification was still possible in this case, and no other innocent bystanders were injured. The worrisome aspect is that this occurred in a public place which should be closely monitored pertaining to entry and exit of potentially hazardous/dangerous articles. Although the selling of these firecrackers is meant to be regulated, it would be nearly impossible to arrest the person who sold the firecracker to the deceased. Stricter access control to public places should be enforced in order to protect innocent bystanders – not only from physical but also from emotional damage.

Key points

1. Self-inflicted explosive deaths due to intra-oral detonation of firecrackers are rare.
2. Flash-powder based firecrackers can result in severe craniofacial injuries.
3. Stricter legislation pertaining to the procurement of firecrackers should be in place.
4. The brain injuries seen in these cases should be classified as blast induced neurotrauma.
5. A coordinated approach between the different agencies: police investigative unit, bomb squad, police forensic science unit and the forensic pathology service enhanced the investigation and helped the pathologist integrate the autopsy findings

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Conflict of interests

The authors declare that there is no conflict of interest.

Ethical approval

This article does not contain any studies with human participants or animals.

Informed consent

The article does not include participants that require informed consent.

References

1. Temple RK. The Genius of China: 3,000 Years of Science, Discovery, and Invention. 3rd ed. Temple RK, editor. Andre Deutsch; 2007. pp. 256–265.
2. Stedman TL. Stedman's medical dictionary for the health professions and nursing. 26th Ed.Spraycar M, Randolph E, editors. Baltimore, MD: Lippincott Williams & Wilkins; 1995. pp. 2029.
3. Blanco--Pampin JM. Suicidal Deaths Using Fireworks. J Forensic Sci. 2001;46(2):402–5.
4. Farooqui JM, Farooqui AAJ, Mukherjee BB, Manjhi SN. Non-terrorist suicidal death by oral explosion: A rare case from India. Med Sci Law. 2016;56(3):233–6.
5. Kunz SN, Zinka B, Peschel O, Fieseler S. Accidental head explosion: An unusual blast wave injury as a result of self-made fireworks. Forensic Sci Int. 2011;210(1–3):e4–6.
6. Elsayed NM, Atkins JL. Explosion and Blast-Related Injuries: Effects of Explosion and Blast from Military Operations and Acts of Terrorism. Academic Press; 2010. pp. 400.
7. Zhao Y, Wang Z-G. Blast-induced traumatic brain injury: a new trend of blast injury research. Chinese J Traumatol [Internet]. Elsevier Ltd; 2015;18(4):201–3
8. Cernak I, Merkle AC, Koliatsos VE, Bilik JM, Luong QT, Mahota TM, et al. The pathobiology of blast injuries and blast-induced neurotrauma as identified using a new experimental model of injury in mice. Neurobiol Dis. 2011;41(2):538–51.
9. Wolf SJ, Bebarta VS, Bonnett CJ et al. Blast injuries. Lancet. 2009;374(9687):405–15.
10. Zwirner J, Bayer R, Japes A et al. Suicide by the intraoral blast of firecrackers — experimental simulation using a skull simulant model. Int J Legal Med. 2017; Published ahead of print. 30 March 2017 doi:10.1007/s00414-017-1580-z