Research Article

Improvised explosive device injuries to the maxillofacial region: Diagnostic findings and treatment approaches in north-eastern Nigeria

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ABSTRACT

Introduction: The use of improvised explosive devices (IED) poses a significant threat, particularly in low- and middle-income countries. These homemade explosives incorporate certain objects that create unique injury patterns that present diagnostic and therapeutic challenges. This study examines the maxillofacial wounds and patterns of Boko Haram IED victims treated at the University of Maiduguri Teaching Hospital (UMTH). Understanding the different wounding patterns these injuries cause and management options will help with proper planning and management.

Method: This retrospective study was carried out over five years at UMTH, Nigeria. The clinical records and treatment approaches of IED injuries to the maxillofacial region were obtained from patient case notes. Data were analyzed using the statistical software SPSS version 20.

Results: The study involved 14 patients, 14–43 years old. There were three (21.4%) females, M:F ratio of 4.7:1. Primary blast injuries were seen in six (42.9%). Lacerations were the most common facial injury at 31.7%%. The most common facial fractures recorded were naso-orbitoethmoidal at 21.9%, maxillary at 18.8%, and frontal bone fractures at 15.6%. Globe rupture occurred in six (42.9%). The most common treatment was closed reduction with intermaxillary fixation (57.4%).

Conclusion: Intermaxillary fixation emerged as the predominant treatment modality, reflecting the pragmatic use of available resources. Prevention is critical to reducing IED injuries.

Keywords: improvised explosive device, maxillofacial injury, resource-limited setting, Nigeria

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Introduction

The Boko Haram insurgency in north-eastern Nigeria, which began in 2009 with Borno State as its epicentre, has been defined by bombings, kidnappings, and attacks on significant sites, affecting millions in the region.[1] The utilisation of Improvised Explosive Devices (IEDs) in the groups' guerrilla-style tactics

presented substantial security obstacles, resulting in mass casualties inflicting multiple injuries primarily from these explosives and, firearms impacting civilians, military, including the insurgents.[2] These homemade explosives are manufactured using commercial blasting supplies or fertilizers, and they often include nails, bolts, and other sharp objects. These objects cause distinct injury patterns that provide diagnostic and treatment difficulties for healthcare practitioners.[3]

Maxillofacial injuries are becoming increasingly important due to the potential for significant psychological, social, and economic effects resulting from disfigurement and trauma in this area.[4] The maxillofacial region is connected to important structures crucial for clinical care and outcomes.[4] While numerous studies have explored the general impact of IED injuries on the body, there remains a lack of focused research on the specific diagnostic and treatment challenges of maxillofacial injuries caused, particularly in conflict zones like North-eastern Nigeria.[3,4] Existing literature often overlooks the unique anatomical complexities of the facial region and the socio-economic and infrastructural challenges that impact effective treatment in such settings, underscoring the need for context-specific data and treatment protocols tailored to resource-limited environments.[4] This retrospective study examines the maxillofacial wounds and patterns of Boko Haram IED victims treated at the University of Maiduguri Teaching Hospital.

Method

This retrospective study was carried out at the Department of Oral and Maxillofacial Surgery, University of Maiduguri Teaching Hospital (UMTH), Borno State, Nigeria, over 5 years from 2016 to 2022 at the peak of the insurgency period. A sample was chosen from the existing data and included all IED victims with maxillofacial injuries who presented to the tertiary hospital. Injuries to the maxillofacial regions were categorised as soft tissue injuries, including facial burns, abrasion, contusion, laceration, avulsion injury, or hard tissue injury: dento-alveolar, maxillary, mandibular, zygomatic complex, naso-orbito-ethmoidal, frontal, and pan-facial fractures. The study protocol was approved by the Ethics Review Committee of UMTH (OHRP-IRB00013572 UMTH/REC/23/1105). The patients' files were reviewed for demographics, diagnostic findings, primary blast injury type, injury severity score, soft tissue injury, hard tissue injury, and treatment approaches.

Data were entered in Microsoft Excel (version 20) and cleaned of errors. Statistical analyses were performed using statistical software SPSS version 20.0 for Windows (SPSS Inc.).

Table 1. Demographic data and Primary blast injuries

Age	Male n (%)	Female n (%)	Total n (%)
Birth – 25 years	2 (14.3)	2 (14.3)	4 (28.6)
25 – 34 years	5 (35.7)	1 (7.1)	6 (42.8)
> 34 years	4 (28.6)	0 (0.0)	4 (28.6)
Total	11 (78.6)	3 (21.4)	14 (100.0)
Occupation			
Military	6 (42.9)	0 (0.0)	6 (42.9)
Civilian	5 (35.7)	3 (21.4)	8 (57.1)
Total	11 (78.6)	3 (21.4)	14 (100.0)
Injury			
Globe rupture	6 (42.9)	0 (0.0)	6 (42.9)
Middle ear damage	3 (21.4)	0 (0.0)	3 (21.4)
Abdominal haemorrhage	0 (0.0)	0 (0.0)	0 (0.0)
Blast lung	0 (0.0)	0 (0.0)	0 (0.0)
Concussion	0 (0.0)	1 (7.1)	1 (7.1)
Total	**9 (64.3)**	**1 (7.1)**	**10 (71.4)**

Table 2. Distribution of concomitant injuries

Variables	Presence of concomitant injuries		p-value
	No n (%)	Yes n (%)	
Sex			
Male	4 (28.6)	7 (50)	0.193
Female	3 (21.4)	0 (0)	
Occupation			
Military	2 (14.3)	5 (35.7)	0.285
Civilian	5 (35.7)	2 (14.3)	

Results

The study consisted of 14 patients aged 14 to 43 years, with a mean age of 29.5 years (SD = 8.81). Females formed 21.4% of the group, with a male-to-female ratio 4.7:1 (Table 1). Primary blast injuries were identified in six patients (42.9%) (Table 1).

When analyzing sex differences in concomitant injuries, 50% of males presented with such injuries, whereas no females did. However, this difference was not statistically significant (p = 0.193). Similarly, the proportion of military personnel with additional injuries (35.7%) exceeded that of civilians (14.3%), though this, too, was not statistically significant (p = 0.285) (Table 2).

Only 7.2% of participants reported using protective gear, which appeared to be associated with less severe injuries (ISS < 15), although the association was not statistically significant (p = 0.260) (Table 3). Lacerations were the most frequently reported soft tissue injuries, while the most common facial fractures were naso-orbitoethmoidal (21.9%), maxillary (18.8%), and frontal fractures (15.6%) (Table 4).

Orbital globe rupture was seen in six patients (42.9%). The most frequently employed treatment method was closed reduction with intermaxillary fixation, used in 57.4% of cases (Figure 1). One patient did not survive the injury.

Table 3. Use of protective gear and injury severity score among participants

Protective gear	ISS<15 n (%)	ISS>15 major trauma n (%)	ISS 75 un-survivable n (%)	Total n (%)	p-value
No	3 (21.4)	9 (64.3)	1 (7.2)	13 (92.8)	
Yes	1 (7.2)	0 (0)	0 (0.0)	1 (7.2)	
Total	4 (28.6)	9 (64.3)	1 (7.2)	14 (100)	0.260

Table 4. Facial soft and hard tissue injury recorded

Injury type	Male n (%)	Female n (%)	Total n (%)	p-value
Soft tissue injury				
Burns	6 (17.1)	0 (0.0)	6 (14.6)	
Abrasion	7 (20.0)	2 (33.3)	9 (22.0)	
Contusion	5 (14.3)	0 (0.0)	5 (12.2)	
Laceration	10 (28.6)	3 (50.0)	13 (31.7)	
Avulsion	7 (20.0)	1 (16.7)	8 (19.5)	
Total	35 (100.0)	6 (100.0)	41 (100.0)	
Hard tissue injury				
Dento-alveolar frac-ture	4 (14.3)	0 (0.0)	4 (12.5)	0.546
Maxillary	5 (17.9)	1 (25.0)	6 (18.8)	
Mandibular	2 (7.1)	2 (50.0)	4 (12.5)	
Zygomatic complex	3 (10.7)	0 (0.0)	3 (9.4)	
Naso-orbito-ethmoidal	7 (25.0)	0 (0.0)	7 (21.9)	
Frontal	4 (14.3)	1 (25.0)	5 (15.6)	
Pan facial	3 (10.7)	0 (0.0)	3 (9.4)	
Total	**28 (100.0)**	**4 (100.0)**	**32 (100.0)**	**0.244**

Discussion

These results show that a more significant percentage of males suffered from IED maxillofacial injuries, considering the increased risk and susceptibility of this group during war. Most military and insurgency combatants are male. This observed higher incidence of male casualties supports previous research conducted by Aras M et al.,[5] and that by Chaiprom et al.[6] The age group with the highest incidence of maxillofacial injuries was 25-34 years, accounting for 42.8% of cases. This may be related to their propensity for risk-taking and sense of invulnerability in this age group.

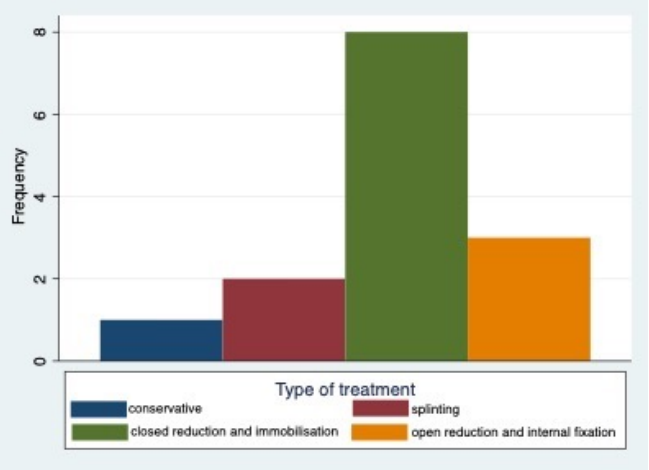

Figure 1. Type of treatment of facial fractures.

Concerning primary blast injuries, over half of the individuals in the study experienced these injuries. Orbital globe rupture (Figures 2 and 3), accounting for 42.9% of primary blast injuries in this study, underscores the vulnerability of the ocular structures to the high-energy forces and projectiles generated by IEDs. The blast waves and shrapnel from such explosions can cause significant ocular damage, leading to globe rupture, which is a severe and vision-threatening condition.[7] Primary blast injuries are often generated by a shock wave of excessive pressure, followed by a wave of reduced pressure, which passes through the body.[3, 4] This injury›s prevalence highlights the ocular structures› vulnerability in blast environments.

Previous literature supports these findings. Mader et al. (2006) emphasized the vulnerability of the eyes to blast waves among military personnel exposed to explosive devices.[7] Weichel et al. (2008) highlighted the common occurrence of ocular injuries, such as globe ruptures, in soldiers injured by IEDs, indicating a significant risk to vision.[8] Comparatively, globe rupture as a primary blast injury is less commonly reported in civilian trauma settings, where the mechanisms of injury differ, such as in traffic accidents or falls, which typically result in different types of ocular trauma.[9] The high incidence of globe rupture in blast injuries underscores the need for protective measures and rapid medical intervention to mitigate the severe consequences.

Figure 2. A: patient at presentation with degloving facial injury and multiple fractures. B: Patient at one month post operatively. (Credit: Mohammed Adam Sheikh Abdullahi)

Figure 3. Patient at presentation with bilateral globe rupture, lip laceration, and multiple abrasions and 1 month post operatively. (Credit: Mohammed Adam Sheikh Abdullahi)

The observed higher incidence of naso-orbitoethmoidal (NOE), maxillary, and frontal fractures in the context of improvised explosive device (IED) injuries can be attributed to the nature of these explosive forces, which often generate high-velocity projectiles and blast waves that predominantly impact the central facial region (Figure 4). This finding is consistent with the literature on maxillofacial trauma in conflict zones, where the direction and intensity of the blast influence the distribution of facial fractures.

Previous studies have documented similar patterns. A study by Levin et al. (2008) on maxillofacial injuries in military personnel found that NOE fractures were among the most common due to the central position of the nose and orbits, which are frequently impacted by explosive forces.[10] Similarly, Masud et al. (2013) reported a high prevalence of maxillary and frontal fractures in victims of IED blasts in Afghanistan, emphasizing the vulnerability of the midface and upper facial skeleton to such injuries.[11]

In comparison, in non-conflict environments, the distribution of facial fractures is often more varied, with mandibular fractures typically being more prevalent due to different mechanisms of injury, such as assaults and traffic accidents.[12] However, the concentration of NOE, maxillary, and frontal fractures in blast injuries underscores the unique injury patterns associated with high-energy explosive forces, which differ significantly from those observed in peacetime trauma.

The high prevalence of closed reduction with intermaxillary fixation (IMF) as a treatment modality aligns with the pragmatic approach often necessitated by limited resources and the lack of health insurance coverage. Closed reduction with IMF is a widely accepted method for managing facial fractures, particularly in environments where advanced surgical facilities and equipment may be scarce. This approach minimizes the need for extensive surgical intervention and relies on relatively accessible materials, making it suitable for resource-constrained settings. Adebayo et al. (2013) emphasized that in Nigerian tertiary hospitals, IMF was the primary method for treating mandibular fractures due to resource limitations and practicality in managing complex injuries.[13] Another study in Iraq by Al-Issawi et al. (2015) found IMF commonly used in treating maxillofacial injuries from explosive devices, highlighting its usefulness in conflict zones with limited surgical resources.[14]

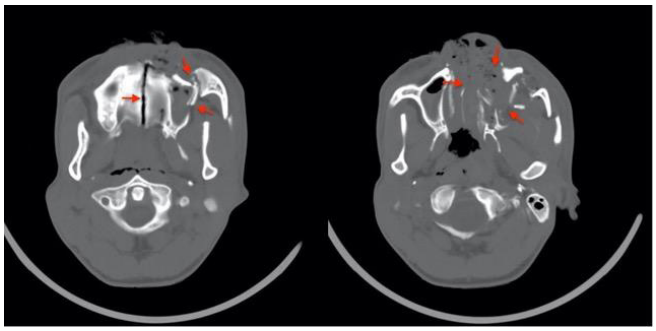

Figure 4. Axial scanograms showing NOE, right maxillary, zygomatic complex fracture, and palatal split. (Credit: Mohammed Adam Sheikh Abdullahi)

The preference for IMF in these settings contrasts with higher-resource environments, where open reduction and internal fixation (ORIF) using plates and screws is more commonly employed due to its potential for more precise anatomical alignment and faster functional recovery.[15] However, IMF remains a vital option in low-resource settings due to its lower cost, ease of implementation, and effectiveness in achieving satisfactory clinical outcomes without advanced surgical infrastructure.

In the long term, individuals with major maxillofacial injuries from IEDs face chronic pain, speech difficulties, and disfigurement, necessitating extensive surgeries. They also endure post-traumatic stress disorder, anxiety, and social isolation, which are exacerbated in regions with limited healthcare access.[14] Treating maxillofacial injuries from IEDs in northeastern Nigeria is impeded by insufficient surgical expertise, limited advanced imaging, scarce rehabilitation, psychosocial support, and inadequate post-operative care. Sustainable solutions include training local healthcare providers and enhanced international collaboration.

Conclusion

Intermaxillary fixation emerged as the predominant treatment modality, reflecting the pragmatic use of available resources. The prevalence of NOE, maxillary, and frontal fractures underscores the central facial region›s vulnerability to high-energy explosive forces. Additionally, the high incidence of globe rupture as the most common primary blast injury highlights the severe impact of IEDs on ocular structures. These findings emphasize the need for specialized training and proper planning to improve outcomes for individuals affected by blast-related maxillofacial trauma.

A more extensive, future study on long-term outcomes of IED-induced maxillofacial injuries in resource-limited settings could provide evidence-based guidelines, improve surgical techniques, and enhance rehabilitation services. Findings from this larger study will guide specialized training for holistic healthcare in conflict zones.

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Patients› consents: Consent was obtained from patients whose photographs are shown.

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