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Original Article

Do Traumatic Acute Subdural Hematoma Patients with a Glasgow Coma Scale Score of 3 and Bilateral Fixed and Dilated Pupils Have any Chance of Survival?

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Abstract

Background: Low Glasgow coma scale score (GCS) and pupillary status predict poor outcomes in traumatic acute subdural hematoma (ASDH) patients. We compared the mortality of GCS 3 patients having bilateral fixed and dilated pupils (BFDPs) with GCS 3 patients having reactive pupils (RPs). We then determined if trauma system or patient factors were responsible for the difference in mortality.

Methods: We reviewed all adult, traumatic ASDH patients with GCS 3, admitted to our institution from December 1, 2015 to December 31, 2017. Demographics, injury data, prehospital times, procedures, and outcomes were recorded.

Results: During this period, 145 patients were admitted with GCS of 3, and met inclusion criteria. In all, 100 patients were analyzed, after excluding 20 patients who were dead on arrival, and 25 others, who were intoxicated with alcohol or received paralytic agents in the trauma room. All BFDP patients died, whereas 87% of RP patients died. With regard to patient factors, BFDP patients were more likely to be unstable, have extra-axial bleeding, and evidence of midline shift and/or herniation. Trauma system factors, however, may also have had an impact on outcome. Despite having more extra-axial bleeding, BFDP patients were less likely to have a neurosurgical operation than RP patients.

Conclusion: Patients with GCS of 3 and BFDPs have a 100% mortality. These patients have suffered devastating brain injuries and tend to be hemodynamically unstable. Clinicians, however, are less likely to aggressively treat BFDP patients than RP patients. Further prospective studies are required to determine which patients with GCS of 3, and BFDPs are likely to benefit from aggressive treatment.

Key words: Acute subdural hematoma, Glasgow coma scale, Outcome, Pupil reactivity, Pupil size, Trauma

INTRODUCTION

Acute subdural hematoma (ASDH) is seen in approximately one-third of patients with severe traumatic brain injury (TBI) and in half to more than two-thirds of those undergoing hematoma evacuation.[1,2] ASDH is associated with high rates of mortality, ranging from 40% to 90%, although recent studies have reported improved rates of mortality as low as 14%.[3-7]

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Traumatic ASDH remains the leading cause of death and disability in young adults. The Brain Trauma Foundation estimates that 1.6 million head injuries occur annually in the United States.[8] Of these, approximately 50,000 die and 70,000–90,000 are left with permanent neurologic disabilities. Head injuries also result in a staggering financial burden, which has been estimated at $75 billion annually in the United States.[9] In Canada, the costs are similarly high: 18,000 Canadians are admitted to hospital with TBI, resulting in an extrapolated societal cost that exceeds $1 billion.[10] Multiple independent risk factors have been shown to predict mortality in traumatic ASDH including age, admission Glasgow Coma Scale score (GCS), pupillary abnormalities, hypotension, and specific findings on computed tomography (CT) scan of the head.[11-14] One of the strongest predictors of mortality, however, remains an initial GCS score of 3. Fearnside

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et al. found that patients with an initial GCS of 3 had a 65% mortality rate.[15] Phuenpathom reported a 100% mortality among those patients with a GCS of 3 from acute subdural bleeding.[16] Pupillary status is another important prognostic indicator of mortality in traumatic ASDH. Bilateral fixed and dilated pupils (BFDPs) are regarded as indirect signs of herniation and brainstem injury,[17] and are often present in patients with traumatic ASDH.[18,19] Braakman *et al.* have reported that the finding of BFDP in traumatic ASDH patients is associated with a mortality of 90% in a well-designed prospective study.[20] One advantage of using pupillary response as a prognostic indicator over initial GCS is that it avoids the bias introduced by prehospital pharmacologic paralysis. Gray *et al.* have shown that neuromuscular blocking agents do not affect pupillary function.[21] The presence of BFDPs in patients with an admission GCS of 3, therefore, should intuitively predict a mortality of close to 100%. As such, there may be a certain temptation to manage these patients conservatively, without aggressive intervention, given current concerns about spiraling health-care costs.[22] We conducted a prospective cohort study at our Level I trauma center to determine the in-hospital mortality of traumatic ASDH patients with an admission GCS of 3, comparing those having BFDPs with those having reactive pupils (RPs). Our secondary objective was to determine whether differences in mortality could be accounted for by variation in either management strategy or severity of brain injury.

PATIENTS AND METHODS

The registry of our institution (Rangaraya Medical College, Government General Hospital, Kakinada) was used to identify all patients who were evaluated, from December 1, 2015 to December 31, 2017. Inclusion criteria included: (1) Adult patients (age 10–90 years), (2) blunt mechanism of injury, and (3) an admission GCS of 3.

Patient demographics, prehospital time, referral information, injury mechanism, abbreviated injury scale (AIS) scores, injury severity score (ISS), length of stay in hospital (days), units of blood transfused, and outcomes (dead/alive) were recorded in our registry. ISS and AIS were calculated after discharge or death of each patient. The trauma resuscitation room charts, electronic hospital records, and radiologic reports were then reviewed. Prehospital intubation and trauma room use of pharmacologic paralytics were determined from the trauma room nursing notes. Furthermore, surgical procedures were identified using hospital records.

Exclusion criteria included penetrating injury, burns, and patients who presented dead on arrival (DOA; pronounced immediately on arrival with no medical intervention). Patients who were intoxicated and who received any pharmacological paralytics in the emergency room before neurologic assessment was also excluded.

BFDPs were defined if this condition was identified by name, or if pupils were reported as 4 mm or more in diameter bilaterally and nonreactive to light. The other study patients were then classified by default as having RPs. The primary outcome measure was defined as in-hospital death. We then compared BFDP and RP patients, in terms of management strategy and injury severity.

Management approach was assessed by looking at specific trauma system factors such as the use of advanced airway interventions in the prehospital setting, initial treating hospital (Level I trauma center or community hospital), time to neurosurgical evaluation, and neurosurgical operations (yes/no). There is some debate as to the clinical relevance of time to neurosurgical (trauma) center and prehospital definitive airway management on outcomes in severe TBI.[23,24] Even so, these were included as potential factors. Brain injury severity was assessed by looking at patient factors, which included findings on CT head and hemodynamic status.

Patient Factors

The ISS for the two groups was compared. As well, the AIS score for the head/neck area was also analyzed.

Hemodynamic instability was then defined as instability such that initial CT scanning of the head was precluded.

Hemodynamic instability is a known predictor of poor outcome in severe TBI. 7 units of blood transfused were also used as an indirect marker of hemodynamic status. For those patients stable enough to obtain an initial CT scan, radiographic reports were evaluated for CT evidence of an extra-axial bleed, subarachnoid hemorrhage, midline shift, or uncal herniation. These findings are all known to independently predict worse outcomes in severe TBI patients.[15] Extra-axial bleed was defined as the presence (as identified by the reporting radiologist) of a subdural, epidural, or extra-axial bleed. Midline shift was defined as the report of a definite shift from the midline on CT, measuring 5 mm or more. Herniation was defined as the report of transtentorial, subfalcine, central, or tonsillar herniation or a report of obliteration of the basal cisterns by the reporting radiologist.[25]

Statistics

Mortality rates of patients with BFDP and those with RP are compared. All intoxicated and chemically paralyzed patients are also included to check the validity of findings in a separate analysis. Intoxication or paralytics can bias neurologic assessment.

However, including these patients would not affect outcome in the BFDP group, because alcohol and paralytics do not affect pupillary function.[21] The mortality of RP patients would be lowered by their inclusion. Analysis is performed to determine significant differences between the BFDP and RP groups.

RESULTS AND OBSERVATIONS

During the 2-year study period, 145 patients met inclusion criteria and were identified by our database as having an initial GCS of 3. 20 patients were DOA and, therefore, excluded from further analysis. Of the remaining 125 patients, 25 received paralytics in the trauma room, immediately before neurologic assessment. Overall, 100 patients were then subject to further analysis 60 (60%) had BFDP and 40 (40%) had RPs. Baseline information for both groups is presented in Table 1. There were no significant differences in age, sex, ISS, and mechanisms of injury.

The BFDP and RP groups were compared with respect to overall in-hospital mortality. No patients with GCS 3 and BFDP survived their hospital stay. This was a significantly higher mortality rate than that observed in patients with RPs and a GCS of 3 [Table 2].

As a check on the validity of this finding, we analyzed the mortality rate after including all intoxicated and chemically paralyzed patients. Our expectation was that inclusion of these patients would not affect outcomes in the BFDP group but may affect outcomes in the RP group. As expected, patients with GCS 3 and BFDP still had a 100% mortality, despite including intoxicated and chemically paralyzed patients. However, the observed mortality of RP patients was reduced to 80% (compared with 87% initially). We then looked for differences in either trauma system or patient factors between the two groups. Patients with RPs were more likely to have arrived from a referring community hospital than those patients with BFDP [Table 3].

Otherwise, there were no significant differences in other trauma system factors. In terms of patient-related factors [Table 3], patients with BFDP were less likely to be stable enough to undergo an initial CT scan. There was a trend toward increased transfusion requirements (first 24 h) in BFDP patients, but this did not reach statistical significance. Of patients who had an initial CT scan, patients with BFDP were more likely to have an extra-axial bleed and more likely to have CT evidence of midline shift and herniation. We then tried to quantify the difference in mortality between BFDP and RP patients that were attributable only to the severity of their brain injuries. We examined mortality in all patients who were treated surgically for extra-axial bleeding. Mortality was still much greater in the BFDP group, compared with the RP group. Likewise, in patients who did not have extra-axial bleeding and who had no neurosurgical operation, mortality was still greater in the BFDP group compared with the RP subgroup.

Table 1: Comparison of baseline characteristics between bilateral fixed dilated pupils and reactive pupils groups

	Bilateral fixed dilated pupils	Reactive pupils
n	60	40
Age	46	38
Male	82.6	86.2
Female	17.4	13.8
Injury severity score	42.8	37.2
Mechanisms (%)		
Road traffic accidents	89.6	90.2
Fall	4.1	5.2
Others	6.3	4.6

Table 2: Comparison of trauma system factors

	Bilateral fixed and dilated pupils	Reactive pupils
n	60	40
Referred (%)	42.4	57.4
Time to neurosurgical care, referred (h)	4.6	5.2
Time to neurosurgical care, direct (h)	2.6	3.2
Arrived intubated	86.6	64.2
Neurosurgical procedures %	15	30

Table 3: Comparison of patient factors

	Bilateral fixed and dilated pupils	Reactive pupils
Stable	76	94.6
SDH (pure) %	36	18
SDH+CONTUSIONS	60	79
SDH+SAH	4	3
Midline shift	96	61
Herniation	81	66
Blood (units)	3.6	2.1

SDH: Subdural hematoma, SAH: Subarachnoid hemorrhage

DISCUSSION

In this study, patients with an initial GCS of 3 and BFDP had a 100% mortality rate and patients with a GCS of 3 and RPs had an 87% mortality rate.

Intubation obviously precludes assessment of the verbal component of the GCS, and pharmacologic paralysis affects all three components. Challenges of using the initial GCS as a prognostic indicator are the widespread use of advanced airway interventions and pharmacologic paralysis in the prehospital setting. Waxman *et al.* observed that almost 10% of patients presenting with an initial GCS of 3 had a good recovery.[28] Multiple investigators have reported that the prognostic significance of the coma scale is reduced if all three components are not assessed.[26,27] All patients with severe head injury should aggressively manage, because of inconsistencies in the initial assessment of neurologic status in ASDH patients. Quigley *et al*. reported five high functioning survivors among 248 trauma admissions with an initial GCS of 3.[29] The combined finding of a GCS of 3 and BFDP is likely a more reliable predictor of mortality. It cannot be claimed that this finding has a positive predictive value for death of 100%. This study was not able to study the impact of other factors for developing a GCS of 3 and/or BFDP. Examples include core body temperature, facial fractures, prior cataract surgery, recent ophthalmologic examinations, and high spinal cord lesions. Severe bilateral facial fractures can cause a patient with no head injury to present with fixed and dilated pupils.[31] In standard ATLS protocol, hypothermic trauma patients should not be considered dead, until aggressively warmed and resuscitated.[30] Patients with high spinal cord lesions may be mistakenly assessed as having a GCS of 3, as patients with moderate and severe brain injuries can often have associated high spinal cord injuries.[31] Moreover, finally, recent instillation of mydriatic agents (topical or systemic) precludes accurate assessment of pupillary status. The impact of these conditions was not determined in this study. We, therefore, caution that they should be taken into consideration before any decision to withdraw care is made in this patient population. Our findings are similar to Lieberman *et al*., who also reported a 100% mortality in a cohort of 104 patients with a GCS of 3 and BFDP.[32] The authors were strict in their inclusion criteria, and excluded anyone who had any prehospital paralytics or who were intoxicated. This study also reported an in-hospital mortality of 67% in the 33 patients with a GCS of 3 and RPs. Lieberman did not, however, determine whether the actual prognosis of their two groups, was due to the extent of injuries, or differences in management strategies. Our reported mortality of 87% for RP patients is significantly lower than Lieberman's group (67%). On possible reason for this discrepancy is selection bias: Our cohort included patients who may have been misclassified as having a GCS of 3 because of the effects of prehospital paralytic use. The mortality rate of our RP cohort decreased even further (80%) after we included intoxicated patients and those who had paralytics administered in the trauma room. Selection bias, however, did not affect mortality in the BFDP group, which still had a mortality of 100%. This suggests that the combination of BFDP and GCS 3 is a sign of such severe brain trauma that any bias introduced by prehospital medications is insufficient to alter its predictive value of a poor outcome. This was also supported by several other observations. Patients with BFDP were more likely to have suffered a dangerous mechanism of injury; they were more often road traffic accidents who were struck by vehicles or victims of falls. These mechanisms of injury have been noted in large, well-designed studies to be more likely associated with intracranial pathology.[33] Similarly, BFDP patients were more likely to have an extra-axial bleed, and more likely to have CT evidence of midline shift and herniation. This again suggests that BFDP patients represented a cohort who had more severe brain injury. Trauma system factors may also have affected mortality.

In our study, BFDP patients were less likely to have had a neurosurgical intervention, despite having a higher incidence of extra-axial bleeding. This suggests that the neurosurgeons at our facility had a tendency to triage BFDP patients to conservative therapy, despite the presence of a surgically treatable hemorrhage. It is unclear, therefore, how outcomes may have been affected if these patients had all been aggressively treated. More than likely, however, most of these patients, if not all of them, would have died anyway, even with aggressive operative treatment. We stratified our analysis, looking at survival in two specific subgroups: Those who received neurosurgical intervention for extra-axial bleeding and those who had no acute indication for neurosurgical intervention. There was still a substantial difference in mortality between the two groups, which suggests that BFDP patients have a worse prognosis than RP patients, independent of treatment bias. Age may also have affected the results of our study.

Although there were no significant differences in age between our RP and BFDP groups, older trauma patients are known to have a significantly worse prognosis than younger patients;[34,35] therefore, the dismal prognosis of our BFDP patients may be partially due to their advanced age. We may not be able to generalize our findings to younger patients.

CONCLUSIONS AND SUMMARY

1. Trauma system factors may also contribute to the zero prognosis of these patients.
2. Patients with GCS 3 and bilateral fixed dilated pupils have no reasonable chance of survival.
3. Alcohol intoxication and prehospital paralytic use do not seem to affect the utility of this observation, which increases its clinical applicability.
4. The poor outcome in these patients is mostly due to the severity of their initial head injury, and the majority of these patients will not benefit from aggressive intervention.
5. It is an urgent need to study the problem. Because of the poor outcome of this finding of GCS 3 and

BFDP may create a self-fulfilling prophecy, as clinicians may choose to withdraw prematurely on these patients, leading to a mortality rate that approximates 100%.

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