ORIGINAL ARTICLE

Evaluation of the effects of explosions: A ten-year retrospective study

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ABSTRACT

BACKGROUND: Explosions are not exclusive to battlefields; they also represent a global security concern that affects all societies worldwide. This study aims to elucidate the effects of injuries caused by explosions with multiple mechanisms, which clinicians may encounter at any time, particularly in the context of military personnel. Furthermore, the clinical characteristics of these injuries were examined.

METHODS: A total of 7,865 patient files evaluated between 2008 and 2017 by the Forensic Medicine Department of Gülhane Medical Faculty, Health Sciences University, were subjected to retrospective review. The study encompassed a total of 906 cases presenting with blast injuries. Medical records and health reports of these cases were reviewed and analyzed in terms of age- and gender-specific incidence, military ranks, type of explosion, origin of explosion, wound types, affected body areas, and sequelae.

RESULTS: The findings of this study indicate that blast injuries predominantly affect young males, particularly those in the military. The most common etiological factor identified was terrorism. Blast injuries were found to occur most frequently in non-vehicular pedestrians and were primarily caused by improvised explosive devices and landmines. Blast injuries most commonly resulted in multiple-site injuries with a shrapnel effect and frequently required surgical intervention. Despite all treatments, 53.4% of explosion-related injuries resulted in long-term sequelae.

CONCLUSION: The results of this study demonstrate that explosion-related injuries present a significant and complex problem. Blasts affect multiple body systems and cause severe injuries. Understanding the impact of explosions on the human body can help develop strategies to minimize or possibly eliminate serious injuries, particularly in explosion incidents encountered by security forces.

Keywords: Explosion; military personnel; forensic medicine.

INTRODUCTION

Traumatic combat injuries suffered by military personnel differ from civilian injuries in terms of wound mechanisms. While civilians generally sustain injuries from short-barreled gunshot wounds and shotgun pellet injuries, military personnel often suffer more severe injuries from long-barreled weapons, rocket launchers, and explosives. Among these, explosives are perhaps the most likely to cause complex and severe injuries. Explosions caused by terrorism represent a global security threat that affects all regions of the world and are not confined to battlefields. Explosives are frequently used for terrorist purposes because they are affordable, easily accessible, simple to manufacture, and easy to deploy.

Explosives are categorized into two groups: high-order explosives (HEs) and low-order explosives (LEs). High-order

Cite this article as: Kaya B, Özsoy S, Balandız H, Safalı M, Akyol M. Evaluation of the effects of explosions: A ten-year retrospective study. Ulus Travma Acil Cerrahi Derg 2025;31:233-241.

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Ulus Travma Acil Cerrahi Derg 2025;31(3):233-241 DOI: 10.14744/tjtes.2024.40088
Submitted: 04.11.2024 Revised: 06.11.2024 Accepted: 23.11.2024 Published: 03.03.2025

explosives, such as trinitrotoluene (TNT), C-4, Semtex, nitroglycerin, dynamite, and ammonium nitrate fuel oil (ANFO), generate a supersonic over-pressurization shock wave. In contrast, low-order explosives, including pipe bombs, gunpowder, Molotov cocktails, and guided missiles, cause a subsonic explosion without an over-pressurization wave. Improvised explosive devices (IEDs) may contain HEs, LEs, or a combination of both.[1-3]

An explosion can cause life-threatening, multi-system injuries affecting multiple individuals simultaneously. The type and severity of the injuries depend on several factors, including the composition and quantity of the explosive material, the surrounding environment, the distance between the victim and the blast, and whether the explosion occurs in an open or enclosed space.

Blast injuries are categorized into four types based on their mechanism. Primary injuries are unique to HEs and result from the impact of the over-pressurization wave on body surfaces. The ears, lungs, and gastrointestinal tract are the most susceptible organs to primary blast injury. Secondary injuries occur due to flying debris or bomb fragments, causing penetrating or blunt trauma to any body part. Tertiary injuries occur when a victim is thrown by the blast wind, leading to fractures and traumatic amputations of any body part. Quaternary injuries encompass conditions that do not fall under the primary, secondary, or tertiary mechanisms. Examples include structural collapse, burns, crush injuries, and respiratory issues caused by dust, smoke, or toxic fumes.[2,4]

Explosions can cause multiple injuries through various mechanisms, and clinicians may encounter such cases at any time. The purpose of this study is to examine the characteristics of explosion-related injuries, particularly among military personnel.

MATERIALS AND METHODS

We retrospectively reviewed forensic reports prepared at the Department of Forensic Medicine, Gulhane Faculty of Medicine, University of Health Sciences, Ankara Türkiye, between January 1, 2008 and December 31, 2017. A total of 7,865 forensic reports were examined, of which 906 (11.5%) were relevant to this study as they involved explosion-related injuries. Cases involving gunshot wounds and other types of injuries were excluded. Medical records and health reports were analyzed based on age- and gender-specific incidence, military ranks, type of explosion, origin of explosion, wound types, affected body areas, and sequelae.

This study was conducted with the approval of the University of Health Sciences Non-Invasive Research Ethics Committee (Approval Number: 18/39, Date: 06.02.2018).

Statistical Analysis

Data were presented using numbers and percentages (n; %). Cross-tabulations were created for categorical variables, and group comparisons were performed using the Chi-square test. Odds ratios (OR) and 95% confidence intervals (CI) were calculated under the assumption that all other factors were constant for the relevant data.

The data obtained from the cases were analyzed using Microsoft Office Excel 2010 and IBM SPSS Statistics version 23.0 (IBM SPSS Statistics for Windows, IBM Corp., Armonk, New York, USA). A p value of less than 0.05 was considered statistically significant.

RESULTS

Between January 1, 2008 and December 31, 2017, a total of 906 forensic reports documented explosion-related injuries. Among these cases, 896 (98.9%) were male, while 10 (1.1%) were female. The mean age of the cases at the time of the incident was 27.8 years (minimum: 2 years, maximum: 55 years). The majority of the cases involved military personnel (n=824; 90.9%), while 73 (8.1%) were civilians, 5 (0.6%) were village guards, and 4 (0.4%) were police officers. Further investigations were conducted on military personnel and other citizens (civilians, village guards, and police officers combined). The highest number of explosions occurred in February (12.9%), followed by October (11.5%) and August (10.5%).

The primary cause of the explosions was terrorism (n=803; 88.6%), whereas accidental explosions accounted for 103 cases (11.4%). The distribution of terrorism-related and accident-related cases among military personnel and other citizens was similar (R2=0.014; p=0.906) (Table 1).

The most common cause of explosions was improvised explosive devices and landmines (n=528; 58.3%), followed by explosions involving rockets, mortar bombs, and artillery shells (n=218; 24.1%), hand grenades (n=121; 13.4%), and other sources (such as bottled gas, boiler explosions, etc.) (n=39; 4.3%) followed. IEDs and landmines were the leading cause of explosion-related injuries among both military personnel and other citizens. However, the proportion was higher among other citizens, reaching 87.8%. The second most common cause of explosion-related injuries among military personnel was rocket, mortar bomb, and artillery bullet explosions (n=217; 26.3%), whereas among other citizens, it was bottled gas explosions, boiler explosions, and similar incidents (n=8; 9.8%) (Table 2).

Cases were classified based on the location where they were affected by the explosion: as pedestrians (open area), inside a vehicle, or inside a building. The majority of cases were affected by explosions as pedestrians (n=694; 76.6%). Military personnel were predominantly affected as pedestrians (80.5%), while other citizens were primarily affected inside vehicles (61%). The rate of explosions occurring inside buildings was similar between the two groups (2.2% vs. 1.2%). The distribution of explosion locations was statistically different between military personnel and other citizens (R^2=83.650; p<0.001).

Table 1. Distribution of cases by terrorism-related or accidental explosions

	Military Personnel	Others	Total
Terrorism	730 (88.6%)	73 (89%)	803
Accidental	94 (11.4%)	9 (11%)	103
Total	824 (100%)	82 (100%)	906

Table 2. Distribution of explosive types by personnel status

Explosive Types	Military Personnel	Others	Total
IED, Landmines	456 (55.3%)	72 (87.8%)	528 (58.3%)
Rocket, Mortar Bomb, Artillery Shell Explosions	217 (26.3%)	1 (1.2%)	218 (24.1%)
Hand Grenade	120 (14.6%)	1 (1.2%)	121 (13.4%)
Others (Bottled Gas, Boiler Explosions, etc.)	31 (3.8%)	8 (9.8%)	39 (4.3%)
Total	824 (100%)	82 (100%)	906 (100%)

*IED: Improvised Explosive Devices.

Table 3. Locations where cases were affected by the explosion

	Military Personnel	Others	Total
Pedestrian	663 (80.5%)	31 (37.8%)	694 (76.6%)
Inside a Vehicle	143 (17.4%)	50 (61%)	193 (21.3%)
Inside a Building	18 (2.2%)	1 (1.2%)	19 (2.1%)
Total	824 (100%)	82 (100%)	906 (100%)

Assuming all other factors remained constant, the likelihood of an explosion involving military personnel on foot (pedestrian) was found to be 7.48 times higher (OR=7.48 (95% CI: 4.61-12.12) than that of other citizens on foot (Table 3).

Explosions most commonly resulted in shrapnel wounds (n=512; 56.5%), followed by multiple injuries (n=233; 25.7%), blast injuries (n=104; 11.5%), burn injuries (n=39; 4.3%), and blunt trauma injuries (such as entrapment in wreckage) (n=18; 2%). Multiple (combined) injuries included two or more injury types. While all blunt trauma injuries were caused by terrorism-related injuries, burn injuries occurred at similar rates in both terrorism-related and accidental explosions (51.3% and 48.7%, respectively). For all other injury types, terrorism-related explosions were significantly more frequent than accidental explosions (R2=60.767; p<0.001) (Table 4).

Among all explosion cases, 23.1% (n=209) involved life-threatening injuries. A significant proportion of life-threatening explosion injuries (83.7%) resulted from terrorism-related incidents (R2=6.472; p=0.011). Assuming all other factors remained constant, the risk of life-threatening injuries from terrorist incidents was found to be 1.77 times higher (OR=1.77 (95% CI: 1.14-2.76) than the risk associated with accidental explosions. It was observed that the rate of life-threatening injuries (24.3%) was significantly higher among military personnel (R2=7.429; p=0.006) compared to other citizens (11.0%). Regarding injury types, combined injuries (33%) and burn injuries (30.8%) were the most common causes of life-threatening conditions, while blast injuries (9.6%) and blunt trauma injuries (11.1%) had the lowest rate. Among cases with shrapnel injuries, one in five (21.1%) experienced life-threatening conditions (Tables 5 and 6).

Bone fractures were observed in 328 cases (36.2%). The injury types most frequently associated with one or more bone fractures were combined injuries (56.2%), blunt trauma injuries (50%), and shrapnel injuries (31.4%). The risk of life-threatening injuries (45.1%) was significantly higher

Table 4. Distribution of injury types caused by explosions

Injury Types	Military Personnel	Others	Total
Shrapnel Wounds	460 (55.8%)	52 (63.4%)	512 (56.5%)
Blast Injury	95 (11.5%)	9 (11%)	104 (11.5%)
Burns	30 (3.6%)	9 (11%)	39 (4.3%)
Blunt Trauma	18 (2.2%)	0	18 (2%)
Multiple Injuries	221 (26.8%)	12 (14.6%)	233 (25.7%)
Total	824 (100%)	82 (100%)	906 (100%)

Table 5. Relationship between injury types caused by explosions and life-threatening injuries

Injury Type	No Life-Threatening Injury	Life-Threatening Injury	Total
Shrapnel Wounds	404 (78.9%)	108 (21.1%)	512 (100%)
Blast Injury	94 (90.4%)	10 (9.6%)	104 (100%)
Burns	27 (69.2%)	12 (30.8%)	39 (100%)
Blunt Trauma	16 (88.9%)	2 (11.1)	18 (100%)
Combined Injuries	156 (67%)	77 (33%)	233 (100%)
Total	697 (100%)	209 (100%)	906 (100%)

Table 6. Relationship between explosive types and life-threatening injuries

Explosive Types	No Life-Threatening Injury	Life-Threatening Injury	Total
IED, Landmines	410 (77.7%)	118 (22.3%)	528 (100%)
Rocket, Mortar Bomb, Artillery Shell Explosions	174 (79.8%)	44 (20.2%)	218 (100%)
Hand Grenade	87 (71.9%)	34 (28.1%)	121 (100%)
Others (Bottled Gas, Boiler Explosions, etc.)	26 (66.7%)	13 (33.3%)	39 (100%)
Total	697 (100%)	209 (100%)	906 (100%)

*IED: Improvised Explosive Devices.

in patients with bone fractures compared to those without fractures (10.6%) (R^2=140.899; p<0.001). Assuming all other factors remained constant, the risk of life-threatening injuries was calculated to be 6.97 times higher (OR=6.97 (95% CI: 4.95-9.82) in patients with bone fractures compared to those without bone fractures. The rate of bone fractures in accidental explosions (44.7%) and terrorism-related explosions (35.1%) was statistically similar (p>0.05). It was also observed that bone fractures influenced the treatment approach. The rate of surgical treatment was more than twice as high in patients with bone fractures (88.1%) compared to those without bone fractures (43.1%) (R^2=175.917; p<0.001).

The affected body regions from the explosions were classified into head and neck, thorax (chest), abdomen, upper extremity, lower extremity, vertebral column, and multi-site injuries (involving two or more body regions). According to this classification, the majority of injuries were multi-site injuries (39.4%), while the least common injuries involved the vertebral column (1.4%), abdomen (1.9%), and thorax (2.2%). Head and neck injuries were also notably high (29.1%).

Surgical procedures were performed in 59.4% (n=538) of all cases. The rate of surgical treatment was significantly higher in life-threatening injuries (93.3%) compared to non-life-threatening injuries (42.9%) (R^2=129.589; p<0.001). Howev-

er, there was no significant difference in surgical intervention rates between terrorism-related and accidental explosion injuries (p>0.05). The surgical intervention rate was significantly higher among military personnel (62.7%) compared to other citizens (R^2=42.634; p<0.001).

Among all cases, 484 (53.4%) had one or more sequelae after treatment, while 422 (46.5%) achieved complete recovery. The most common sequelae were extremity joint mobility disability (36.9%), hearing loss (25.6%), visual loss (24.5%), extremity amputation (21%), nerve injury (19.8%), and psychiatric disorders (14%). The total percentage exceeds 100% because multiple sequelae could be present in a single patient.

DISCUSSION

With the increasing prevalence of terrorism worldwide, explosion-related injuries have become a significant public health concern. Today, not only military personnel but also civilians are frequently exposed to such injuries. Explosions cause complex and often fatal injuries, affecting both physical and psychological well-being. These injuries can impact multiple body systems, including the auditory, visual, respiratory, circulatory, digestive, central nervous, and musculoskeletal systems.[1-3]

There are numerous studies in the literature on the mechanisms of explosion-related injuries[1-10] and, in particular, bombings associated with regional terrorism.[11-18] However, most of these studies focus on injuries affecting only a single body region.[7,12,13] Additionally, we could not find a comprehensive study on explosion-related injuries in Türkiye. A distinguishing feature of our study is that the majority of the cases involved military personnel, and all individuals in the study survived their injuries.

Most cases included in the study involved young males, with military personnel comprising 90.9% of the cases. Explosions cause injuries across various age groups worldwide; however, the age distribution differs between civilians and military personnel. On a global scale, the mean age of military personnel is lower than that of the general civilian population. Studies have shown that the average age range for blast injuries among military personnel is between 25 and 29 years, with the vast majority being male.[19,20] A meta-analysis indicated that this predominance is due to the larger number of males in the military.[11,17,19] Similarly, men are more frequently affected by explosions in civilian cases, although the disparity is less pronounced than in military cases. Civilian explosion cases span a broader age range, typically between 13 and 45 years, with average ages being relatively higher than those observed in military cases.[19] The low average age and male predominance in our study are believed to be due to the high proportion of military personnel included. In both Türkiye and globally, most military personnel are male, resulting in a higher prevalence of injuries among men. This gender distribution is attributed more to male-dominated employment patterns rather than inherent gender differences. Indeed, a study reported no significant difference in blast injuries between male and female soldiers.[19] Additionally, the younger age of military personnel is thought to contribute to the higher incidence of blast injuries among younger individuals.

The findings of our study indicate that the majority of blast injuries (88.6%) were caused by terrorism, affecting both military personnel and civilians. However, injuries resulting from accidental explosions also constituted a significant proportion of cases. Explosions are a global phenomenon that impact not only military and security personnel but also civilians. The causes of explosions vary depending on the geographical location of different countries. Terrorism-related explosions have been observed in both civilian and military cases in the Middle East and North Africa.[21,22] Conversely, in countries where terrorism is not a major concern, accidental explosion-related injuries are more prevalent. A study conducted in China, which analyzed 17 years of official data, reported 2,098 explosions and 29,579 explosion-related injuries, the majority of which were attributed to occupational accidents in various industries.[23] Similarly, an 18-year study conducted in Scandinavia revealed that all explosion-related deaths in the region were due to non-terrorist causes, including accidents and suicides.[24] The findings of our study, when considered alongside existing literature, indicate that explosions are not confined to war zones or terrorist incidents but constitute a global threat. These results suggest that blast injuries are a complex issue that must be addressed on a worldwide scale while considering regional differences in explosion causes. Consequently, the development of strategies tailored to local conditions is of paramount importance for the prevention and management of such injuries, ensuring the protection of both military personnel and civilians.

The findings of our study indicate that explosions are most frequently caused by improvised explosive devices and landmines (n=528; 58.3%), followed by rocket and mortar explosions (n=218; 24.1%) and grenade-related injuries (n=121; 13.4%). Furthermore, it was established that IED and landmine explosions were the most prevalent causes of injury among civilian populations. The severity of explosion-related injuries depends on the type of materials and weapons used. In a study conducted by Eskridge et al. in Iraq,[25] 78.1% of explosion-related injuries were attributed to IEDs, 12.7% to rockets and mortars, and 4.1% to grenades. Similarly, a study by Ritenour et al.[26] identified IEDs as the most common cause of injuries (64%), followed by rockets and grenades (15.3%), mortars (11.5%), and landmines (3.4%). fAnother study reported that the majority of explosion-related injuries were caused by long-barreled weapons (52.2%), followed by rocket launchers (33.3%) and IEDs (14.4%).[27] In Türkiye, improvised explosive devices, rocket launchers, mortars, and grenades are commonly employed by terrorist organizations. IEDs are frequently chosen by terrorists due to their ease of construction using readily available materials, low cost, and

significant destructive impact. While terrorist acts primarily target security forces, they also have a considerable impact on civilians. Therefore, the causes of injuries observed among both civilian and security force victims of explosion-related incidents appear to be similar. Moreover, during the period in which the data was collected, the study was conducted at a military hospital. This institution often serves as the initial point of care for soldiers and civilians injured in terrorist attacks or as a referral center for ongoing treatment after initial care at another hospital. Consequently, although the findings differ from those of studies conducted on civilians in developed countries, they closely resemble injuries observed in military cases.

In our study, explosion-related injuries were more commonly observed among individuals outside of vehicles and pedestrians, regardless of whether they were civilians or military personnel. Explosions have the potential to cause injuries to both individuals inside vehicles and those situated outside. A study conducted by Leibovici et al.[28] in Israel revealed that the majority of explosion-related injuries occurred among pedestrians outside of vehicles (n=204; 68.7%). Similarly, another study reported that nearly all cases (n=83; 95.3%) involved individuals who were outside vehicles at the time of the explosion.[24] It is hypothesised that explosions occurring outside of vehicles are more prevalent in terrorist attacks because they result in a greater number of casualties. Furthermore, military vehicles are often equipped with advanced safety features designed to mitigate injuries from explosive devices, potentially reducing the incidence of such injuries among military personnel. Therefore, it can be reasonably concluded that explosion-related injuries are more likely to occur outside of vehicles.

The findings of our study indicate that the majority of cases sustained injuries primarily due to the shrapnel effects of explosions, followed by blast effects and a combination of both. Explosions can cause a variety of injuries to the human body through four primary mechanisms: primary, secondary, tertiary, and quaternary effects. An individual may be affected by one or more of these effects simultaneously. The primary effect, also referred to as the blast effect, results from high-energy explosions that lead to acoustic trauma. The secondary effect comprises injuries caused by shrapnel, bomb fragments, and debris, such as rocks and soil, propelled by the explosion. The tertiary effect includes injuries such as bone fractures, blunt force trauma, and amputations caused by the blast wind. Quaternary effects encompass burns, environmental exposure, and psychological disorders that do not fall under the other three categories.[2] A study conducted on United States soldiers in Iraq reported that approximately half of the soldiers injured in explosions sustained secondary injuries (shrapnel-related), followed by injuries from the blast effect.[29] Similarly, a study conducted by Yazgan et al.[30] on the 2015 Ankara bombing found that shrapnel-related injuries were the most common. This finding aligns with the observations of Singh et al.,[31] who also reported a higher incidence of shrapnel injuries in explosion cases. The findings of Akay et al.[27] further corroborate the assertion that shrapnel injuries represent the most prevalent type of injury resulting from explosions. The findings of our study indicate that secondary effects, particularly shrapnel injuries, are frequently observed in explosion-related cases. Among the four primary mechanisms of explosion-related injuries, shrapnel and blast injuries are the most prominent.[32] Our study, which primarily examined explosions related to terrorism, suggests that shrapnel effects, due to the high-energy dispersion of fragments, can lead to fatal injuries. Furthermore, the observation that blast effects typically affect a relatively limited area, particularly in open settings, provides additional support for these findings.

In our study, explosion-related injuries were most commonly observed in multiple body regions, followed by injuries to the head and neck. It is well documented that explosions can cause injuries to various parts of the human body. Kluger et al.[21] reported that 43.2% (n=205) of cases involved injuries to multiple regions. Similarly, another study found that approximately half of the cases involved injuries to multiple body regions, with the head and neck being the most frequently affected area, accounting for 59.4% (n=388) of cases.[33] In the study conducted by Tahtabasi et al.,[34] head and neck injuries were the most prevalent among explosion-related cases, accounting for 87.5% (n=14) of the total cases. Likewise, a study by Ron Golan et al. in Israel[22] revealed that 44.7% of cases involved head and neck injuries. Explosions cause injuries through four primary mechanisms, each of which results in distinct types of trauma. The effects of shrapnel can result in injuries to various body regions within the blast radius. Additionally, the blast effect itself, even if no immediate injury is apparent, can cause internal injuries, particularly affecting the auditory system and internal organs. The pressure effect generated by the explosion can also cause blunt trauma by propelling the affected individual.[2] Therefore, the occurrence of injuries in multiple body regions is an inevitable consequence of explosions. Although military personnel are typically equipped with protective gear and helmets, the prevalence of head and neck injuries in explosion incidents may seem unexpected. However, while protective gear is effective in safeguarding the torso, it often provides inadequate protection for the head and neck.[32] Moreover, the higher incidence of blast injuries among military personnel compared to civilians may be attributed to the increased frequency of explosions in military settings and the design of protective equipment, which is primarily focused on reducing fatalities rather than preventing injuries. The inherent vulnerability of the head and neck region, even with protective equipment, further exacerbates this issue.

The findings of our study indicate that surgical treatment was the most frequently applied intervention in cases of explosion-related injuries, with a rate of 59.4% across all cases and 62.7% among military personnel. Additionally, the duration

of hospitalization was found to be prolonged. The severity of explosion-related injuries can vary considerably depending on the intensity of the explosion and the extent of the individual's exposure. Consequently, the appropriate treatment approach must be tailored to the specific circumstances and the severity of the injury. A study revealed that 47% of injuries resulting from explosions were classified as critical, while 35.7% were severe.[35] Kluger et al.[21] reported that injuries caused by explosions were more severe than those resulting from other trauma mechanisms, necessitating a higher rate of surgical intervention and longer hospital stays. In a study conducted by Weil et al., 67.2% (n=433) of cases required surgical treatment, demonstrating a significantly higher rate of surgical intervention compared to other injury mechanisms.[33] Similarly, a meta-analysis indicated that the incidence of fractures in explosion-related injuries could reach up to 87% among civilians and 89% among military personnel, underscoring the severe outcomes of explosion-related trauma in both groups.[19] A review of the literature on military cases indicates that hospital and intensive care unit stays are often prolonged due to the severity of explosion injuries.[20] The Israel National Trauma Registry, which includes 906 civilian cases injured by explosions, confirmed that these patients have higher injury severity scores, lower Glasgow Coma Scale scores, greater hemodynamic instability, and more injured body regions than patients injured by other mechanisms.[21] The findings of our study further demonstrate that the destructive nature of explosion injuries, with their multifaceted impact, leads to severe trauma affecting multiple body regions. Consequently, surgical interventions and prolonged recovery processes, including intensive care, are often necessary. Additionally, post-explosion rehabilitation and physical therapy may require extended durations, proportional to the severity of the injuries sustained.

The findings of our study indicate that injuries resulting from explosions frequently lead to permanent hearing loss, vision impairment, and nerve damage. Certain regions of the body are particularly vulnerable to blast-related injuries, which can result in a range of long-term complications for patients. The auditory system, eyes, and nervous system are especially susceptible to damage, with the ear and hearing system being the most commonly affected.[36,37] Explosions generate a primary blast effect that causes significant changes within the auditory system. The abrupt pressure fluctuations produced by the blast can lead to barotrauma, which may result in hearing impairment. [38] The high-energy blast effect can damage not only the tympanic membrane but also the cochlea and central auditory pathways, leading to severe hearing loss.[36,37] In the aftermath of the 2013 Boston Marathon bombings, cases of tympanic membrane rupture and permanent hearing loss were documented among the injured.[39] Furthermore, explosions can cause irreversible damage to various bodily systems. Ramasamy et al.[40] reported that among explosion victims, 15% sustained burns, 15% experienced hearing loss, and 15% exhibited vision impairment. Golan et al.[22] identified nerve damage (10%), vision loss (8%), and orthopedic sequelae (20%) among post-explosion cases. The findings of our study corroborate previous research, confirming that explosion-related injuries can cause lasting damage across multiple systems. These results emphasize the critical importance of prompt medical intervention, particularly in detecting and treating injuries to sensitive areas such as the auditory, visual, and nervous systems. Given the long-term effects and the potential for permanent disability, a multidisciplinary approach to treating explosion-related injuries is essential.

Limitations

The limitations of our study include its retrospective nature and its single-center design. Additionally, because the study was conducted in a military hospital that has since been closed, most of our patients were military personnel. However, we believe that this factor enhanced the power of our study results by increasing the sample size.

CONCLUSION

The findings of our study indicate that explosion-related injuries represent a significant and complex public health concern. Explosions can occur in various settings, including conflict zones, terrorist attacks, and accidental incidents, resulting in severe injuries that affect multiple body systems. The results underscore the necessity of developing preventive and therapeutic strategies tailored to local conditions, both regionally and globally, to effectively manage explosion-related injuries. It has been established that these injuries are more prevalent among young male soldiers, a finding attributed not to gender differences but to the demographic characteristics inherent to military service. Furthermore, the early diagnosis and treatment of potential permanent sequelae, such as hearing loss, vision impairment, and nerve damage, are of critical importance in enhancing patients' quality of life. A comprehensive understanding of the nature of explosion injuries is essential to address a wide range of complex trauma, including primary blast injuries, penetrating wounds, burns, crush injuries, and other explosion-related conditions. To reduce the fatal impact of these injuries, advancements in body armor and battlefield emergency first-aid training are crucial. An improved understanding of how explosions affect the human body can assist security forces in developing strategies to reduce or potentially eliminate extensive harm to individuals during such incidents. The findings of this study provide valuable insights into the effects of explosions on the human body, which can inform the development of strategies by security forces to mitigate or possibly prevent the severe damage caused by explosions.

Ethics Committee Approval: This study was approved by the University of Health Sciences Non-Invasive Research Ethics Committee (Date: 06.02.2018, Decision No: 18/39).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.Ö., H.B.; Design: B.K., S.Ö.; Supervision: B.K., S.Ö.; Resource: B.K., S.Ö. H.B.; Materials: B.K., S.Ö., H.B.; Data Collection and/or Processing: B.K., S.Ö., H.B.; Analysis and/or Interpretation: B.K., S.Ö., M.A.; Literature Review: B.K., S.Ö., H.B.; Writing: B.K., S.Ö., H.B.; Critical Review: B.K., S.Ö. H.B., M.S.

Conflict of Interest: None declared.

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

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ORİJİNAL ÇALIŞMA - *ÖZ*

Patlamaların etkilerinin değerlendirilmesi: On yıllık retrospektif çalışma

AMAÇ: Patlamalar yalnızca savaş alanlarına özgü olmayıp; aynı zamanda dünya çapında tüm toplumları etkileyen küresel bir güvenlik sorununu temsil etmektedir. Bu çalışma, özellikle askeri personel bağlamında, klinisyenlerin her an karşılaşabileceği, çoklu mekanizmalara sahip patlamaların neden olduğu yaralanmaların etkilerini aydınlatmayı amaçlamaktadır. Ayrıca, bu yaralanmaların klinik özellikleri de incelenmiştir.

GEREÇ VE YÖNTEM: Sağlık Bilimleri Üniversitesi Gülhane Tıp Fakültesi Adli Tıp Anabilim Dalı (Gülhane Askeri Tıp Fakültesi) tarafından 2008-2017 yılları arasında değerlendirilen toplam 7865 hasta dosyası retrospektif olarak incelenmiştir. Çalışmamızda patlama sonucu yaralanan toplam 906 vaka değerlendirilmiştir. Olguların tıbbi kayıtları ve sağlık raporları incelenerek yaş ve cinsiyete göre görülme sıklığı, askeri rütbeleri, patlama tipi, patlamanın kaynağı, yara tipleri, etkilenen vücut bölgesi ve sekel lezyonlar açısından analiz edilmiştir.

BULGULAR: Bu çalışma, patlama yaralanmalarının ağırlıklı olarak genç erkekleri, özellikle de askeri personeli etkilediğini göstermektedir. Tespit edilen en yaygın etiyolojik faktör terörizmdi. Patlama yaralanmalarının en sık araç dışı yayalarda meydana geldiği ve çoğunlukla el yapımı patlayıcılar ve mayınlarından kaynaklandığı tespit edildi. Patlama yaralanmalarının çoğunlukla şarapnel etkisi ile çoklu bölge yaralanmalarına neden olduğu ve sıklıkla cerrahi müdahale gerektirdiği tespit edildi. Tüm tedavilere rağmen patlama yaralanmalarının %53.4'ünün sekel bıraktığı görüldü.

SONUÇ: Çalışmamızın sonuçları, patlama yaralanmalarının önemli ve karmaşık bir sorun olduğunu ortaya koymaktadır. Patlamalar birden fazla vücut sistemini etkilemekte ve ciddi yaralanmalara neden olmaktadır. Patlamaların insan vücudunu nasıl etkilediğinin anlaşılması, özellikle güvenlik güçlerinin karşılaştığı patlama olaylarında ciddi yaralanmaları en aza indirecek veya muhtemel ortadan kaldıracak planların geliştirilmesine yardımcı olabilir.

Anahtar sözcükler: Adli tıp; patlama; askeri personel.

Ulus Travma Acil Cerrahi Derg 2025;31(3):233-241 DOI: 10.14744/tjtes.2024.40088