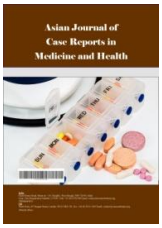

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Orbital Emphysema: Is it Due to Primary Blast Injury or Nose Blowing? A Case Report

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Case Study

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ABSTRACT

The authors wish to discuss the possibilities and pathophysiology of orbital emphysema of a live victim of high-explosive blast attack. A 35-year-old male suffered a terrorist blast resulting in shrapnel injuries, flash-burns and bilateral ear drum perforation. Throughout in a conscious and rational state, he was taken to the nearest tertiary-care hospital. Two shrapnels were surgically removed and all external injuries cleaned and dressed. Swollen left eye was examined by the ophthalmologist to reveal unilateral subcutaneous emphysaema and diplopia but no orbital wall fracture was detected. Specialized ENT referral revealed bilateral central eardrum perforation with impaired hearing. Treating clinicians have already attributed all injuries to the effects of the blast, by the time the Forensic Specialists examined the patient for medico-legal purposes. The forensic specialists were reluctant to attribute orbital emphysema to the effects of the initial blast. Detailed history from the examinee revealed an incident of forceful and violent nose-blowing immediately after the blast to relieve the abnormal sensation he felt within his ears. We discuss here the pathophysiology of orbital emphysema and possible mechanisms of its causation. In conclusion, we emphasize the need for careful interpretation of injuries specially in complex situations such as bomb blasts to prevent attribution of erroneous aetiological factors.

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Keywords: Primary blast injury; blow-out fracture; periorbital emphysaema; ear drum perforation; nose blowing.

1. INTRODUCTION

All medico-legal issues are secondary to life-saving emergency interventions. As such, patients are generally referred to forensic clinicians (Judicial Medical Officers as they are called in countries like Sri Lanka and India) once the emergency management is over. Interpretation of injuries is a heavy responsibility vested upon forensic practitioners. This includes (though not limited to) categorization of hurt, identification of the type of injury, dating and timing of injury, deducing the mechanisms of causation, features of the possible weapon, compatibility with the given scenario, complications, disabilities, collection of trace material, reconstruction of the event and so on. In the case under discussion almost all other medico-legal issues were straight forward except for the periorbital subcutaneous emphysaema with diplopia as he was an innocent victim of mass casualty following a high-explosive suicidal terrorist bomb attack. According to the existing literature, isolated unilateral periorbital emphysaema is not known as a consequence of primary blast injury and a suspicion as to the attribution of the condition to the blast incident by the clinicians was raised by the forensic specialists.

A blast or an explosion poses a wide array of deleterious effects on the living [1]. The origins of an explosion could be mechanical, chemical, sonic or nuclear. The commonest encountered by doctors is chemical explosions. Due to a self-propagating exothermic reaction, chemical explosions instantaneously produce highly pressurized gasses (which are often noxious to life), flame, heat, noise and small amount of stable products [2].

Explosives could broadly be divided in to two groups: low order explosives such as conventional black gun powder and high order explosives such as nitroglycerin, RDX, PETN, dynamite, C4 and TNT. Detonation of high order explosives produce rapidly expanding gasses in a form of a shock wave or a supersonic blast wave within few milliseconds. Characteristically it is followed by a negative pressure wave or a suction wave that lasts relatively longer than the positive pressure front and these are responsible for the characteristic primary blast effects. In contrast to high order explosives, in low order explosives it is not a detonation but a much slower deflagration that occurs as a result of the chemical reaction and as such the amount of energy released and the devastating effects are much less. The low order explosives are therefore virtually incapable of producing a blast wave and a subsequent suction wave. High order explosives have a diffused seat of explosion while low order explosives generally have a dispersed seat of explosion. When an equal weight is concerned, magnitude of damage is much higher in high order explosives though this may also depend on multiple other factors such as the proximity to the centre of explosion, intervening objects, whether the blast has taken place in an enclosed compartment or in an open area etc [3]. Terrorist bombs usually contain high order explosives. Composition 4 was found in the present case under discussion. By convention, injuries due to a blast are classified into four groups namely [4,5,6].

1. **Primary blast injuries:** These injuries are unique to high order explosives. They are typically due to shock/blast wave. Gas containing structures or organs with air-fluid interface are particularly at risk such as the lungs, tympanic membranes and gastrointestinal tract. Rarely globe rupture of the eye and cerebral concussion without any obvious head injuries too have been reported.
2. **Secondary injuries:** Any of the body parts can be affected and it is due to flying shrapnels, broken glasses and fragments of a bomb. Both penetrating and blunt force injures are encountered. Such injuries could occur in both types of explosives.
3. **Tertiary injuries:** Any of the body parts can be affected and it is the result of 'blast wind' which is different from the shock wave. Individuals are thrown away ('windaged') from the blast seat/centre resulting in head injuries, traumatic amputations and fractures. Crush injuries and traumatic asphyxia from collapsing buildings/masonry too could result.
4. **Quaternary injuries:** These include the indirect effects of an explosion other than the primary, secondary and tertiary injuries. Aggravation of asthma due to dust and smoke, hypertension, angina etc. are included here.

The injury pattern of the victim under discussion is compatible with primary blast injuries in the form of bilateral ear drum rupture and flash burns with torn attire as well as secondary blast injuries in the form of shrapnel injuries on both lower limbs. The isolated left sided periorbital emphysaema does not match with any of the above categories as he did not suffer any head or facial injuries or blast lung type of injures or any trauma to his upper torso.

2. PRESENTATION OF THE CASE

A 35-year-old father of two children, the sole breadwinner of the family, working as a salesman from a remote village from upcountry has visited Colombo, for business purposes. He happened to be at close proximity to a suicidal bomber who had blown-up himself in a spacious building which was fairly crowded. The victim had heard a loud noise and seen and felt a large warm ball of fire. He immediately understood that a powerful bomb had exploded and witnessed many individuals dead and wounded amidst massive destruction. He then noticed an abnormal sensation within his both ears and that his hearing was grossly impaired. His clothing was torn and he was bleeding from his lower limbs. He was immediately taken to a tertiary care hospital with in a matter of few minutes. On admission he was fully conscious with no history of loss of consciousness, headache, vomiting or nasal bleeding. During the emergency management, two foreign bodies were removed from his lower limbs. Multiple scorched abrasions with singed hair were seen on certain areas of his lower limbs indicating the direction of the shrapnels [Fig. 1].

Fig. 1. Singeing of hair, multiple abrasions with deep injuries were noted

On examination his body temperature was normal. Periorbital cellulitis was not present. Other biological parameters such as pulse, blood pressure, hydration, respiratory rate etc. were unremarkable. He was referred to the specialist otorhynolaryngologist (ENT surgeon), ophthalmologist and orofaciomaxillological (OFM) surgeon. According to the ophthalmologist there had been a significant left-sided periorbital emphysaema with crepitus and significant diplopia. The sclera, cornea, lens, vitreous humour, retina and the optic disc were normal and the intra ocular pressure was also unremarkable. Hess chart showed left lateral gaze with mild restriction of movement. Multiple radiographs of the skull and two orbital CT scans could not identify any orbital fracture [Fig. 2]. Yet, clinically, a fracture was unable to be exclude because of the presence of unilateral periorbital emphysaema. Chronic sinus disease, chronic infection of the ear, nose and the throat, other co-morbidities such as previous ENT or dental procedures, head, neck or facial trauma or surgeries affecting those areas were excluded by the history. The OFM surgeon excluded facial fracture. The ENT surgeon diagnosed bilateral, large, central tympanic membrane ruptures with no active bleeding or infection along with bilateral conductive-type hearing loss which was 20db on the right and 50db on the left. Subcutaneous thoracic emphysaema, pneumo-mediastinum or pneumothorax were clinically and radiographically excluded. He had not shown dysphagia or episodes of vomiting leading to Boerhaave syndrome or chronic gastritis or regurgitative symptoms.

The patient was referred to the medico-legal specialists only prior to be discharged. Unlike clinicians whose primary concern is treating the patient, forensic specialists are more concerned about the aetio-pathology and interpretation of injuries. A detailed history had been obtained as it was quite unusual or even unheard of, to have subcutaneous periorbital emphysaema as an isolated injury secondary to a high order blast. Since there was no directly identifiable cause either medically or surgically or with direct trauma, attributable to emphysaema, the authors considered other possibilities such as forceful sneezing, coughing or nose blowing. After direct questioning, he remembered that he had blown his nose immediately after the blast vigorously and violently for a number of times, because of the tinnitus and dull 'filled up' sensation he had experienced in his both ears hoping at least for a little relief. His verbatim was "once I blew the nose I experienced a popping sound and had felt abnormal around the left eye with difficulty in opening", and importantly this had occurred within few minutes after the blast injury. After 5 days of treatment he was discharged and reviewed with no visual complications.

Fig. 2. The CT orbit was unable to elicit any obvious fracture of his left eye

Fig. 3. The left sided periorbital haematoma

3. DISCUSSION

Subcutaneous emphysaema is a condition where air or other gases introduced into the soft tissues result in distension of the overlying skin or mucosa [7]. The orbital emphysaema is of two types as extra-conal (periorbital) or intra-conal (intraorbital). The extra-conal type may be clinically associated with periorbital emphysaema, subconjunctival ecchymosis, pain, tenderness and proptosis. The clinical findings of intra-conal type may include diplopia, ophthalmoplaegia and even blindness. The diagnosis of periorbital emphysaema is straight forward and history alone will be of great importance. Yet, to find out the underlying cause for periorbital emphysaema further investigations such as orbital CT may be of great value [8].

An extensive literature review shows that isolated unilateral periorbital emphysaema is not a primary injury encountered in blasts/explosions. Anyhow, one review article about true primary blast injuries states that it is only the debris and the shrapnels that are more responsible for causing damage to eyes though it is unable to unequivocally rule out primary eye injuries due to primary blast [9,10]. The development of orbital emphysaema is almost always attributable to injury as development of the same without trauma is extremely rare [11]. In this case under discussion, direct trauma could easily be excluded. The remaining identified causes are oropharyngeal operations, infections of the eye especially orbital abscesses by gas forming micro-organisms, injury with compressed air, air travelling, nose blowing and forceful sneezing [12]. The CT scan of the orbit did not show intraconal air, fractures of the orbital walls or paranasal sinueses. All such other possibilities could confidently be exluded in this case.

There is first hand clear information that the patient had attempted forceful nose blowing prior to the formation of emphysaema. The underlying mechanism for the development of orbital emphysaema is that when the pressure at nasopharyngeal region is instantaneously increased with violent nose blowing, sneezing, coughing or vomiting, such force causes dehiscenc of the the paper-thin lamina papyracea leading to orbital emphysaema. Such fratures are often classified under the catergory of blow out fratures. Blow out fractures of orbital wall are of two types. One is the fracture of the orbital floor and the other is that of the medial orbital wall as described above by fracturing the thinnest part of the orbit-the so called lamina papyracea. When the bony margins surrounding the eye remain intact, such fractures are then termed ‘pure [7,13]. As described above, the victim who survived the blast had forcefully blown his nose to get a relief from the abnormal

sensation in his ears and he gave a clear history that with the blowing he had heard a popping sound along with the inflation, heaviness and pain in the left eye. No nasal bleeding was noted. He also started to experience 'double vision' from this point onwards. All these had happened clearly but shortly after the blast.

The mind-sets of forensic specialists are trained to answer the medico-legal issues revolving around a given case. They employ a high degree of suspicion while analyzing facts and observations before them. The attribution (by the clinicians) of orbital emphysaema of this patient to the primary blast effects was not in agreement with the known aetio-pathology of blast injuries which led the forensic clinicians to deeply look in to the background of its causation. The true cause was then discovered as the medial wall pure blow-out fracture due to violent nose blowing subsequent to the blast event. Its non-demonstrability on the CT scan could be due to the very nature of the fracture as well as the non-refined nature of the routine CT scan taken at the emergency situation primarily to exclude major demonstrable cranial trauma.

4. CONCLUSION

It is the prime duty of the forensic experts to address the medico-legal issues of the case before them. One such issue is the interpretation of injuries. Admission of a patient with shrapnel injuries, flash burns, bilateral ear drum perforation and left sided periorbital emphysaema following a high explosive suicidal bomb attack made avenue to revisit the mechanisms of causation of injuries. All the injuries except the periorbital emphysaema were able to be explained within the patho-physiology of primary and secondary blast injuries. Since he was free of cranio-facial injuries, it was initially suspected that his periorbital emphysaema could have been due to an isolated orbital wall fracture due to the blast wave though it had never been reported in the literature, though isolated ocular injuries (injuries to the globe) are rarely reported. The extensive probing in to the history revealed that the condition appeared several minutes after the blast event following several attempts of violent nose blowing. This emphasizes the importance of objective investigation into mechanisms of individual injuries specially when they are not in keeping with the patterns recognized in the literature or unfamiliar or unusual with in the practice and experience of the forensic specialist.

CONSENT

Witten informed consent had been obtained from the patient.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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