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# Evaluation of the functional outcome in cases of penetrating brain injuries

Heba Hassan Hanafy[1], Wael Ahmed Fouad[2], Ihab Helmy Zidan[3]

[1] *Emergency Department Faculty of Medicine University of Alexandria, Egypt*
[2, 3]*Neurosurgery Department Faculty of Medicine University of Alexandria, Egypt*

*Email:* drhebahassan2011@hotmail.com

## ABSTRACT

The purpose of this study is to evaluate the functional outcome in cases of penetrating brain injuries using Karnofsky performance scale (KPS). This prospective study was conducted to include 47 patients subjected to penetrating brain injury and admitted to the Emergency Department (ED) of Alexandria Main University Hospital from March 2014 to February 2016. Primary survey and secondary survey done for those patients, radiological investigations done including CT brain and other radiological investigations to exclude associated injuries (thoracic, abdominal injuries). 27 patients (57.5 %) died and 20 patients (42.5 %) survived. 17 patients (36.2%) got KPS A, 3 patients (6.4%) got KPS B and 27 patients (57.4%) got KPS C. Many predictors of the functional outcome of the patients are discussed as age, sex, mode of trauma, SBP, MGAP score and CT brain findings.

**Key words:** penetrating traumatic brain injury (pTBI) , karnofsky performance scale (KPS)

## INTRODUCTION

Trauma is a time-sensitive condition, especially during the first hour of trauma. Management, assessment, resuscitation and definitive care are very important. Providing definitive care earlier at trauma centers has been shown to decrease mortality (Nirula et al 2010). Head injuries are among the most common types of trauma encountered in emergency departments (EDs). Traumatic brain injury (TBI) is a major cause of death and disability worldwide, especially in children and young adults and presents a major social, economic and health problem. Mechanism-related classification divides TBI into penetrating and non- penetrating head injury. Non-penetrating (closed) injury occurs when the brain is not exposed. Penetrating (open) head injury occurs when an object pierces the skull and breaches the dura matter. Penetrating traumatic brain injury (pTBI) is the most lethal form of traumatic head injury. Approximately 70-90% of these victims die before arriving at the hospital, and 50% of those who survive to reach the hospital die during resuscitation attempts in the ED (Aarabi et al 2014).

The pathological consequences of penetrating head wounds depend on the circumstances of the injury, including the properties of the weapon either missile or non-missile, energy of the impact, and the location and characteristics of the intracranial trajectory. TBI can be classified into primary brain insult caused by the weapon itself and into secondary brain injuries that could happen days later (Folio et al 2013).

The ability of bullets, shrapnel, and low-velocity objects such as knives and arrows to penetrate the brain is dependent on their energy, shape, the angle of approach and the characteristics of intervening tissues (skull, muscle, mucosa, etc.). Primary injury to the brain is determined by the ballistic properties (kinetic energy, mass, velocity, shape, etc.) of the projectile and any secondary projectiles, such as bone or metallic fragments. The kinetic energy is defined by the relationship: $E = 1/2mv^2$, which implies that the velocity of the projectile has a greater influence than the mass of the projectile alone (Aarabi et al 2015).

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The exact pathophysiology of secondary tissue injury associated with pTBI is poorly understood and differs from that of closed-head injuries. Secondary injury is an indirect result of the insult, it occurs in the hours and days following the primary injury and plays a large role in the brain damage and death that results from TBI. Secondary injury can result from complications of the injury. These include ischemia, cerebral hypoxia, hypotension, cerebral edema, changes in the blood flow to the brain and raised intracranial pressure (Granacher 2007).

Severity of Traumatic brain injuries can be classified to mild, moderate, severe according to Glasgow coma scale. TBI with a GCS of 13 or above is mild, 9–12 is moderate, and 8 or below is severe. However, the GCS grading system has limited ability to predict outcomes (Saatman et al 2008).

The utility of various neuroimaging methods used in patients with PBI lies on the potential management and prognostic implications of these modalities. Neuroimaging is vital for surgical decision making, the type of surgery, the size and site of craniotomy, the route for extraction of foreign body, etc (Roberts 2015).

The Karnofsky Performance Status (KPS) is a widely-used method to assess the functional status of a patient. The KPS describes a patient's functional status as a comprehensive 11-point scale correlating to percentage values ranging from 100% (no evidence of disease, no symptoms) to 0% (death). The percentages of the KPS describe three states (conditions): A (100–80%), B (70–50%) and C (40–0%). These states describe different levels of performance. "Functionality" and "performance" comprise the core concerns of the KPS (Karnofsky and Burchenal 1949).

## Materials and Methods

### Patients:

47 patients subjected to penetrating brain injury and admitted to the Emergency Department (ED) of Alexandria Main University Hospital from March 2014 to February 2016. This study includes isolated penetrating traumatic brain injured patients either missile or non-missile injuries admitted within 48 hours of trauma.

### Methods:

Primary survey and secondary survey done for those patients, radiological investigations done including CT brain and other radiological investigations to exclude associated injuries (thoracic, abdominal injuries).

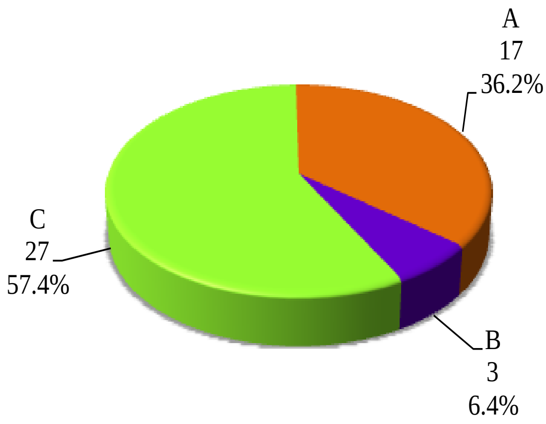
### Statistical analysis:

The results were expressed as means, standard deviation (SD), counts and percentages. Univariate analysis was performed using a $\chi 2$ test for categorical data. Fisher's exact test was used when a data table had at least one cell with an expected frequency of < 5. Differences were considered to be significant at the ($p \leq 0.05$) probability level. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS 14) for Windows (SPSS, 2005).

## RESULTS AND DISCUSSION

The present study was conducted to evaluate the functional outcome in cases of penetrating brain injuries using Karnofsky performance scale. 17 patients (36.2%) got KPS A, 3 patients (6.4%) got KPS B and 27 patients (57.4%) got KPS C as demonstrated in figure (1). Class C includes those who died and consequently got 0%. Unfortunately, all 27 patients who had grade C were the dead patients.

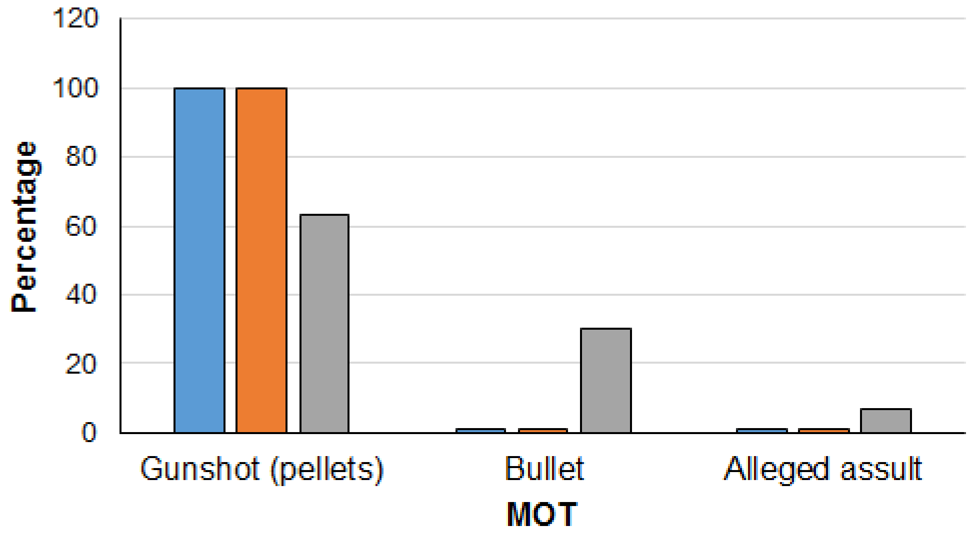
**Figure-1. Distribution of the studied cases according to Karnofsky scale**




In this study, it was observed that the percentage of male patients is higher than the percentage of female patients (89.4% versus 10.6% respectively). In this study, males were more than females in the group of patients who died (92.6% versus 7.4% respectively). Also, males were found more than females in the group of patients who survived (85% versus 15% respectively). As regards gender, in group A, 15 patients (88.2%) were males and 2 patients (11.8%) were females. In group B, 2 patients (66.7%) were males and 1 patient (33.3%) was a female. In group C, 25 patients (92.6%) were males and 2 patients (7.4%) were females. This reflects that males are more prone than females to penetrating brain injuries. Similar findings were reported by Kondo et al where percentages of male patients were 68.9%, but it was not found to have an effect on either mortality or functional outcome of patients, so it could not be used as a predictor of either one of them (Kondo et al 2011).

As regards MOT, patients were subjected to 3 main modes of trauma. 37 patients (78.7%) were subjected to gunshot wounds,8 patients (17%) were subjected to bullet wounds and 2 patients (%3) were assaulted. Among the group of patients who died, 17 patients (63%) were subjected to gunshot wounds,8 patients (29.6%) were subjected to bullet injuries and 2 patients were assaulted. While in patients who survived 20 patients (100%) were subjected to gunshot wounds but none were subjected to either bullet injuries or assault.

**Figure-2. Relation between karnofsky scale and MOT**




In group **A**,17 patients (100%) were subjected to gunshot wounds, none were subjected to bullet injuries or assault. In group **B**, 3 patients (100%) were subjected to gunshot wounds and none were subjected to bullet injuries or assault. In group **C**,17 patients were subjected to gunshot wounds, 8 patients were subjected to bullet injuries and 2 patients were assaulted. From these data patients with gunshot injuries can survive their injuries with variable functional outcome on the KPS. While patients subjected to bullet injuries or assaulted with sharp objects commonly do not survive their injuries. This could be attributed to the fact that less structural damage occurs with gunshot injuries. Thus, the MOT can be used as a significant predictor of the mortality and the functional outcome of patients. Similar findings were reported where patients with less structural destruction of the brain parenchyma do better functionally over the long term as in Ambrosi PB et al (Ambrosi PB et al 2012).

As regards systolic blood pressure, the patients were divided into 3 subgroups: 13 patients (27.7%) had blood pressure >120mmHg, 27 patients (57.4%) had blood pressure 60-120 mmHg and 7 patients (14.9%) had blood pressure >120 mmHg. The patients who died had a mean systolic blood pressure lower than that of survivors (79.81 ± 45.88 versus 120.50 ± 16.38 respectively) as in table (1). As regards KPS, the mean systolic blood pressure in group **A** was 121.18 ± 17.64. In group **B**, it was 116.67 ± 5.77. In group **C**, it was 79.81 ± 45.88. From these data, it was concluded that the higher the systolic blood pressure, the better the outcome of patients as regards mortality and functional outcome. The SBP can be used as a significant predictor of both mortality and functional outcome. Similar results and conclusions were shown by Ahun et al, they reported that the continuous increase in mortality as systolic arterial blood pressure decreased has been recognized **(Ahun et al 2014).**

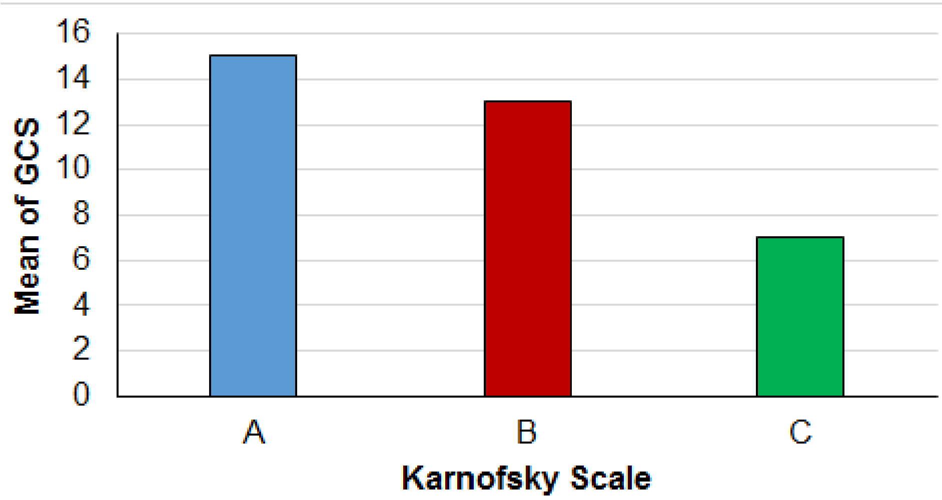
**Table-1. Relation between outcome and SBP**

| | Outcome | | Total (n = 47) | Z | p |
|---|---|---|---|---|---|
| | **Died (n = 27)** | **Survived (n = 20)** | | | |
| **SBP** | | | | | |
| Min. – Max. | 0.0 – 140.0 | 90.0 – 150.0 | 0.0 – 150.0 | 3.412* | 0.001* |
| Mean ± SD. | 79.81 ± 45.88 | 120.50 ± 16.38 | 97.13 ± 41.40 | | |
| Median | 90.0 | 120.0 | 110.0 | | |

*: Statistically significant at p ≤ 0.05

As regards GCS, TBI is classified into mild (GCS>12), moderate (GCS 9-12) and severe (GCS <8). 19 patients (40.4%) showed GCS>12,8 patients (17%) showed GCS 9-12 and 20 patients (42.6%) showed GCS <8. The patients who died had mean GCS lower than that of survivors (6.96 ± 2.1 versus 14.25 ± 0.97 respectively). As regards KPS: Patients in group A had a mean GCS 14.47 ± 0.80, patients in group B had a mean 13.0 ± 1.0 and patients in group C had a mean 6.96 ± 2.14 as demonstrated in figure (3). From these data, it was concluded that the better the GCS of the patient, the better the outcome as regards mortality and functional outcome. Thus, the GCS can be used as a significant predictor of both mortality and functional outcome. Similar findings were reported by Ambrosi et al where postresuscitation GCS was a strong variable predicting mortality and outcome (Ambrosi et al 2012).

**Figure-3. Relation between karnofsky scale and GCS**




According to MGAP score, patients are divided to 3 risk categories (mild, moderate and severe), the higher the score, the lower the risk.14 patients (29.8%) showed low risk, 10 patients (21.3%) showed moderate risk and 23 patients (48.9%) showed high risk. 14 patients (29.8%) had low risk ,10 patients (21.3%) had moderate risk and 23 patients (48.9%) had high risk. The patients who died had a mean lower than that of the patients who survived (14.11 ± 3.40 versus 23.05 ± 1.85 respectively). Among the patients who died 23 patients (85.2%) had high risk, 4 patients (14.8%) had moderate risk and none had low risk. Among the patients who survived where 14 patients (70%) had a low risk, 6 patients (30%) had moderate risk and none had a high risk. Among group **A**, 13 patients (76.5%) had a low risk, 4 patients (23.5%) had a moderate risk and none had a high risk. Among group **B**,1 patient (33.3%) had a low risk, 2 patients (66.7%) had a moderate scale and none had a high risk. Among group **C**, 23 patients (85.2%) had a high risk, 4 patients (14.8%) had a moderate risk and none had a low risk. From these data, it was concluded that the higher the risk category (the lower the scale), the mortality increases and the functional outcome worsens. MGAP scale can be used as a significant predictor for both mortality and functional outcome. Similar findings were reported by Rehn et al as MGAP can predict survival adequately and is recommendable for routine use (Rehn et al 2011).

CT brain showed many types of bone and soft tissue insults and most patients showed one or more type of insult. SAH (61.7%) is the most common insult in our patients followed by brain oedema (36.2%) followed by intracerebral hemorrhage (27.7%) and hemorrhagic contusions (27.7%) followed by fissure fracture (21.3%) then intraventricular hemorrhage (19.1%) and finally depressed fracture (10.6%). Among patients with SAH,23 patients (85.2%) died and 6 patients (30%) survived. Among patients with ICH,13 patients (48.1%) died and none survived. Among patients with IVH, 9 patients (33.3%) died and none survived. Among patients with brain edema, 17 patients (63%) died and none survived. Among patients with depressed fractures, 1 patient (3.7%) died and 4 patients (20%) survived. Among patients with hemorrhagic contusions, 7 patients (25.9%) died and 6 patients (27.7%) survived. Among patients with fissure fractures, 2 patients (7.4%) died and 8 patients (40%) survived. Among patients with SAH, 4 patients (23.5%) were in group **A**, 2 patients (66.7%) were in group **B** and 23 patients (85.2%) were in group **C**. Among patients with ICH, 13 patients (48.1%) were in group **C** and none in groups **A** and **B**. Among patients with IVH,9 patients (33.3%) were in group **C** and none was in groups **A** and **B**. Among patients with brain edema, 17 patients (63%) were in group **C** and none in groups **A** and **B**. Among patients with depressed fractures, 4 patients (23.5%) were in group **A** and 1 patient (3.7%) was in group **C** and none was in group **B**. Among patients with hemorrhagic contusions, 4 patients (23.5%) were in **A** and 2 patients (66.7%) were in group **B** and 7 patients (25.9%) were in group **C**. Among patients with fissure fractures, 8 patients (47.1%) were in group **A**, 2 patients (7.4%) were in group **C** and none was in group **B**. From these data, it was found that SAH, brain oedema, intracerebral hemorrhage and intraventricular hemorrhage were associated with increased mortality and worse functional outcome. The presence of fissure fractures was not associated with higher mortality and functional outcome while the presence of depressed fractures or hemorrhagic contusions were not found to be of significance to either mortality or functional outcome. Overall, CT brain can be a significant predictor of both mortality and functional outcome. The importance of CT brain has been stated in other studies as Kim KA et al (Kim et al 2005).

## CONCLUSION

The KPS is a simple scale for assessment of functional outcome in patients with penetrating brain injuries. Sex was not found to be a significant predictor of both mortality and functional outcome while MOT, SBP, GCS, MGAP score and CT brain findings were found to be significant predictors for both.

## Conflict of Interests

Authors declare that there is no conflict of interests regarding the publication of this paper.

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