Pattern and Outcomes of Penetrating Neck Injuries in Warzones: A Cohort Study

Original Article

Hossam A. Hussein[1,2], Ali M. Alqannass[2], Abdullah M. Assiri[3], Ahmad Z. Almagribi[3] and Mohammed H. Al Mansour[2]

[1] Department of Otorhinolaryngology, Faculty of Medicine, Menoufia University, Egypt

[2] Department of Otorhinolaryngology, King Khalid Hospital, Najran, Saudi Arabia

[3] Department of Surgery, Collage of Medicine, Najran University, Saudi Arabia

ABSTRACT

Objective: Penetrating neck injuries (PNIs) are serious injuries that affect 5%–10% of trauma patients with the potential for significant morbidity and an estimated mortality of 5%. The goal of this study was to provide valuable insights and information that can be used to improve the quality of care for individuals who have suffered warzone bomb blast and gunshot PNIs.

Methods: This was a retrospective cohort study of patients with PNIs presented at King Khalid Hospital, Najran, Saudi Arabia between March 2020 and September 2022. Demographic information, mechanism of injury, zone of injury, clinical presentation, radiological examinations, presence of vascular injury, and the state of the aero-digestive systems, clinical investigations, intraoperative findings, and post-operative outcomes were analyzed.

Results: A total of Twenty-five patients with PNI were included in the study. All patients were male (100%) with a mean age of 27.36 ± 5.37 years. Most patients (76%) had zone II injury. Bomb blast was the mechanism of injury in 18 patients (72%) and gunshot in 7 cases (28%). There were no statically significant differences between gunshot group and bomb blast group regarding hospital stay ($P = 0.2113$), mortality ($P = 1$), morbidity ($P = 0.0526$), tracheostomy ($P = 0.3781$), surgical visceral injury ($P = 0.0752$), and surgical vascular injury ($P = 1$).

Conclusion: Findings from our study showed that gunshot and bomb blast PNIs have no significant differences regarding the outcome measures, thus suggesting that medical professionals can have a similar approach to management regardless of the mechanism of injury.

Key Words: Bomb blast, gunshot, neck, penetrating injuries, warzone.

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Corresponding Author: Mohammed Hamad Al Mansour, Department of Otorhinolaryngology, King Khalid Hospital, Najran, Saudi Arabia, **Tel.:** +966 549256788, **E-mail**: Dr.almansour2@gmail.com

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INTRODUCTION

Any trauma to the neck that invades the platysma muscle layer is referred to as a penetrating neck injury (PNI)[1] and they are thought to account for 5–10% of all trauma cases[2]. PNIs have a mortality rate of 5% and account for 1% of all trauma admissions in the US, 80 percent of morality is a result of cerebral infarction and 20% of deaths that are caused by uncontrolled bleeding[3].

These injuries provide a significant risk of possibly catastrophic damage to vascular, neurological, and aero-digestive tissues, which are all contained inside a tiny and susceptible anatomic area[3].

Gunshots, stabbings, bomb blast, and other assorted traumas are the most common etiologies of PNIs[4]. The site of the entry wound has been used to divide PNI into three anatomical zones of the neck. Roon and Christensen's classification of the top (zone III), middle (zone II), and lower (zone I) regions of the neck is widely recognized. Zone II, between the angle of the mandible and the cricoid cartilage, is involved in 50% to 80% of injuries[5-7].

Several writers, however, have demonstrated that the position of the entry wound does not reliably predict the region of internal injury. As a result, some writers have called for a "no zone" approach to PNI, relying solely on clinical evaluation of hard and soft symptoms[8].

Modern contrast computed tomography (MCCT) angiography is a non-invasive, rapid first diagnostic method that offers global information on the state of arteries, the upper aero-digestive tract, and skeletal structures, and has been found to lower the rate of negative neck explorations[9,10].

Rather than platysma muscle penetration, decision-making is based on the presence of clinical signs and symptoms. There is no shock, no enlarging hematoma,

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no progressive stroke, no pain when swallowing, no hemoptysis, no subcutaneous emphysema, and no neurological damage, thus non-operative therapy is the best option[11].

To the best of our knowledge, no previous studies had been undertaken about PNIs in the study area. Thus, this study set out to provide valuable insights and information that can be used to improve the quality of care for individuals who have suffered warzone bomb blast and gunshot PNIs.

PATIENTS AND METHODS

All patients with warzone PNIs who were presented at King Khalid Hospital, Najran, Saudi Arabia, between March 2020 and September 2022 were included in this retrospective cohort study. This study eliminated patients with incomplete or missing data, those who were brought in dead, patients with non-warzone injuries and injuries that did not penetrate the platysma, and patients who were unstable for pre-operative imaging.

Advanced trauma life support (ATLS) recommendations were followed in the emergency room for the initial resuscitation of all recruited patients. Patients from the emergency room who had clear indicators that demanded exploration were transported right away to the operating room. Patients with penetrating neck trauma who did not exhibit any indicators of exploration were admitted to surgical wards or the intensive care unit (ICU), where additional care was started and the required tests were carried out.

All of the patients in our study required surgical intervention because they had hard signs or had significant gunshot or shrapnel in need for removal; there were no conservative scenarios.

Patients' information was gathered from medical record departments, surgical wards, and operating rooms. Demographic information, mechanism of injury, zone of injury in the neck, clinical presentation according to hard and soft signs (Table 1)[12], radiological examinations (neck ultrasound and/or MCCT) with emphasis on the presence of vascular injury, and the state of the aero-digestive systems, clinical investigations, intraoperative findings, tracheostomized or not, morbidity, and post-operative outcomes (i.e. length of hospital stay, complications, morbidity and mortality) were analyzed. A head and neck radiologist reviewed all radiological studies.

Table 1: Hard and soft clinical signs in PNI

Hard signs	Soft signs
Expanding hematoma	Non-expanding hematoma
Refractory shock	Subcutaneous or mediastinal air
Active, brisk bleeding	Hoarseness
Airway compromise	Stridor
Bubbling wound	Dysphagia
Neurological deficit	Oropharyngeal blood
Vascular bruit or thrill	
Massive subcutaneous emphysema	
Massive hemoptysis	

Regarding the surgical approach used in our cases, we used the conventional zonal approach as our main surgical tool; however, in certain cases, depending on the clear clinical presentation's hard signs in addition to the findings of high-resolution computed tomography angiography (CTA), regardless of the zone of neck injury, no-zone approach was used.

Statistical Product and Service Solution (SPSS) software version 22.0 (Armonk, NY: IBM Corp) was used for statistical analysis. The mean and standard deviation (Mean ± SD) were measured to represent continuous variables, while frequencies and percentages were measured to represent categorical variables. The Chi-Square test ($\chi 2$) was applied to explore the presence of significant relationships between variables. A p-value of less than 0.05 was deemed to be the level of significance.

The research was carried out in compliance with the 2013 revision of the Helsinki standards. Informed consent for surgery was obtained from every patient according to KSA law. This was an observational research that had no bearing on patient care. Ethical approval according to ICH GCP guidelines was obtained from the Directorate of Health Affairs in Najran, Saudi Arabia under IRB Number 2022-73 E

RESULTS

Twenty-five patients with penetrating neck trauma were admitted to our Otorhinolaryngology department over the course of the study. All cases were male (100%) with a mean age of 27.36 ± 5.37 years. Regarding zone of injury, 5 cases (20%) had zone I injury, 19 cases (76%) had zone 2 injury, and 1 case (4%) had zone III injury. 18 cases (72%) resulted from bomb blast as a mechanism of injury and 7 cases (28%) from gunshot (Table 2).

Table 2: Demographic and clinical characteristics of the study group

Parameter		Value	
Age (Mean ± SD)		27.36 ± 5.37	
		No	%
Gender	Male	25	100
Zone of injury	I	5	20
	II	19	76
	III	1	4
Mechanism of Injury	Gunshot	7	28
	Bomb blast	18	72

There were no statically significant differences between gunshot group and bomb blast group regarding hospital stay in days (P = 0.2113), mortality (P = 1), morbidity (P= 0.0526), tracheostomy (P = 0.3781), surgical visceral injury (P = 0.0752), and surgical vascular injury (P = 1) (Table 3).

Table 3: Comparison between Gunshot and bomb blast patients regarding hospital stay, surgical findings, tracheostomy, morbidity, and mortality

Parameter		Gunshot (7)	Bomb blast (18)	Statistical test *P value*
Hospital stay (days) (Mean ± SD)		15 ± 11.12	10.89 ± 6.78	U*=49 P= .2113
Mortality	Yes	0	1	1
	No	7	17	
Morbidity	Yes	3	1	0.0526
	No	4	17	
Tracheostomy	Yes	4	6	0.3781
		3	12	
Surgical visceral injury	Yes	5	5	0.0752
	No	2	13	
Surgical Vascular injury	Yes	3	7	1
	No	4	11	

Regarding hard signs distribution, airway compromise and massive subcutaneous emphysema were the most commonly observed signs in (40%, 40%, respectively) of patients. Other hard signs are shown in (Table 4). Soft signs distribution showed that crepitus was the most commonly observed sign in (16%) of patients. Other soft signs are shown in (Table 4).

Table 4: Distribution of hard and soft signs among study patients

Sign	No.	%
Hard signs		
Airway compromise	10	40
Massive Subcutaneous Emphysema	10	40
Active bleeding	2	8
Expanding Hematoma	7	28
Neurological deficit	1	4
Hypovolemic shock	1	4
Soft signs		
Crepitus	4	16
Oropharyngeal bleeding	3	12
Nonexpanding Haematoma	2	8
Subcutaneous Air	3	12

Our outcomes showed that neck exploration conducted in all cases (100%) with a zonal approach in (52%) and a no-zone approach in (48%), followed by the removal of foreign bodies, which was noted in 24 patients (96%), and then bleeding control was done in 36% of the cases. Lastly, esophagoscopy in (12%), and bronchoscopy in (8%) of the cases (Table 5).

Table 5: Different types of surgery conducted on study patients

Intervention		No.		%	
Neck exploration	Zonal approach	13	25	52	100
	No- Zone approach	12		48	
Tracheal repair		4		16	
Foreign body removal		24		96	
Bleeding control		9		36	
Esophagoscopy		3		12	
Bronchoscopy		2		8	

As shown in (Table 6), trachea was the most commonly injured visceral structure (28%), and common carotid artery (CCA) was the most commonly injured vascular structure (20%).

Table 6: Various visceral and vascular injuries among the study participants

Affected structure	No.	%
Visceral injury		
Trachea	7	28
Larynx	1	4
Hypopharynx	3	12
Brachial Plexus	1	4
Left vocal Cord	1	4
Vascular injury		
Facial artery	1	4
CCA	5	20
Vertebral Artery	3	12
Internal Jugular Vein	3	12
ECA	1	4

The recorded morbidities among the study patients were subglottic stenosis in two patients (8%), hoarseness of voice (4%), hemorrhagic alveolitis (4%), inability to move the shoulder (4%), and loss of hand sensation (4%) (Table 7).

Table 7: Patient morbidities in the study

Morbidity	No.	%	Mechanism of injury
Hemorrhagic alveolitis	1	4	Gunshot
Inability to move the shoulder	1	4	Gunshot
Loss of hand sensation	1	4	Gunshot
Hoarseness of voice	1	4	Gunshot
Subglottic stenosis	1	4	Bomb blast
	1	4	Gunshot

DISCUSSION

PNIs are extremely complicated owing to the high density of vital anatomical structures housed in a confined region. Across the emergency rooms of most hospitals, these injuries are associated with a high level of anxiety and constitute a significant challenge to surgeons.

Typical of most military casualties, the patients in our retrospective study were all young adult males, which is consistent with findings of several reviews across the globe[9,13-15]. Hundersmarck et al.[16] and Seok and Cho[17], however, reported a slight discrepancy,, which revealed higher median ages of 40 and 54 years, respectively. Given the fact that young men are the most active segment of society and are vulnerable to accidents, violence, and army recruitment, these injuries are common among this population.

The current study found that zone II of neck is the most commonly injured region. This finding also accords with previous studies, which reported that zone II accounts for the majority of PNI[9,16,18,19]. It is important to highlight the fact that this zone of neck is the largest and the most exposed portion for trauma.

Understanding the mechanism of penetration holds importance in predicting potential injuries and management strategies. Stabbing injuries account for the majority of PNIs worldwide, followed by gunshot injuries[9,11,18,20,21]. However, on the contrary, the present study reported that bomb blast is the most common mechanism of injury. This difference may be explained by the fact that Najran, the study area, is a war zone region and our cohort of patients were those victims of war in addition to being the explosive devices are the weapon of choice for the majority of terrorist attacks in the modern warfare owing to the availability of information on the construction of bomb devices and easiness of production and portability.

Surprisingly and for the first time, no statically significant differences were found between gunshot group and bomb blast group regarding the outcome measures in terms of hospital stay, mortality, morbidity, tracheostomy, surgical visceral injury, and surgical vascular injury. Further studies, which take these variables into account, will need to be undertaken.

Airway compromise and massive subcutaneous emphysema were found to be the most commonly reported hard signs among our cohort of patients, followed by expanding hematoma. However, this was found to be contradictory to other studies which reported that active bleeding was the most common hard sign[9,18,22]. This inconsistency might be attributable to the relatively lower incidence of vascular injuries in the war zone among our patients. On the other hand, crepitus was the most frequently reported soft sign in our study. Whereas, Ibraheem et al. [9] and Teixeira et al. [18] reported that stable hematoma and dysphagia, respectively, were the most commonly seen soft sign.

Our results demonstrated that neck exploration was conducted in all cases (100%) with zonal approach in (52%) and no-zone approach in (48%), followed by foreign body removal that was conducted in 24 patients (96%), followed by bleeding control (36%). This is attributed to bullets, flying debris, and bomb fragments that penetrate and lodge in victims' bodies. However, in a retrospective review of 192 patients with PNI conducted by Mahmoodie M et al.[15], bleeding control was the most common surgical intervention (67.2%), followed by laryngotracheal repair (24.6%). Different mechanisms of injury might have accounted for the differences.

PNIs most commonly affect the vascular system, with the internal jugular vein being the most vulnerable structure owing to its lateral position and thin wall[11,23,24]. However, our study showed that CCA was the most commonly affected vascular structure. The literature search showed that the carotid injuries are seen in 6-10% of patients with PNIs[23,25].

The anterior and lateral regions of the neck are most vulnerable to injury since the head, inferiorly by the chest, and posteriorly by the spine, protect the neck superiorly. The trachea is located anteriorly and is therefore readily exposed to harm as reported in our study, which showed that trachea is the most commonly injured visceral structure among our patients. Ibraheem et al.[9] and Cruvinel Neto and Dedivitis[26] also reported this finding.

This study has significant implications when it comes to the management of PNIs, particularly in cases with gunshot and bomb blast mechanisms of injury. The study results suggest that medical professionals involved in treating patients with PNIs can have a similar approach to management regardless of the mechanism of injury.

However, it is important to take into account some of the study's limitations. First off, the findings cannot be generalized to a larger population due to the limited sample size of only 25 patients. Furthermore, the study only

included male patients, which may limit the applicability of the findings to female patients or to a more diverse community. The findings might have to apply to other types of neck injuries because the study primarily focused on PNIs. Despite these limitations, the study provides useful information about the outcomes of PNIs due to gunshot and bomb blasts in Najran warzones.

Our suggestion is to conduct additional multicentric research with larger sample sizes in order to corroborate these findings. An in-depth study on neck surgery in PNI that compares zone and no zone surgical approach is also required. Overall, the study provides valuable insight into the outcomes of patients with gunshot and bomb blast PNIs.

The findings suggest that the mechanism of injury may not influence the outcomes of patients, and that medical interventions should be focused on treating the specific injuries sustained by each patient.

CONCLUSION

In conclusion, while this study has some limitations, the results indicate that both mechanisms of injury lead to similar outcomes, thus suggesting that medical professionals can have a similar approach to management regardless of the mechanism of injury. The study adds to the existing literature on this topic and highlights the importance of prompt and effective management of these injuries to minimize morbidity and mortality. Further research is needed to confirm these findings and identify the best practices for the management of these injuries.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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