Neurosurgical Management of Nonmissile Penetrating Cranial Lesions

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■ OBJECTIVE: **The objective of this study is to present a case series of nonmissile penetrating (NMP) injuries and to establish a workflow for an uncommon mechanism of traumatic head injury through the analysis of each case, classification of the type of lesion, management, and outcome score at follow-up.**

■ METHODS: **From January 1991 to December 2008, 36,000 patients presenting with traumatic brain injury (TBI) were admitted in the Department of Neurosurgery, Hospital Antônio Targino, Campina Grande-PB, Brazil. From these patients, 11 presenting with lesions caused by NMP objects were selected.**

■ RESULTS: **Among the 11 patients, 9 were men and 2 were women. Their ages ranged from 7 to 74 years old (mean age ± SD, 29.1 ± 22.99 years). All patients underwent neuroradiologic evaluation. The entry point was classified as natural (orbit) or artificial (skull transfixation), and we also divided the patients presenting with secondary parenchymal or vascular damage from those presenting with only lesions caused by the primary penetration into the cranium and meninges. All patients were neurosurgically treated with removal of the foreign body through craniotomy, except the patient whose object (pen) was removed without craniotomy with local anesthesia. Glasgow Coma Scale (GCS) score on admission was a statistically significant factor on prognosis, and any patient who presented with a GCS score of 15 evolved satisfactorily, and there were no deaths in this group of patients ($P = 0.04$).**

■ CONCLUSIONS: **TBIs caused by NMP objects are unusual and caused by aggression, self-inflicted harm (in the case of psychiatric patients), and accident. The foreign body may enter into the skull through a natural hole (orbit, nose, mouth, or ear) or crosses the skull, causing a fracture and creating an artificial hole. Preoperative neuroradiologic assessment is paramount for the correct neurosurgical approach. The main prognostic factor for these patients is the GCS score at admission.**

INTRODUCTION

Penetrating lesions to the skull and brain can be classified as missile or nonmissile; the main difference between the 2 is the velocity of impact.[1] Nonmissile penetrating (NMP) lesions are defined as having an impact velocity of <100 m/s, causing injury by laceration and maceration, whereas missile projectiles cause lesions by kinetic and thermal energy.[2] NMP injuries usually occur in young men who suffer accidental injury to the orbit or natural orifices.[1-3] Most of these lesions are caused by aggression, self-inflicted harm (in the case of psychiatric patients), and accident.[4]

Traumatic brain injuries (TBIs) caused by NMP objects are unusual and described in case reports in the literature,[5-7] which makes the neurosurgical management of this subject extremely controversial.

In addition, we may classify NMP injuries in 2 types: those entering through a natural orifice (orbit, nose, mouth, or ear) and those whose object really crosses the skull, causing a fracture and creating an artificial orifice.

Key words
- Neurosurgical management
- Nonmissile penetrating injury
- Penetrating lesion
- Trauma
- Traumatic brain injury

Abbreviations and Acronyms
AED: Antiepileptic drug
CSF: Cerebral spinal fluid
CT: Computerized tomography
GCS: Glasgow Coma Scale
MRI: Magnetic resonance imaging
NMP: Nonmissile penetrating
TBI: Traumatic brain injury

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The neurosurgical management of NMP injuries is based on the correction of entry point to avoid cerebral spinal fluid (CSF) leakage (primary lesion) and to treat secondary lesions caused by the penetrating object, such as brain parenchyma and vascular lesions. In this regard, the preoperative neuroradiologic assessment is paramount for the correct neurosurgical approach.

The objective of this study is to present a case series of NMP injuries and to establish a workflow for an uncommon mechanism of traumatic head injury through the analysis of each case, classification of the type of lesion, management, and outcome score at follow-up.

METHODS

From January 1991 to December 2008, 36,000 patients presenting with TBI were admitted in the Department of Neurosurgery, Hospital Antônio Targino, Campina Grande-PB, Brazil. From the patients, we selected 11 presenting lesions with caused by NMP objects. The patients who had an object penetrated through the oral cavity were also evaluated by a buccomaxillary dentist (N.R.C.).

In this article we analyzed the object that caused the injury, the entry point, the mechanism of lesion, the presence of secondary injury to the brain (subarachnoid hemorrhage, brain hematoma, vessel injury, etc.), clinical presentation according to the Glasgow Coma Scale (GCS), neurosurgical management, and outcomes according to the Glasgow Outcome Scale.

Data Evaluation

Each group was distributed into categories of outcome, with the aim of observing whether some of these variables influence the Glasgow Outcome Scale. The Fisher exact test was used to describe the relationship between sex (men or women), entry point (natural or artificial orifices), mechanism of lesion (aggression or not), and GCS score at admission. Therefore, each variable was transformed in a table 2×2 for statistical analysis. Weighted mean differences and 95% confidence intervals were calculated. Significance was set at $P < 0.05$.

RESULTS

Among the 11 patients, 9 were men and 2 were women. Their ages ranged from 7 to 74 years old (mean age $\pm$ SD, 29.1 $\pm$ 22.99 years).

All patients underwent neuroradiologic evaluation before surgery, which included cranial plain radiography, computerized tomography (CT) scans, and intracranial angiography when vascular lesion was suspected. All NMP objects had metallic components, which contraindicated the use of magnetic resonance imaging (MRI) because of magnetic fields that could move those foreign bodies.

Based on a careful review of medical charts and neuroradiologic examinations of the patients included in this series, the entry point was classified as natural (orbit) or artificial (skull transfixation), and we also divided the patients presenting with secondary parenchymal or vascular damage from those presenting with only lesions caused by the primary penetration into the cranium and meninges.

Table 1. Summary Data of Demographics, Nonmissile Penetrating Object and Entry Point, Mechanism of Lesion, Clinical Presentation, Neurosurgical Management, and Outcome

Patient Number	Sex	Age (years)	Entry Point	Object	Mechanism	Secondary Lesions	Admission (GCS score)	Neurosurgical Management	Outcome (GOS score)
1	Male	14	Orbit	Iron bar	Accident	No	15	Orbitopterional craniotomy	5
2	Female	12	Orbit	Iron bar	Accident	No	15	Orbitofrontal craniotomy + duroplasty	5
3	Male	14	Orbit	Pen	Aggression	No	15	Object removal	5
4	Male	20	Face (maxilar)	Iron bar	Accident	No	15	Craniotomy + duroplasty	5
5	Female	8	Temporal	Screwdriver	Aggression	No	14	Craniotomy + duroplasty	5
6	Male	45	Parietal	Chisel	Aggression	Traumatic SAH	13	Craniotomy + duroplasty	5
7	Male	7	Frontal	Knife	Aggression	Traumatic SAH	15	Craniotomy + duroplasty	5
8	Male	74	Parietal	Nail	Self-inflicted (psychiatric)	No	14	Craniotomy + duroplasty	5
9	Male	64	Parietal	Nail	Aggression	Focal seizures	15	Craniotomy + duroplasty	4
10	Male	35	Parietal	Axe	Aggression	Deep hematoma	5	Craniotomy + duroplasty	1
11	Male	28	Orbit	Knife	Aggression	Traumatic SAH Carotid artery thrombosis	13	Craniotomy + duroplasty	1

GCS, Glasgow Coma Scale; GOS, Glasgow Outcome Scale; SAH, subarachnoid hemorrhage.