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Research Article

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The Clinical Impacts of Stray Ammunition on Craniocerebral Injuries

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Abstract

Background: Stray ammunition injuries are firearm injury inflicted outdoors by an unidentified assailant caused by shooting into the sky to celebrate a happy event or to express anger. Aerial shooting during a riot and mob control is noted in conflict zones. ***Objective***: To assess the severity of stray ammunitions and the clinical impact of such injury on the craniocerebral structures. ***Methods***: It was a case series study conducted retrospectively at the Neurosurgery Teaching Hospital, Baghdad, from the 1st of February 2019 to the 1st of October 2025. 109 patients with cranial stray bullet injuries, where patients with direct shootings to the head and blast injuries were excluded from the study. ***Results***: There was male predominance, and the initial Glasgow Coma Scale (GCS) played a major role in indicating the severity of injury and was highly significant in relation to outcome (p=0.002) with a mortality rate reaching 43%. The worse outcome occurred from a deeper brain injury that reached the midline structures like the brainstem (p=0.001).Regression models were employed to identify variables that independently influenced functional recovery. ***Conclusions***: Iraq is one of the countries that are affected by stray ammunition injurieswith a mortality rate reaching 43%. The initial GCS at presentation plays a crucial role in determining the fate and outcome of the injured patients, and understanding this fact helps us in the sorting and triage system in the emergency room. Thus, the use of guns and firearms must be restricted and under control.

Keywords: Craniocerebral injuries; Gravitational bullet injury; Head trauma; Stray ammunitions.

التأثيرات السريرية للذخائر الطائشة على إصابات الجمجمة والدماغ

الخلاصة

الخلفية: تُعرَّف إصابات الذخيرة الطائشة بأنها إصابات غير مقصودة ناجمة عن إطلاق نار في الهواء الطلق من قبل مهاجم مجهول. وعادةً ما تحدث هذه الإصابات نتيجة إطلاق النار في الهواء احتفالاً بمناسبة سعيدة أو تعبيراً عن الغضب، وكذلك إطلاق النار في الهواء أثناء أعمال الشغب والسيطرة على الحشود، وهو أمر شائع في مناطق النزاع. **الاهداف**: تقييم شدة اصابات الذخائر الطائشة وتاثيرها على الدماغ وعضام الجمجمة. **الطرائق**: اجريت دراسة بأثر رجعي في مستشفى جراحة الجملة العصبية التعليمي للفترة من الاول من شباط 2019 الى الاول من تشرين الاول 2025 وشملت (109) مريض مصابين بجروح في الرأس نتيجة طلقات نارية طائشة، مع استبعاد المرضى الذين تعرضوا لإطلاق نار مباشر على الرأس أو إصابات ناجمة عن الانفجارات. **النتائج**: شملت دراستنا 109 مريض، وكان معظمهم من الذكور. لعب مقياس غلاسكو للغيبوبة (GCS) الأولي دورًا رئيسيًا في تحديد شدة الإصابة، وكان ذا دلالة إحصائية عالية فيما يتعلق بالنتائج (قيمة p=0.002). وقد لوحظت أسوأ النتائج في حالات إصابات الدماغ العميقة التي تصل إلى نقط عميقة في الدماغ مثل جذع الدماغ (قيمة p=0.001). **الأستنتاجات**: يُعد العراق من بين الدول الأكثر تضررًا من إصابات الذخيرة الطائشة. هذه الإصابات خطيرة ومُهمة، حيث تصل نسبة الوفيات إلى 43%. يلعب مقياس غلاسكو للغيبوبة (GCS) عند وصول المصابين دورًا حاسمًا في تحديد مصيرهم ونتائج علاجهم، وفهم هذه الحقيقة يُساعدنا في نظام الفرز والتصنيف في غرف الطوارئ. لذا، يجب تقييد استخدام الأسلحة النارية وإخضاعها للرقابة.

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INTRODUCTION

Stray bullet injuries, defined by the International Classification of Diseases as an unintentional firearm injury inflicted outdoors by an unidentified assailant, can affect any part of the human body including the head, neck, chest, abdomen, and extremities [1]. These injuries commonly occurred in developing countries and some developed countries found in the middle of Asia, south America, the Middle East, and North Africa. Usually caused by shooting into the sky to celebrate a happy event or to express anger, aerial shooting during a riot and mob control is noted in the setting of conflict zones [2]. This type of bullet injury can cause severe injury and death, as the terminal velocity required to penetrate the skin is low. Moreover, the incidence and outcome of such injuries are challenging and difficult to determine, as many victims do not seek medical advice and care at the scene and are not registered in the hospital. Although the stray bullet can affect any age and gender, it is commonly affected males aged from fifteen to thirty-five years old [3]. Many factors affect the bullet velocity after falling from the sky, including its composition, angle of firing, shape and caliber, direction of movement, and height [4]. Iraq is one of the countries suffering from stray bullet injuries; therefore, this article highlights the importance of raising awareness of the danger of such injury and the need to reduce the availability of and use of firearms and ammunitions in Iraq. The study will deal with and discuss only the stray ammunitions that cause craniocerebral injuries and the clinical computed tomography scan criteria occasions associated with ammunition shootings and the fate of these injuries.

METHODS

Study design and sampling

This retrospective study was conducted at the Neurosurgery Teaching Hospital from the 1st of February 2019 to the 1st of October 2025. One hundred nine patients with cranial stray bullet injuries, where patients with direct shootings to the head and blast injuries are excluded from the study. They were transferred from different hospitals of Baghdad to Neurosurgery Teaching Hospital and ordered according to the genders, ages, initial Glasgow coma scale (GCS), event type, extent of bullet injury, and CT scan (computed tomography scan) findings (Figure 1).

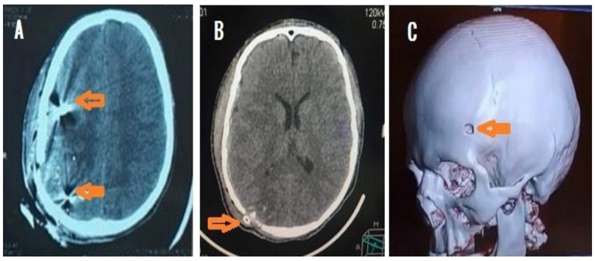

Figure 1: Brain CT scan findings. A) brain window axial CT scan shows tract hematoma and metallic shadow of bullet (red arrow), B) brain window axial CT scan shows the entry point of bullet where it settled near the skull bone (red arrow), and C) 3D skull bone CT scan reconstruction shows site of entry of bullet.

Outcome measurement

All the patients had been received at the casualty department, where they were fully assisted. After that, the Glasgow Coma Scale was measured for a commencing assessment in all of the victims. The patients with GCS less than 8 were admitted to the ICU (intensive care unit) for specific resuscitation. A full history was taken either from the relatives of patients or eyewitnesses because the majority of victims presented to us with a disturbed level of consciousness. A precise neurological evaluation was accomplished for each patient. Craniocerebral CT scans were done as the radiological tool of choice for all of the patients. Definitive treatment was executed for the patient according to the clinical assessment and brain CT finding either continue on conservative measures or do surgery. Finally, assessment of outcome by measuring the Glasgow Outcome Scale (GOS) with follow-up intervals ranging from 3 to 24 months.

Ethical considerations

The study protocol was revised and approved by the local ethical committee in the Department of Surgery, Neurosurgery Teaching Hospital, Baghdad, Iraq.

Statistical analysis

Statistical analysis utilized the Statistical Packages for the Social Sciences program (SPSS) version 26, with classification data presented in percentage form. The analysis of categorical data was conducted using the Chi-square test. Regression models were employed to identify variables that independently influenced functional recovery, disability, and mortality, i.e., comparison of the studied variables to the Glasgow Outcome Scale (GOS). The significance level for the tests was considered at $p < 0.05$.

RESULTS

In our study, a total of one hundred and nine injured patients were enrolled, 60 males and 49 females (Table 1). Regarding the clinical examinations of the injured patients and their related outcomes, fourteen percent of patients had a GCS of 3-5; 14 of them (93%) had a poor outcome, and one patient (7%) had a good outcome. Twenty-three percent of patients had a GCS of 6-8; 21 of them (84%) had a poor outcome, and 4 patients (16%) had a good outcome. Thirty-one percent of patients had GCS (9-12); 6 of them (18%) had a poor outcome, while 18 patients (82%) had a good outcome. The remaining thirty-two percent were with mild GCS (13-15); 7 of them (20%) had poor outcomes, and 28 patients (80%) had good outcomes ($p = 0.002$). When talking about the extent of injury, we found twenty-six percent of patients had extradural injuries (scalp and skull bone); only one (4%) had a poor outcome, while 27 patients (96%) got a good outcome. Thirty-eight percent of patients injured with penetrating head trauma without an exit site and without ricochet, 22 of them (73%) had poor outcomes, and 8 only (27%) got good outcomes. Another 28 had penetrating injuries without exit wounds but with ricochets; 22 of them (73%) had poor outcomes, and 8 only (27%) got good outcomes. Seven percent of patients had perforating injuries with exit wounds through the orbits; 88% of them had poor outcomes, and 12% had good outcomes. Four percent of patients suffered from perforating injury with exit wounds through the paranasal sinuses or skull base; 60% got poor outcomes, and 40% had good outcomes ($p = 0.001$). On computed tomography (CT) scan findings and the related outcomes, the major category (twenty-eight percent) had unilobed injury; 2 of them (7%) had poor outcomes, while 28 (93%) had good outcomes. Fifteen percent of patients had injury to both cerebral hemispheres; 14 of them (88%) got a poor outcome, and 2 (12%) had a good outcome. Sixteen percent of patients had a bullet tract through the central area, 15 of them (88%) suffered from a poor outcome, while 2 (12%) had a good outcome. Eighteen percent of patients had transventricular with intraventricular hemorrhage; 18 of them (90%) had poor outcomes, and only 2 (10%) got good outcomes. Thirteen percent of patients suffered from subarachnoid hemorrhage; 4 patients (29%) suffered from a poor outcome, and 10 (71%) were with a good outcome. Six percent of patients of all had significant intracranial hematoma; 2 of them (29%) were with poor outcomes, while 5 (71%) had good outcomes. The least number (four percent) was affected by small intracranial hematomas (<1 cm); one (20%) suffered from a poor outcome, while 4 (80%) had a good outcome (p= 0.001) (Table 2).

Table 1: Distribution of studied demographic variables according to the outcome (n=109 patients)

Variables	No.	Poor outcome	Good outcome	*p*-value
Gender				
Male	60	23(38)	37(62)	0.60
Female	49	22(45)	27(27)	
Age (year)				
< 10	34(31)	14(41)	20(59)	0.9
10-20	39(36)	15(38)	24(62)	
21-30	28(26)	8(29)	20(71)	
31-39	4(3.5)	2(50)	2(50)	
≥40	4(3.5)	1(25)	3(75)	
Event type				
Happy event or to express anger	42(39)	17(40)	25(60)	0.9
Riot and mob in conflict zones	67(61)	25(37)	42(63)	

Values are presented as frequency and percentage.

Table 2: Distribution of clinical and radiological variables according to the outcome (n=109 patients)

Variables	No.	Poor outcome	Good outcome	*p*-value
Glass coma scale at presentation				
3-5	15(14)	14(93)	1(7)	0.002
6-8	25(23)	21(84)	4(16)	
9-12	34(31)	6(18)	28(82)	
13-15	35(32)	7(20)	28(80)	
Extent of bullet injury				
Extradural injuries (scalp + bone)	28(26)	1(4)	27(96)	0.001
Penetrating injury (no exit wound) without ricochet	38(35)	27(72)	11(28)	
Penetrating injury (no exit wound) with ricochet	30(28)	22(73)	8(27)	
Perforated injury with exit wounds through the orbit	8(7)	7(88)	1(12)	
Perforating injury with exit wounds through the paranasal sinuses or base	5(4)	3(60)	2(40)	
CT scan findings				
Unilobed injury	30(28)	2(7)	28(93)	0.001
Bihemispheric injuries	16(15)	14(88)	2(13)	
Bullet tract through the central area	17(16)	15(88)	2(12)	
Transventricular with IVH	20(18)	18(90)	2(10)	
Subarachnoid hemorrhage	14(13)	4(29)	10(71)	
Significant intracranial hematoma	7(6)	2(29)	5(71)	
Small intracranial hematomas (<1cm)	5(4)	1(20)	4(80)	

Values are presented as frequency and percentage.

Long-term complications and mortality varied. Most of the patients (43) had motor deficits (39%), 11 patients had seizures (10%), 12% complained of speech problems, 19% developed personality issues, 6% of patients turned in a vegetative state, and 34% of the injured cases ended with death (Table 3).

Table 3: Long-term complications and mortality (n=109 patients)

Variables	n(%)
Seizure	11(10)
Motor deficits	43(39)
Speech problems	13(12)
Personality related issues	21(19)
Vegetative state	7(6)
Death	37(43)

DISCUSSION

Iraq is one of the countries that are suffering from stray bullet injuries. As mentioned above, 47 patients suffered from injuries due to social activities since some Iraqi people, especially in rural and suburban areas, use guns and firing as an expression of their anger or happy activities. Another 60 patients had injuries due to conflict zones, as Iraq suffered from many wars and conflicts, and many people were injured or died due to that. Regarding age, most injuries occur in young people, who are victims of interpersonal violence, and this is consistent with other reports [5-7]. This underscores the social and public health issues prevalent in regions like ours, where violence significantly impacts young adults. Regarding the clinical examination, the GCS score upon presentation is a well-established predictor of mortality and functional outcome [8-12]. In this study, as GCS is classified as mild, moderate, and severe, the percentages are approximate, with the highest number in severe injuries (GCS 3-8), and this is the usual with these types of injuries. The more severe the injuries, the poorer the prognosis, and this is compared to the study by Ambrossini *et al*. [13], as the more penetration to the brain, the more damage to the neural and glial brain tissue, leading to a poorer prognosis. GCS has a high level of significance in our study. The extent of missile injury varies from superficial ones limited to scalp and skull bones to penetration with or without exit sites, and it is noted that the deeper the injury, the poorer the outcome. This is explained as deep injuries have more harm to vital cerebral structures; this is compared to what Polin et al. reported [14]. A similar comparison of outcomes is illustrated when we discuss the results of injury on a brain CT scan. Brain injuries vary from unilobed only to transventricular and biventricular. And the deeper injury related to the ventricular system, the poorer the outcome is. That is explained as more damage happens when the missile tract destroys more brain tissue, injuring the deepest ventricular structures, which are nearby other studies that deal with civilian ammunitions [15-17].

This entity has a significant impact on our study. The long-term complications are varied. They include motor weaknesses, seizures, personality changes, speech problems, and others. These symptoms develop according to the brain lobe and part affected; for example, when the brain cortex is injured, a seizure may develop, and when the precentral gyrus is affected, motor weakness will occur [18].

Conclusion

Iraq is one of the countries that are affected by stray ammunitions injuries. These injuries are important and dangerous, with a mortality rate reaching 43%. The initial GCS at presentation plays the crucial role in determining the fate and outcome of the injured patients and appears highly clinically significant. Understanding this fact helps us in the sorting and triage system in the emergency room, i.e., our target patients to manage firstly with a GCS range from 9 to 12; the interventions for this group will change their outcome. CT scan findings and extent of bullet injury carry significant relations to outcome, and they are used as a guide for management of craniocerebral stray bullet injuries. Thus, the use of guns and firearms must be restricted and under control.

Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

The data that supports the findings of this study are available from the corresponding author upon a reasonable request.

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