J Arch Mil Med. 2016 November; 4(4):e44324. doi: 10.5812/jamm.44324.

Published online 2016 November 30. **Case Report**

# Grenade Explosion Leading to Penetrative Brain Trauma and Demise of Three Children during High Altitude Counter Insurgency Operations

Inam Danish Khan[1,*]

[1]Assistant Professor (Clinical Microbiology and Infectious Diseases), Army College of Medical Sciences and Base Hospital, Delhi Cantt 110010, India

[*] *Corresponding author*: Inam Danish Khan, Assistant Professor (Clinical Microbiology and Infectious Diseases), Army College of Medical Sciences and Base Hospital, Delhi Cantt 110010, India. Tel: +91-9836569777, Fax: +91-1125693490, E-mail: titan_afmc@yahoo.com

**Received** 2016 November 27; **Accepted** 2016 November 27.

**Abstract**

Unexploded ordnance from old wars and conflicts pose a serious threat in war and conflict zones. An incident of abandoned grenade explosion during high altitude counter insurgency operations led to penetrative brain trauma and demise of three children. A high index of suspicion is warranted with aged/expired/unexploded ordnance, which may have unstable explosive ingredients; and hence, could pose a threat to the military.

*Keywords:* Blast Injury, Grenade, Explosion, Unexploded Ordnance, High Altitude, Counter Insurgency, Civil-Military Medicine

## 1. Background

Regions dominated through land forces, militia and artillery shelling during full-fledged war, low intensity conflict, terrorism and insurgency may have hidden unexploded ordnance, which could wreck havoc during routine civilian and military activities. Abandoned grenades, artillery shells and bombs can become unstable due to deterioration of detonator and charge and can explode on minimal manipulation. Unexploded ordnance may be encountered during farming and construction by civilians and during camping, cordon and search operations by the military. An incident of abandoned grenade explosion during high altitude counter insurgency operations led to penetrative brain trauma and demise of three children.

## 2. Cases Presentation

The cases were 3 five- year- old boys playing in twilight hours in the farmlands around their village, located at high altitude. They accidentally found and manipulated an unexploded grenade, which exploded in point-blank range. The explosion was fatal to two children spreading their mortal remains over a large area. The third child possibly playing at a distance, suffered from penetrative brain trauma. The child was lifted in arms and rushed immediately by local inhabitants on foot to the military medical aid post. The child was conscious and responding to commands. He had tachycardia, tachypnea and cold limbs. There was a comminuted triangular fracture of frontal bone over his forehead, measuring 1.5 by 1 by 1 cm with protrusion of brain parencyma out of the fracture. The child suffered an episode of partial seizures, lasting for 2-3 minutes on arrival. There were no other apparent injuries. Quick cardiorespiratory and abdominal examination revealed no abnormality. The child was administered tetanus prophylaxis, analgesics, antiepileptics and empirical antimicrobials before being evacuated in an ambulance. Unfortunately, the child could not survive the five-hour journey to the secondary healthcare facility.

### 2.1. Ethical Approval

Patients' consent and ethical approval were covered by the institutional committee.

## 3. Discussion

Children may get attracted to toy-like appearance of unexploded ordnances such as hand grenade in conflict zones, and consequently suffer from severe blast injuries due to their relative small size. The child brought to the medical aid post with protruding brain parenchyma sustained secondary blast injury leading to penetrating brain injury possibly through projectile splinters causing fracture of frontal bone. Although not apparent, the possibility of primary, tertiary and quaternary blast injuries could not be excluded in the limited resource set up of the remote medical aid post. Space occupying nature of the impregnated shrapnel causing raised intracranial pressure would have led to protrusion of brain parenchyma, seizures and subsequent demise.

The concept of golden hour and platinum half hour are important determinants in the outcome of explosive injuries. The approximate time of arrival of the child to the medical aid post would have been at least 30 - 40 minutes after the explosion. There were limitations of injury screening and provision of definitive care at the medical aid post. Furthermore, ambulance evacuation in mountain terrains is slow due to tortuous and narrow roads with limited visibility at night (1-3). Early air-evacuation, assessment through advanced whole body imaging, surgical intervention and identification of specific molecular biomarkers could have resulted in a better outcome; however, it could have been possible only with immediate availability of rotor-wing aircraft with night flying capabilities.

Hand grenades have a grooved cast iron pineapple, containing plasticized pentaerythritol tetranitrate or trinitrotoluene controlled by pyrotechnic delay of 1 - 5 seconds. The throwing distance, shrapnel travel and lethal range is 40, 200 and 15 meters, respectively (4). Grenade explosion generates a supersonic over-pressurizing blast-wave of compressed and high-velocity expanding gases, producing a hurricane-force wind at approximately 200 km/h, which carry highly damaging shrapnels (4, 5). Blast-waves are most damaging in immediate proximity of direct wave or places of constructive interference through entire objects, humans and shrapnels being set in projectile motion. Blast waves generated by high-order explosives such as trinitrotoluene, C-4, semtex, nitroglycerin, dynamite and ammonium nitrate fuel oil are followed by negative pressure blast winds.

Explosions are implicated in four major forms of injuries viz. blast, blunt, penetrating and thermal injuries, which may be sustained simultaneously. Blast injuries are five-pronged. Primary blast injury caused by blast-wave or blast over-pressure, results in internal injury to hollow organs such as lungs, viscera, vessels, ears; as well as concussion of the brain. Blast lung/pulmonary barotrauma is the most common fatal injury amongst initial survivors. Secondary blast injury caused by blast-wind (forced superheated airflow) occurs from bomb-fragments and projectiles striking humans resulting in both blunt and penetrative trauma. Tertiary blast injury occurs when humans flying as projectiles strike other objects or any structural collapse resulting in fracture and/or traumatic amputations. Quaternary injuries occur due to exposure to heat, dust, toxic fumes and/or radioactivity causing burns from fires and explosions per se, or exacerbating asthma, chronic obstructive pulmonary disease, angina, hyperglycemia and/or hypertension. The patient's hyperinflammatory response unrelated to injury severity and complexity forms the fifth prong (6).

Blast-related traumatic brain injuries have been common in war theatres such as Iraq and Afghanistan (2). Brain injuries comprise 50% of non-survivable injuries (7). Penetrative cranial injuries may either lead to mortality on 92% patients or cause severe impairment in survivors. Apart from various possibilities of penetrating trauma, post-concussive syndrome, post-traumatic stress disorder (PTSD) and chronic headache are seen as a triad. Syndromic presentation includes headache, poor concentration, depression, anxiety, insomnia, lethargy, fatigue or other constitutional features. There may be considerable overlap between post-concussive syndrome and post-traumatic stress disorder (PTSD). Blast-related concussion has been known to increase PTSD. Persistent impairment may be due to chronic traumatic encephalopathy or psychological factors (2). Complications such as cerebral vasospasm and hypoperfusion, acute respiratory distress syndrome, disseminated intravascular coagulation, neurogenic pulmonary edema and posttraumatic seizures may be encountered (8).

Large unexploded bombs from World Wars have led to mass evacuations before disarming them. Geotechnical/geophysical magnetometer probes are used to detect unexploded ordnance in heavily contaminated areas. Explosion injuries and fatalities due to manipulation of aged/expired/unexploded ammunition have been reported amongst civilians as well as military forces (4, 9). The severity of blast-related traumatic brain injury is dependent on the magnitude of blast energy, distance from blast epicenter and open/confined space explosions (2). A force of the blast is directly related to the size and type of explosion compound and is inversely related to the square of distance from detonation (3). Open-air explosions have less immediate mortality compared to confined-space explosions subject to situational complexity (2, 5).

Grenade handling expertise is quintessential, while using them as offensive or defensive force-multipliers in low intensity conflict, counter-terrorism, counter-insurgency, cordon and search, urban warfare and riot-control operations. Precautions are required for cooking-off, re-pinning and handling dud grenades even in mission-critical situations.

The case emphasizes upon civil-military medicine perspectives in conflict zones, where military and community awareness about unexploded ordnance, in addition to enhanced health support systems, are required to safeguard soldiers and inhabitants who are vulnerable to war and insurgency related risks (10, 11).

### 3.1. Conclusion

A high index of suspicion is warranted with aged/expired/unexploded ordnance, which may have unstable explosive ingredients; and hence, could pose a

threat to the military and civilian population in conflict zones. Knowledge of post-war hazards, risk assessment based on health resources and due diligence can help prevent loss of lives.

## Footnotes

**Authors' Contribution:** The author served as the medical officer at 2700 m/ 9000 ft and attended to the patients in low resource healthcare set up, located on the Indian Himalayas.

**Conflicts of Interest:** No conflicts of interest

**Funding/Support:** None.

## References

1. Khan ID, Basu A, Trivedi S, Prasad M, Rappai TJ, Narayanan RV, et al. Battlefield, Bullets and Bugs: The vicious Circle in Gunshots. *J Basic Clin Med.* 2016;**5**(1):11–2.
2. Rosenfeld JV, McFarlane AC, Bragge P, Armonda RA, Grimes JB, Ling GS. Blast-related traumatic brain injury. *Lancet Neurol.* 2013;**12**(9):882–93. doi: 10.1016/S1474-4422(13)70161-3. [PubMed: 23884075].
3. Mac Donald CL, Johnson AM, Cooper D, Nelson EC, Werner NJ, Shimony JS, et al. Detection of blast-related traumatic brain injury in U.S. military personnel. *N Engl J Med.* 2011;**364**(22):2091–100. doi: 10.1056/NEJMoa1008069. [PubMed: 21631321].
4. Pavlidis P, Karakasi V, Birbilis TA. Fatal accident due to anti-personnel ARGES EM01 rifle grenade explosion. *Chin J Traumatol.* 2016;**19**(3):136–8. [PubMed: 27321291].
5. Kamauzaman TH, Ahmad R, Latif KA, Hamzah MS, Kheng CP. Hand grenade blast injuries: an experience in hospital universiti sains malaysia. *Malays J Med Sci.* 2007;**14**(2):58–61. [PubMed: 22993493].
6. Mishra A, Baranwal V, Parihar J. An interesting case of grenade blast splinter injury-in peace. *Med J Armed Forces India.* 2012;**68**(2):187–9. doi: 10.1016/S0377-1237(12)60031-8. [PubMed: 24669066].
7. Keene DD, Penn-Barwell JG, Wood PR, Hunt N, Delaney R, Clasper J, et al. Died of wounds: a mortality review. *J R Army Med Corps.* 2016;**162**(5):355–60. doi: 10.1136/jramc-2015-000490. [PubMed: 26468431].
8. Blissitt PA. Care of the critically ill patient with penetrating head injury. *Crit Care Nurs Clin North Am.* 2006;**18**(3):321–32. doi: 10.1016/j.ccell.2006.05.006. [PubMed: 16962454].
9. Coupland RM. Hand grenade injuries among civilians. *JAMA.* 1993;**270**(5):624–6. [PubMed: 8331764].
10. Clunan AL. Civil-Military Medicine: On Dangerous Ground. DTIC Document; 2006.
11. Khan ID, Sahni AK. Possession syndrome at high altitude ( 4575 m/15000 ft ). *Kathmandu Univ Med J (KUMJ).* 2013;**11**(43):253–5. [PubMed: 24442177].