Management of War-Related Ballistic Craniocerebral Injuries in a French Role 3 Hospital During the Afghan Campaign

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■ INTRODUCTION: **France deployed to Afghanistan from 2001 to 2014 within the International Security and Assistance Force. A French role 3 hospital was built in 2009 in the vicinity of Kabul International Airport (KaIA). The objectives of this study were to describe the epidemiology, management, and outcome of war-related craniocerebral injuries during the Afghan campaign in a French role 3 hospital.**

■ METHODS: **From March 1, 2010 to September 30, 2012, we conducted a retrospective descriptive study in Kabul, Afghanistan. All patients presenting with a ballistic craniocerebral injury to the KaIA role 3 hospital were included.**

■ RESULTS: **We analyzed 48 records. Mean age was 21.9 years (1—46 years) with a 37:11 (male:female) sex ratio and a majority Afghan population ($n = 41$). Civilians represented 64.6% ($n = 31$) of casualties. On the battlefield, mean Glasgow Coma Scale score was 9.4 [3—15]. On arrival at the KaIA field hospital, 20 of the 48 patients were hemodynamically unstable. All patients underwent a full-body computed tomography scan. The majority of our casualties had associated injuries. Neurosurgery was indicated for 42 (87.5%) patients. The surgery consisted of wound debridement plane by plane associated with decompressive craniectomy ($n = 11$), debridement craniectomy ($n = 19$), and craniotomy ($n = 12$). A total of 32.4% wounded died at the point of injury, 8.4% at the emergency department, and 16.9% after surgery.**

■ CONCLUSIONS: **War casualties with ballistic head injuries were predominantly multitraumatized patients with hemodynamic compromise requiring neurosurgical damage control management and multidisciplinary care. The neurosurgeon has thus an essential role to play.**

INTRODUCTION

France deployed to Afghanistan from 2001 to 2014 within the International Security and Assistance Force (ISAF) led by the United States of America. After the intensification of combat operations in 2008, the number of French troops began to increase and reached 4000 in July 2010. To insure the most appropriate medical support for ISAF forces, a French role 3 hospital, with standards of care almost similar to those in France, was built in 2009 in the vicinity of Kabul International Airport (KaIA). According to North Atlantic Treaty Organization, a role 3 is a military medical structure deployed to a foreign country at war that includes specialist diagnostic resources, specialist surgical and medical capabilities, dentistry, and operational stress management teams.[1] This structure also welcomed Afghan National Army personnel and civilians not only for routine consultations but also for medical and surgical emergencies as part of the traditional French Medical Civic Action Program. As a consequence of the growing numbers of brain injuries in 2009, French neurosurgeons started ensuring regular rotations in it, which was the first time since the Gulf War.[2] Indeed, they previously used to deploy temporarily to Afghanistan within a role 2 structure.[2] As a consequence, neurosurgery represented

Key words
- Afghanistan
- Ballistic craniocerebral injuries
- Damage control
- War injury

Abbreviations and Acronyms
AUC: Area under the receiver operating characteristic curve
GCS: Glasgow Coma Scale
ISAF: International Security and Assistance Force
ISS: Injury Severity Score
KaIA: Kabul International Airport
RTS: Revised Trauma Score
TRISS: Trauma Injury Severity Score

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10.6% of the KaIA role 3 surgical activity.[1] Moreover, ballistic craniocerebral wounds are frequent in armed conflicts, with a 41% mortality rate.[3]

Regarding wounding agents, explosives and bullets are responsible for 75%–78% and 18%–20% of all war wounds, respectively[4,5]; however, their proportions in craniocerebral injuries specifically have always varied not only according to the period and location of conflicts but also to the combat strategies used. Furthermore, the distribution of injury mechanisms also varied within the same conflicts according to the evolution of warfare tactics.[3,4,6-9] Our objectives were to describe the epidemiology, neurosurgical management, and outcomes of war-related ballistic craniocerebral injuries during the Afghan campaign in a French role 3 hospital.

METHODS

From March 1, 2010, to September 30, 2012, we conducted a retrospective descriptive study in Kabul, Afghanistan. All patients presenting with a ballistic craniocerebral injury to the KaIA role 3 hospital were included. We excluded nonballistic craniocerebral injuries (bladed weapons, road traffic accidents, falls, etc.). We recorded the following data: demographics (age, sex, serviceman/civilian), mechanism of injury (shrapnel, bullet), use of protection gear, Glasgow Coma Scale (GCS) on the frontline and on admission and discharge from KaIA role 3, associated injuries, hemoglobin level, radiologic assessment, surgical management, and mass casualty incident. We used the Injury Severity Score (ISS), Revised Trauma Score (RTS), and Trauma Injury Severity Score (TRISS) to describe the associated injuries.

Data were then entered and analyzed with Microsoft Excel software (Microsoft, Redmond, Washington, USA). The statistical analysis for comparing the GCS, RTS, TRISS, and ISS between the 3 Glasgow outcome score groups was conducted using the following tests: *f* test or analysis of variance, a parametric test for inequality of population means, which is a generalization of the *t* test, Bartlett test for inequality of population variances, and nonparametric tests: Kruskal-Wallis and Mann-Whitney U test/Wilcoxon rank-sum test. We used the nonparametric tests when the Bartlett test indicated heterogeneous variances and analysis of variance was not appropriate. The statistical analysis for finding risk factors for favorable postoperative outcome was performed with the R software, version 3.3.2 (R Core Team, 2016; R Foundation for Statistical Computing, Vienna, Austria). The comparison of the average scores regarding postoperative survival was assessed with the Student *t* test ($P < 0.05$ for significant threshold). The Youden index and the overall accuracy were determined for different thresholds. The construction, receiver operating characteristic curve analysis, area under the receiver operating characteristic curve (AUC) calculation, and confidence interval were determined with the ROCR (2015; R package 'ROCR' version 1.0-7) and pROC R (2017; R package 'pROC' version 1.9.1) packages. DeLong test and bootstrapping were used for comparing the AUC. A model was considered highly discriminating if its AUC was between 0.87 and 0.9. It had an excellent discrimination if its AUC was >0.9.

RESULTS

We collected 77 patients; however, in 6 cases, the medical record was incomplete and in 23 cases, the patient had died before arrival to the hospital. These 29 records were therefore excluded. As a consequence, we analyzed the remaining 48 cases (Figure 1).

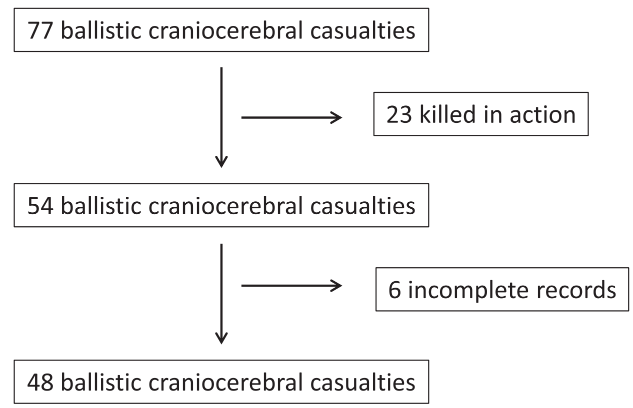

Figure 1. Flow chart of the 77 collected casualties.

Demographics and Mechanism of Injury

Mean age was 21.9 years (1–46) with a 37:11 (male:female) sex ratio and a majority Afghan population ($n = 41$). Civilians represented 64.6% ($n = 31$) of casualties. The other 17 were servicemen from ISAF ($n = 7$) and Afghan National Army ($n = 10$). Adults represented 64.6% ($n = 31$) with a mean age of 29 years (17–46 years) and a 28:3 (male:female) sex ratio. Mean age of children (<16.5 years) was 9.5 years (1–16 years) with a 9:8 (male:female) sex ratio. The mechanism of injury was shrapnel-related in 28 cases: improvised explosive device ($n = 19$) and rocket propelled grenade ($n = 9$). Bullets with high kinetic energy injured the other 20. Only 4 of the 17 wounded soldiers were wearing a helmet.

Clinical Evaluation

On the battlefield, mean GCS was 9.4 (3–15), and 12 patients required intubation for impaired consciousness (GCS < 8 and/or agitation). A deterioration of the GCS (decrease of at least 2 points) during evacuation was reported in 13 cases.

On arrival at the KaIA field hospital, 20 of the 48 patients were hemodynamically unstable and 43 patients underwent a focused assessment with sonography in trauma, which was positive in 9 cases. Mean GCS was 7.5 (3–15). Specifically, 21 patients had a GCS varying from 9 to 15 and the other 27 between 3 and 8. Pupillary abnormalities were recorded in 16 patients with 12 and 4 cases of unilateral and bilateral mydriasis, respectively. Mean hemoglobin level was 10.9 g/L. Nine casualties were admitted during 3 mass casualty incidents. Six of these were categorized T1 and 3 classified T4. Among the latter ones, only one was operated on the management of all T1 cases.

Radiologic Investigations

All 48 patients underwent a full-body computed tomography scan. The distribution of skull fractures and intracranial hemorrhagic injuries is shown in Table 1. We observed 37 incidences of cerebral