

Michael B. Larkin PharmD; R. Michael Meyer; Nicholas S. Szufliita MPH; John J. Delaney MD; Randy S. Bell MD  
F. Edward Hebert School of Medicine, Uniformed Services University, Bethesda, MD;  
Division of Neurosurgery, Walter Reed National Military Medical Center, Bethesda, MD

## Introduction

Outcomes of penetrating brain injuries (PBI) have historically been very poor. In the civilian trauma setting, PBI is predominated by gunshot wounds and mortality has been noted to be greater than 90% [1-7]. Twenty-one percent of civilian PBI patients achieve functional independence (FI), defined as a Glasgow Outcomes Scale (GOS) score of 4 or greater, at 2 years [6]. Outcomes for combat-related PBI have been observed to be better with a 5.8% mortality, up to 68% achieving FI at 2-years and a mean 2-year GOS score of 4 [8]. The difference between civilian and military PBI patient outcomes is primarily because the mechanism of injury (MOI) in combat related PBI is mostly blast, and military service members wear protective equipment to include ballistic helmets. Previous combat-PBI studies did not begin analysis at point of injury and thus the authors believe that the true mortality and long-term prognosis in this population remains unknown [8].



## Methods

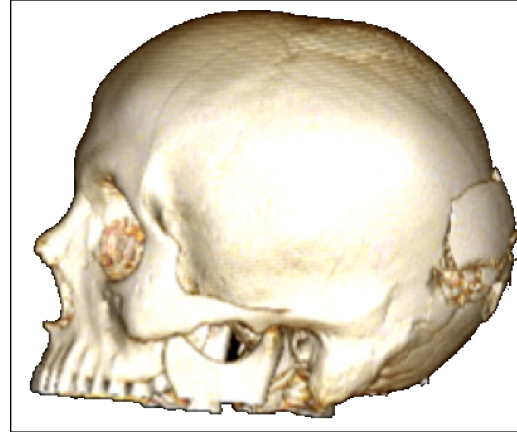
Retrospective chart review of neurosurgical consults of PBI that presented to the Role III Medical Unit at Kandahar Airfield, January 2010-March 2013. Of the 908 patients, 80 cases involved PBI of US active duty service members whose records were available for review. The primary outcome measure of interest was GOS score at 24 months.

## Results

All patients were male, mean age 25 years, and mean admission GCS (aGCS) 8.5. The predominant injury mechanism was blast (72.5%). The most frequent lesions were IPH (80%), retained fragments (45%) SAH (40%), SDH (30%), and transtentorial or tonsillar herniation (18.8%). Epidural hematoma, IVH, and major cerebrovascular injury (ICA, proximal ACA/MCA/PCA, vein of Galen, vertebral/basilar artery or a dural venous sinus) occurred in less than 10%.

Mortality was 21% and the mean GOS score at 2-years was 3.96. Sixty-three percent had an aGCS of 3-8, 64% of which achieved FI at 2 years and their 2-year mean GOS score was 3.42. In patients without FI at 2 years, there was a statistically significant difference in terms of MOI, aGCS and admission Injury Severity Score (aISS) compared to those patients who achieved FI.

Herniation or cerebrovascular injury was correlated with lower two year GOS scores (1.47, 3.14), and comorbid herniation and cerebrovascular injury was universally mortal.



Herniation was the only injury characteristic found to have a statistically significant correlation with a Poor GOS at 2 years ( $p < 0.0001$ ). While not significant, subdural and epidural hematomas were correlated with higher 2-year GOS scores (4.26, 3.8). Thirteen patients had grossly unsalvageable neurological injuries; excluding these, the mean 2-year GOS score was 4.54.

## Conclusions

Contrary to the historically nihilistic understanding of PBI, the prognosis of combat-related PBI is good provided that the patient survives to reach neurosurgical care without frankly non-survivable injury. Even when these are included, GOS at two years still approaches functional independence. GSWH, Low aGCS, low aISS, herniation, and major cerebrovascular injury appear to confer a worse prognosis; extra-axial lesions that are readily amenable to surgery appear to confer an improved prognosis.

## Learning Objectives

1) Discuss the outcomes of penetrating brain injury in the military population, and how it differs from civilian casualties.

2) Discuss the clinical presentations that are associated with worse and better outcomes in combat induced PBI.

3) Discuss the reasons that PBI outcomes appear to differ between the civilian and the military populations.

### References:

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