JOURNAL OF
CONTEMPORARY MEDICINE

DOI:10.16899/jcm.1604661
J Contemp Med 2025;15(1):26-29

Original Article / Orijinal Araştırma

Do Accompanying Traumas Affect Mortality in cases of Blast-Induced Head Trauma?

Blast Etkiyle Oluşan Kafa Travmalarında Eşlik Eden Travmalar Mortaliteyi Etkiler Mi?

Mustafa Emrah Kaya[1], Mehmet Emin Çelikkaya[2]

[1]Department of Neurosurgery, Tayfur Ata Sökmen Faculty of Medicine, Hatay Mustafa Kemal University, Hatay, Turkey
[2]Department of Pediatric Surgery, Tayfur Ata Sökmen Faculty of Medicine, Hatay Mustafa Kemal University, Hatay, Turkey

Abstract

Aim: In today's wars, there are more civilian victims of war than soldiers. Most war-related deaths occur in civilians and children are the most affected. Although military injuries in the battlefield are usually penetrating, blast-induced blunt trauma is common in civilian injuries. In this study, the frequency of thoracic and abdominal trauma in children with blast-induced head trauma was analysed.

Material and Method: Twenty-five paediatric patients with blast head trauma in war were retrospectively reviewed.

Results: Sixteen of the patients were male and 9 were female. The mean age was 9.4±5 years. All patients had head trauma. In terms of type of trauma, 84% had multiple trauma (head, chest, abdomen) and 16% had only head trauma. Head trauma was accompanied by lung contusion in 60% and free abdominal fluid in 32%. Eleven patients (44%) died

Conclusion: Bomb blast injuries affect the whole body and have a high mortality rate. Developing children are the focus of war and terrorism, which increases mortality rates. In such injuries, the whole body should be carefully examined for damage, not only the parts with external cuts.

Keywords: Blast trauma, head trauma, gunshot wounds

Öz

Amaç: Günümüz savaşlarında askerlerden çok sivil savaş mağdurları görülmektedir. Savaşla ilgili ölümlerin çoğu sivillerde meydana gelir ve en çok etkilenenler çocuklardır. Savaş alanındaki askeri yaralanmalar genellikle delici olsa da, patlama etkisi olan künt travmalar sivil yaralanmalarda yaygındır. Bu çalışmada, savaşta blast etkisiyle kafa travması geçiren çocuklarda torasik ve abdominal travma sıklığı incelenmiştir

Gereç ve Yöntem: Savaşta patlama kafa travması geçiren 25 pediatrik hasta retrospektif olarak incelenmiştir.

Bulgular: Hastaların 16'sı erkek , 9'u kadındır. Ortalama yaş 9,4±5 idi. Tüm hastalarda kafa travması vardı. Travma türü açısından, %84'ünde çoklu travma (kafa, göğüs, karın) ve %16'sında sadece kafa travması vardı. Kafa travmasına %60 ile akciğer kontüzyonu ardından %32 ile serbest abdominal sıvı eşlik etmekteydi. On bir hasta (%44) kaybedildi

Sonuç: Bomba etkisine bağlı patlama yaralanmaları, tüm vücudu etkiler ve yüksek ölüm oranına sahiptir. Gelişme çağında çocuklar, savaş ve terörizmin odak noktasıdır ve bu da ölüm oranlarını artırır. Bu tür yaralanmalarda, yalnızca dış kesiklerin olduğu kısımlar değil tüm vücut hasar açısından dikkatlice incelenmelidir..

Anahtar Kelimeler: Blast travma, kafa travması, ateşli silah yaralanmaları

Corresponding *(İletişim)*: Mehmet Çelikkaya, Department of Pediatric Surgery, Tayfur Ata Sökmen Faculty of Medicine, Hatay Mustafa Kemal University, Hatay, Turkey
E-mail *(E-posta)*: eminctf@hotmail.com
Received *(Geliş Tarihi)*: 21.12.2024 **Accepted *(Kabul Tarihi)*:** 17.01.2025

INTRODUCTION

The vast majority of modern wars now take place in areas close to civilian settlements.[1] In these wars, blast injuries, particularly among civilians, as well as penetrating and burn injuries, are common.[2] In today's wars, more civilians than soldiers are killed. Most war-related deaths occur among civilians, and children are the most affected.[3]

The explosion of high-energy explosives creates a shock wave in the air or water. The blast propagates at a speed greater than the speed of sound and has three components. The first stage is the overpressure stage of the blast wave. The pressure can be hundreds of bar per square centimetre and decreases as the blast moves away from the source. The second stage is the negative pressure stage with a relative vacuum effect that sucks in air after the positive component. The third stage is the blast flow stage. The rapidly expanding gases caused by the explosion displace an equal volume of air. It has a lower pressure than a positive pressure blast wave but can travel further.[4,5]

Blast injuries cause trauma by 4 different mechanisms. Primary blast injuries are injuries caused by excessive blast waves, secondary blast injuries are injuries caused by flying particles as a result of the explosion, and tertiary blast injuries occur as a result of the displacement of the victim's body by the blast wave. These are quaternary injuries resulting from burns, toxic inhalation and radiation exposure.[10]

Blast induced traumatic brain injury has been a common form of injury in many wars.[11] However, all parts of the body are affected when the blast wave passes over people. A victim exposed to the blast effect may not have any external injuries. However, fatal injuries may occur.

This study investigated the incidence of head trauma associated with blast injury to the thorax and abdominal organs in children who sustained blast head trauma during the Syrian civil war and were followed up at the neurosurgery clinic.

MATERIAL AND METHOD

The study was carried out with the permission of Hatay Mustafa Kemal University Ethics Committee (Date: 25.12.2023, Decision No: 09). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Our study retrospectively analysed patients aged 1-17 years who were brought to the Faculty of Medicine Hospital by 112 emergency services between 2010 and 2021 with injuries related to the Syrian civil war. Among the available patients, 25 patients with blast injuries were included in our study and their computed tomography, magnetic resonance, radiographs and biochemical values in the hospital database were analysed. The treatments given to our patients in our hospital were evaluated with epicrisis notes.

In the statistical analyses, numbers and percentages were used to show frequency distributions among the descriptive statistics, and mean and standard deviation among the distribution criteria. The Fisher exact test was used to compare percentages of two discontinuous variables, and the Mann-Whitney U test was used to compare two independent continuous variables, since the number of samples was less than 30, the data were considered incompatible with normal distribution, and $p>0.05$ was considered significant.

RESULTS

16 patients were male and 9 were female. The mean age of the 25 patients included in the study was 9.4±5.0 years (min:1, max:16). All patients suffered from head trauma. Regarding the type of trauma, 84.0% had mixed trauma (head, thorax, abdomen) and 16.0% had only head trauma. When we analysed the trauma conditions other than head trauma, pulmonary contusion was the most common trauma with 60.0%, followed by free abdominal fluid with 32.0% (**Table 1**). When we analysed the head trauma of the patients, we found fractures of various types and locations in 80.0%, subarachnoid haemorrhage (SAH) in 36.0%, haematoma of various levels in 24.0% and cerebral contusion in 24.0% (**Figure 1**, **2**).

Table 1. Other trauma conditions of the patients accompanying head trauma

Trauma Type	Number	Percent
Lung contusion	15	60.0
İntra abdominal free fluid	8	32.0
Pneumothorax	6	24.0
Retroperitonel haematoma	3	12.0
Pericardial effusion	2	8.0
Liver laceration	2	8.0
Spleen laceration	1	4.0

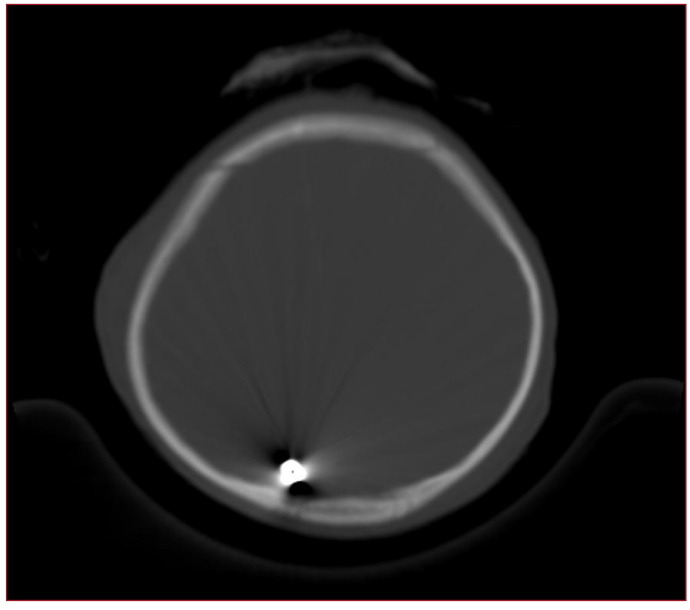

Figure 1: Presence of a foreign body approximately 7.5 mm in diameter in the left posterior parietal region with dense metallic artefacts

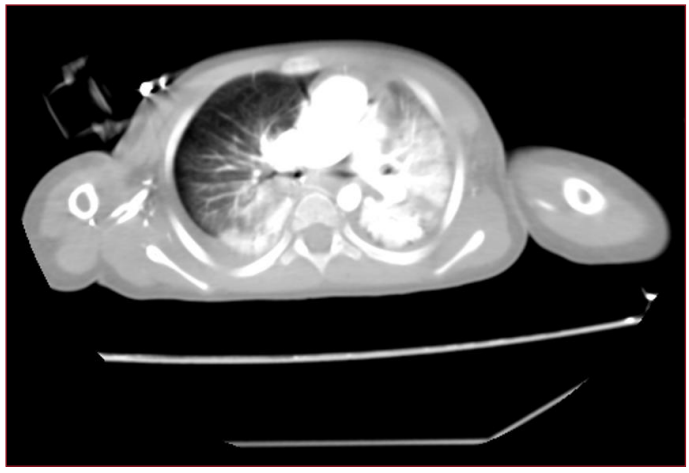

Figure 2: Lung tissue in the lower lobe of the right lung and in all lobes of the left lung has an atelectatic appearance.

11 patients (44.0%) died. The mean duration of ex was 7.9±7.1 days. When comparing the relationship between type of trauma and ex status, no statistical relationship was found between any type of trauma and the presence of ex (p>0.05) (**Table 2**). The mean Glasgow Coma Scale (GCS) score of the patients was 7.9±3.7. When the relationship between the types of trauma and GCS was compared between the mean GCS of the patients with and without each type of trauma, no statistical relationship was found for any type (p>0.05).

Table 2. The relationship between the type of trauma and exitus status

		Death				P**
		+		-		
		N*	%	N*	%	
Mixed Trauma	+	8	38.1	13	61.9	0.288
	Isolyted Head	3	75.0	1	25.0	
Lung Contusion	+	7	46.7	8	53.3	1.000
	-	4	40.0	6	60.0	
Liver Laceration	+	1	50.0	1	50.0	1.000
	-	10	43.5	13	56.5	
İntra Abdominal Free Fluid	+	3	37.5	5	62.5	1.000
	-	8	47.1	9	52.9	
Pneumothorax	+	1	16.7	5	83.3	0,180
	-	10	52.6	9	47.4	
Retroperitoneal Haematoma	+	1	33.3	2	66.7	1.000
	-	10	45.5	12	54.5	
Pericardial Effusion	+	1	50.0	1	50.0	1.000
	-	10	43.5	13	56.5	

* Line Percentage, **Fisher Exact Test

DISCUSSION

Explosions create a shock wave due to the compression of the air, which travels outwards from the explosion site at the speed of sound, hitting any object in front of it. The force of this shock wave is directly proportional to the amount of explosive and inversely proportional to the distance. In the second stage, which begins after the first stage has ended, the vacuum effect created in the blast zone hits everything in front of it again, creating an inward pressure wave that causes forced displacement. The destructive effect of these pressure storms forms the basis of blunt and penetrating injuries, which constitute secondary and tertiary injuries.[8]

In blast injuries, head/neck and extremity injuries and burns are common in children under 16 years of age, in contrast to extremity injuries, which are more common in adults.[9-11] The mortality rate in our study was very high at 44%, which is very close to the range of 0.6%-40% in the.[12-14] The main reason for the high mortality rate is secondary and tertiary injuries unrelated to the primary blast injury.[12-14] The cause of mortality in primary blast injury is severe head and brain trauma.[15] In our study, 84% of patients had mixed trauma and 16% had isolated head trauma. The mortality rate of patients with only head and brain injury was 75%, and the Glasgow coma score of these patients in the emergency department was 3. In addition, the mortality rate increased from 38.1% to 46.7% in patients with head and brain injury with the addition of pulmonary contusion, which correlates with information in the literature.[16]

In a study conducted in Israel, it was reported that 33% of the people affected after the explosion had serious injuries and could be transported to the hospital alive, 26% of those who reached the hospital required intensive care, 55% had open wounds, 31% had internal injuries and 50% underwent surgery.[17] In our study, 84% of the patients admitted to our hospital had mixed injuries. 16% of the patients had isolated head trauma. In mixed type trauma, all patients had head and brain injury and the most common associated pathology was pulmonary contusion (60%), followed by intra-abdominal free fluid (32%) and pneumothorax (24%).

On the other hand, while intra-abdominal organ injury in bomb victims is reported in the literature to be between 5% and 12%, mostly in the liver and small intestine, in our study intra-abdominal free fluid was found in 32%, liver laceration in 8% and splenic laceration in 4%10.[18]

When we analysed the head trauma, we found that 80% of the patients with head trauma had fractures of various types and locations, 36% had subarachnoid haemorrhage, 24% had intracerebral, subdural and/or epidural haemorrhage and 24% had cerebral contusion. These rates are higher than in adults, probably because children are more vulnerable and can be more easily and violently thrown by the blast effect due to their lighter weight.[19] Mortality from primary blast injury is therefore higher in children than in adults.

The data we have on primary blast injury are from patients who could be admitted to hospital. However, the mortality rate of primary blast injury is even higher than we have determined. This is because if we add to the mortality rate children who died at the scene, those who died before reaching medical assistance or during transport, the rate is even higher.

If we think about the reasons for such a wide range of values in the literature and the different results in our study, we can consider the severity of the blast as the most important one. In fact, as the intensity increases, the primary blast intensity increases and the mortality at the scene is higher. On arrival at the hospital, victims of a higher intensity blast may suffer more damage and mortality may increase. The second reason is the lack of protective instinct in the paediatric age group. In recent terrorist attacks and war bombings, children have been targeted. Children are more affected by primary blast injuries because they are lighter and more vulnerable.

CONCLUSION

While primary blast injuries in the adult population are mainly extremity and external injuries, in the paediatric age group they can cause mixed trauma and significantly increase mortality rates. In the developing world, children are at the centre of war and terrorism, increasing mortality rates.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Hatay Mustafa Kemal University Ethics Committee (Date: 25.12.2023, Decision No: 09).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Hinsley DE, Rosell PA, Rowlands TK, Clasper JC. Penetrating missile injuries during asymmetric warfare in the 2003 Gulf conflict. Br J Surg. 2005;92(5):637-42.
2. Scope A, Farkash U, Lynn M, Abargel A, Eldad A. Mortality epidemiology in low-intensity warfare: Israel Defense Forces' experience. Injury. 2001;32(1):1-3.
3. Santa Barbara J. Impact of war on children and imperative to end war. Croat Med J. 2006;47(6):891-4.
4. Volgas DA, Stannard JP, Alonso JE. Ballistics: a primer for the surgeon. Injury. 2005;36(3):373-9.
5. Santucci RA, Chang YJ. Ballistics for physicians: myths about wound ballistics and gunshot injuries. J Urol. 2004;171(4):1408-14.
6. Milwood Hargrave J, Pearce P, Mayhew ER, Bull A, Taylor S. Blast injuries in children: a mixed-methods narrative review. BMJ Paediatr Open. 2019;3(1):e000452.
7. Arriola VD, Rozelle JW. Traumatic Brain Injury in United States Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) Hispanic Veterans-A Review Using the PRISMA Method. Behav Sci (Basel). 2016;6(1):3.
8. Phillips YY. Primary blast injuries. Ann Emerg Med. 1986;15(12):1446-50.
9. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. J Trauma. 2008;64(2):295-9.
10. Bilukha OO, Brennan M, Anderson M, Tsitsaev Z, Murtazaeva E, Ibragimov R. Seen but not heard: injuries and deaths from landmines and unexploded ordnance in Chechnya, 1994-2005. Prehosp Disaster Med. 2007;22(6):507-12.
11. Stansbury LG, Lalliss SJ, Branstetter JG, Bagg MR, Holcomb JB. Amputations in U.S. military personnel in the current conflicts in Afghanistan and Iraq. J Orthop Trauma. 2008;22(1):43-6.
12. Stapczynski JS. Blast injuries. Ann Emerg Med. 1982;11(12):687-94.
13. Hadden WA, Rutherford WH, Merrett JD. The injuries of terrorist bombing: a study of 1532 consecutive patients. Br J Surg. 1978;65(8):525-31.
14. Cooper GJ, Maynard RL, Cross NL, Hill JF. Casualties from terrorist bombings. J Trauma. 1983;23(11):955-67.
15. Hill JF. Blast injury with particular reference to recent terrorist bombing incidents. Ann R Coll Surg Engl. 1979;61(1):4-11.
16. Peleg K, Aharonson-Daniel L, Michael M, Shapira SC; Israel Trauma Group. Patterns of injury in hospitalized terrorist victims. Am J Emerg Med. 2003;21(4):258-62.
17. de Ceballos JP, Turégano-Fuentes F, Perez-Diaz D, Sanz-Sanchez M, Martin-Llorente C, Guerrero-Sanz JE. 11 March 2004: The terrorist bomb explosions in Madrid, Spain--an analysis of the logistics, injuries sustained and clinical management of casualties treated at the closest hospital. Crit Care. 2005;9(1):104-11.
18. Turégano-Fuentes F, Pérez-Diaz D, Sanz-Sánchez M, Alfici R, Ashkenazi I. Abdominal blast injuries: different patterns, severity, management, and prognosis according to the main mechanism of injury. Eur J Trauma Emerg Surg. 2014;40(4):451-60.
19. Eastridge BJ, Salinas J, Wade CE, Blackbourne LH. Hypotension is 100 mm Hg on the battlefield. Am J Surg. 2011;202(4):404-8.