TRAUMATIC INTRACRANIAL HAEMORRHAGE: A CORRELATION WITH GLASGOW COMA SCALE, HAEMATOMA VOLUME AND PATIENT PROGNOSIS

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ABSTRACT

BACKGROUND AND PURPOSE

To describe the role of Glasgow Coma Scale (GCS) as an initial and simple tool of neurological assessment and also haematoma volume in selection of patient for surgery.

MATERIALS AND METHODS

After an initial GCS assessment, 50 patients with a history of head trauma were referred for a head CT which was done with a GE Bright Speed Elite 16 slice CT scanner.

RESULTS

42 patients (84%) were males and 8 (16%) were females. The mean age was 33.54 years and the maximum numbers of patients affected belonged to the age group of 21 to 30 years. The most common mode of injury in this study was road traffic accident (RTA) accounting for 86%. 42% of patients presented with a GCS of </= to 8. Most of the patients had more than one type of extraaxial haemorrhage. 20 patients in this study were operated, the indication being either SDH or EDH with a volume more than 20 mL and 30 mL respectively. Among intra-axial haemorrhages, cerebral contusions were the commonest type encountered with 34 out of 50 patients that is 68%. DAI was the other less common type of intra-axial haemorrhage accounting for 6%. Patients were selected for surgery based on the admission GCS and haematoma volume as determined using Petersen and Esperson formula on the CT images. Both GCS score and haematoma volume assessment were most crucial indicators for the surgical management of the patients in this study. Immediate surgery for patients with large haematomas was associated with positive outcome.

CONCLUSIONS

It was concluded that the initial GCS score played a major role in quick and reliable assessment of neurological status of the patient. The GCS score also correlated with the haematoma volume as seen on the CT. Both GCS score and haematoma volume assessment were most crucial indicators for the surgical management of the patients in this study.

KEYWORDS

Computed tomography, GCS, TSAH, SDH, EDH, Contusions, DAI, Haematoma volume, RTA.

HOW TO CITE THIS ARTICLE: Babu CRS, Megha RN, Nitesh BN. Traumatic intracranial haemorrhage: A correlation with Glasgow Coma Scale, haematoma volume and patient prognosis. J. Evid. Based Med. Healthc. 2016; 3(37), 1854-1859.
DOI: 10.18410/jebmh/2016/412

INTRODUCTION: Injuries are a major public health problem today. Traumatic brain injury (TBI) in India has been increasing significantly due to rapid motorisation, industrialisation, migration and changing value systems of Indian society. The consequences on health are tremendous and have been underestimated due to absence of research. Apart from instantaneous deaths, the suffering and poor quality of life among survivors is a living testimony to the impact of TBIs. At the national level, nearly two million people sustain brain injuries, 0.2 million lose their lives and nearly a million need rehabilitation services every year.[1]

The Glasgow Coma Scale (GCS) score, since its introduction in 1974 by Teasdale and Jennett as an objective measure of the level of consciousness, has been frequently used as one of the most important predictors of outcome after head injury.[2,] The initial assessment of a patient with TBI includes the Glasgow Coma Scale (GCS), data regarding the accident and computed tomography (CT). It is essential to determine the cause of the trauma, the impact intensity, presence of neurological symptoms, convulsion, and particularly document any reports of loss of consciousness,

Financial or Other, Competing Interest: None.
Submission 30-03-2016, Peer Review 11-04-2016,
Acceptance 23-04-2016, Published 09-05-2016.
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DOI: 10.18410/jebmh/2016/412

time elapsed between the accident and the examination, vomits and seizures.[3]

CT is standardly the first imaging test performed in the emergency department setting for evaluation of head trauma. The goal of emergency imaging is to depict lesions like intracranial haemorrhages that need emergent neurosurgical treatment or in other ways alter therapy.[4]

In the acute setting, CT is the modality of choice because it is fast, widely available, and highly accurate in the detection of skull fractures and intracranial haemorrhage. Life-support and monitoring equipment can easily be accommodated in the CT scanner suite. Also CT is more accurate in detecting radio-opaque foreign bodies.[5]

METHODS: All patients referred to the Department of Radiodiagnosis with a history of head injury and with or without positive clinical symptoms and signs of head trauma during the period of November 2012 to February 2014. Data acquisition was performed using - 16 Slice GE Bright Speed Elite CT scanner. Patients were scanned using the following protocol: 120 kV, 200 mA, 20 mm collimation. Patients who have at least 5 days of hospital admission with at least one followup CT scan other than the initial admission CT scan during the hospital stay were included in this study. Patients with normal CT scan and those who are not willing for hospital admission were excluded from the study.

Patients with head injury underwent CT scan following initial assessment by GCS. The images were obtained in axial sections followed by multiplanar reconstruction. The images were evaluated to look for intracranial haemorrhages which was followed by estimation of the volume of the haemorrhages. Volume estimation was done using 1.2 mm thin sections. Haematoma volume was calculated using Petersen and Espersen equation formula that is AxBxCx0.5, where A and B represent the largest perpendicular diameters through the hyperdense area on the CT scan and C represents the thickness of the lesion. For TSAH grading was done using Morris-Marshall grading system.

The data of patients were collected in the form of age, sex, mode of injury, GCS score, type of haemorrhages with their volume. Documentation of treatment options i.e., whether patient underwent surgery or was managed conservatively and volume of the haemorrhage on followup CT scan were also done.

RESULTS: Of these 50 patients, 42 patients (84%) were males and 8 (16%) were females. 30 out of 50 patients were in the age group between 21 to 40 years accounting for 60%.

42 patients were males accounting for 84% and road traffic accident (RTA) being the most common mode of injury accounting for 86% in this study. Other less common modes of injury were bull-gore injury and fall from height.

GCS plays a major role as the initial tool of assessment in the traumatic brain injury. In this study, 21 patients that is 42% presented with a low initial GCS of </= 8. Most of the patients had combination of extra-axial haemorrhages. TSAH was the most common type of extra-axial haemorrhage accounting for 50% of the cases. There were totally 5 deaths in this study out of which 4 patients had TSAH in combination with other haemorrhages. There were no cases of isolated TSAH in this study.

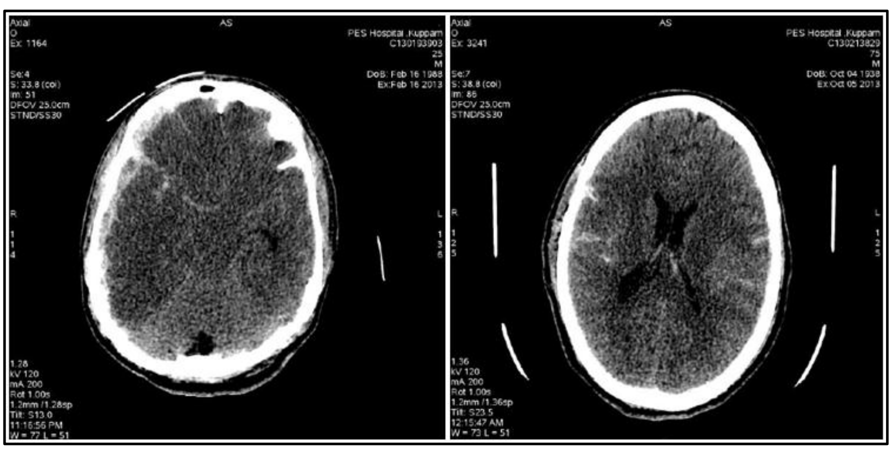

Fig. 1: SAH along the Right Basal Cisterns. SAH is Associated with Right Frontal Temporal SDH.
Fig. 2: Bilateral Frontal Lobe SAH

Subdural haemorrhage (SDH) was found to be the second commonest type of extra-axial haemorrhage accounting for 46%. 10 patients who underwent surgical management had a mean GCS of 6 and conservative management was opted in remaining patients with a GCS of 13. Out of 10, 6 patients had good prognosis, 2 patients died in the post-operative period and 2 patients had poor prognosis. Among the patients managed conservatively, 9 patients had good prognosis. 17 out of 50 patients in this study had extradural haemorrhage (EDH) accounting for 34% of cases. 10 patients underwent surgery based on their mean admission GCS which was 7. Remaining 7 patients whose mean admission GCS was 13 were managed conservatively. 8 out of 10 surgically managed patients had good prognosis whereas other 2 patients died in the post-operative period. 6 out of 7 patients who were managed conservatively had good prognosis and 1 patient in this group had died immediately after hospital admission.

Intra-axial haemorrhages encountered in this case were contusions and diffuse axonal injury (DAI).

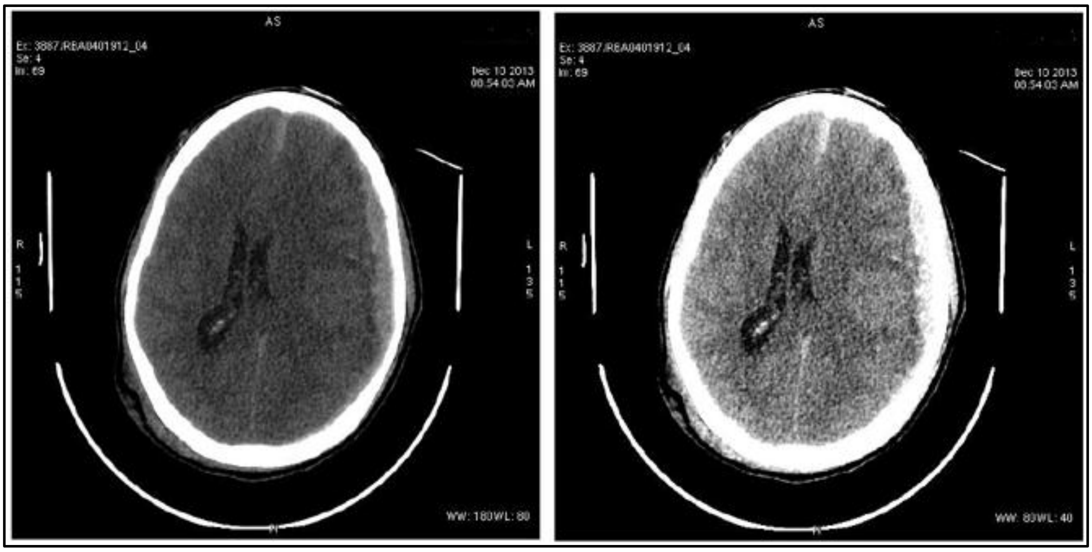

Fig. 3 & 4

Fig. 3 & 4: Axial NECT images of brain in subdural (150-200 HU) and brain window showing a crescent shaped hyperdense extra-axial collection in the left frontotemporoparietal region suggestive of SDH, causing a mass effect and midline shift to the right. There is also SDH along the falx. The subdural window allows better appreciation of the extent of the haemorrhage.

Fig. 5 & 6

Fig. 5 & 6: Axial and Coronal NECT images of brain showing a large hyperdense biconvex shaped hyperdense collection in the left frontoparietal region suggestive of EDH, causing mass effect and midline shift to the right. Heterodense centre of the haematoma suggests active bleeding and is called "swirl sign".

Intracerebral Contusions (Haemorrhagic and Non-haemorrhagic) was seen in 34 out of 50 patients. Most common sites observed were frontal, temporal and frontotemporal lobes. Only one patient had left capsuloganglionic haematoma.

Out of 34 patients with cerebral contusions, only 8 patients were selected to determine the prognosis as other patients had combination of haemorrhages and these other haemorrhages also influence the prognosis. The 8 patients included here had only cerebral contusions as the intracranial abnormality. Out of 8, 6 patients had good prognosis and 2 patients were discharged against medical advice following few days of hospital admission.

Out of 50 patients, 3 patients were associated with DAI and all of them had poor prognosis.

Fig. 7 & 8

Fig. 7: Left temporal haemorrhagic contusions.
Fig. 8: There are multiple foci of haemorrhagic contusions in bilateral frontal lobes with significant pericontusional oedema.

DISCUSSION: In an attempt to establish a correlation between admission GCS and haematoma volume with patient prognosis in traumatic brain injury, our data showed that higher the admission GCS better is the outcome with conservative management. A low admission GCS was a major criteria for surgical management along with the volume of the haematoma. Along with these parameters, midline shift of more than 5 mm also played an important role.

GCS score provided an invaluable assistance in the initial assessment of patient's neurological status. The GCS score was inversely proportional to the volume of haemorrhage. This holds good for all types of intracranial haemorrhage. Even in large haematomas, timely surgical intervention and aggressive neurocritical care was shown to have a positive impact on patient outcome as observed in this study.

In a study conducted by Randall M. Chesnut and colleagues[3] in which 109 adults with acute subdural haematomas showed a significant inverse relationship with GCS score (best score within 24 hours) and mortality. They also concluded that in a series of 115 patients with epidural haematomas the initial GCS score was the single most important factor affecting outcome. If the initial GCS score is reliably obtained and not tainted by pre-hospital medications or intubation, approximately 20% of the patients with the worst initial GCS score will survive and 8%-10% will have a functional survival.

Wayne S. Kubal, et al [6] described that the mortality from TBI is related to the severity of brain injury as determined by the initial GCS score. A GCS score of 7 or less represents severe injury, requiring emergent imaging and possible emergent neurosurgery. A score between 8 and 14 represents a moderate injury, also requiring emergent imaging, and a normal GCS score of 15 represents a mild injury that may be managed conservatively. In a large, traumatic coma databank study, patients with severe injury had approximately 36% mortality, whereas in another study, patients with moderate injury showed a mortality of approximately 2% to 3%.

In this study, there were 23 patients with SDH accounting for 46% much more common than EDH which accounted for 34% of cases (17 patients). 10 patients underwent surgical management. The criteria for patient selected for surgical management in this study had a midline shift of >/= 5 mm, mean initial GCS score of 6.7 and a mean midline shift of 1.1 cm. This correlated with study conducted by Murat Kalayci et al[7] who concluded that patients with SDH of thickness greater than 1 cm, midline shift of more than 5 mm and GCS score less than 8 should be operated upon. Conservative management done in this study matched with the study conducted by Franco Servadei et al [8] who also opined that patients with small haematomas (<10 mm) and with midline shift under 5 mm may be managed conservatively.

EDH was found in 17 out of 50 patients in this study accounting for 34% of cases. This was less common than SDH and SAH. Out of 17, 10 patients (59%) were managed surgically. In this study, the criteria followed for selection of patients for surgery included haematoma volume of >30 mL, midline shift of >/= 5 mm and mean initial GCS score in these patients was 7. This was in accordance with M. Ross Bullock. et al[9] in which they recommended that an epidural haematoma greater than 30 cm^3 should be surgically evacuated regardless of the patient's Glasgow Coma Scale score. An EDH less than 30 cm^3 and with less than a 15-mm thickness and with less than a 5-mm midline shift in patients with a GCS score greater than 8 without focal deficit can be managed non-operatively. In another study, Shibu Pillai et al[10] concluded that a patient with an EDH volume of more than 30 cm^3 and GCS score of less than 13 should not be considered for conservative management.

Out of 10 patients managed surgically, one patient was a child aged 13 years and the haematoma volume in this patient was 15 mL. In this patient, the haematoma thickness was 1.4 cm, midline shift was 6 mm, GCS score was 8, the haematoma was located in the right temporoparietal region and there was diffuse cerebral oedema with effacement of basal cisterns. This was similar to the criteria followed for surgery in children by the study conducted by Bejjani GK et al [11] which also stated that the most important radiological parameters in determining the therapeutic intervention in children were thickness, midline shift, mass effect, and temporal location of EDH. A thickness of the EDH > 18 mm, a midline shift >4 mm, moderate or severe mass effect and location of haematoma correctly predicted therapy in 31 out of 33 patients.

Out of 25 patients who had SAH, 17 patients (68%) had multiple other types of haemorrhages (EDH, SDH & Haemorrhagic Contusions) associated with SAH, 4 patients (16%) had SAH associated with SDH and 3 patients (12%) had SAH associated with haemorrhagic contusions. Mean GCS of patients with tSAH was 9.5. Out of 25 patients, 14 patients (56%) had good prognosis. 4 out of 25 patients with SAH died, this accounted for 16%. Among these 4 patients who died, 3 of them had undergone surgeries for other associated haemorrhages. There were no cases of isolated TSAH in this study. Therefore, out of 5 deaths in this study of 50 patients, 4 patients had associated TSAH along with other haemorrhages.

This was in conjunction with study conducted by Cristina Mattioli., et al[12] wherein they observed that among the extra and intra-axial haemorrhages, SDH and intracerebral contusions were most often associated with tSAH. They also found that patients with tSAH had a 3.6% higher risk that their condition could deteriorate into a vegetative state or death than patients without this lesion.

Similarly Chieregato Arturo. et al[13] concluded that the outcome of patients with tSAH at admission is related to the admission Glasgow Coma Scale score and to the amount of subarachnoid blood. They also opined that the amount of subarachnoid blood and the presence of associated parenchymal damage are powerful independent factors associated with CT progression, thus linking poor outcomes and CT changes.

Among these 34 patients, 32 of them had haemorrhagic contusions of varying sizes at the time of presentation. 17 out of 34 patients that is 50% had progression of contusion either in the haemorrhagic component or the pericontusional oedema component on the first followup CT scan. This data coincided with the figures quoted by Robert P. Granacher et al[14] who suggested cerebral contusions have a 51% incidence of evolution in the first hour after injury. Evolution is associated with clinical deterioration.

Among 34 patients with cerebral contusions, 32 of them had haemorrhagic contusions of varying sizes at the time of presentation. 17 out of 34 patients, that is 50%, had progression of contusion either in the haemorrhagic component or the pericontusional oedema component on the first followup CT scan. This data coincided with the figures quoted by Robert P. Granacher et al [15] who suggested cerebral contusions have a 51% incidence of evolution in the first hours after injury.

Similarly, David Kurland et al[15] also described that when head trauma results in a contusion, the haemorrhagic lesion often expands or a new haemorrhagic lesion may develop remotely (non-contiguously) from the original contusion during the first several hours after impact.

In this study, two patients who had focal areas of non-haemorrhagic contusions on initial CT scan also progressed to have haemorrhagic component on the first followup CT scan. In remaining patients, though the contusions remained stable, it took some time to evolve to iso or hypodensity and this evolution was more evident on either 2nd or even 3rd followup.

In 17 cases who had progression in size of contusion, on 2nd followup scan, 11 patients had increase in the pericontusional oedema component. This accounted for 64.7%. The haemorrhagic component in these patients either remained stable or started decreasing in density. The second followup CT scan was usually scheduled within first 24 hours of the first CT scan. On further followup CT scans, there was more favourable resolution of the haemorrhagic component in these 11 patients. This was explained by one study conducted by A. Beaumont. et al[16] who described that as a contusion matures it is associated with the development of a rim of pericontusional oedema that gradually increases as haemorrhagic tissue undergoes necrosis. This process often takes days to weeks. They suggested that the presence of pericontusional oedema early after injury is associated with a lower risk of contusion expansion.

There was one patient out of 34 patients who had haematoma in the left capsuloganglionic region with a GCS score of 10 and approximate volume of 21 mL with almost no perilesional oedema.

S Kumar et al[17] described that traumatic basal ganglion haematoma is defined as intracerebral haemorrhagic lesion located in basal ganglion (caudate nucleus, putamen and globus pallidus) and neighbouring structures like thalamus and internal capsule. Basal ganglia haematomas were infrequently described before the scan era. In post computerised scan era, its incidence is approximately 3% of closed head injured patients. This incidence matched the present study where in out of 34 patients of cerebral contusions, 1 patient had capsuloganglionic haematoma accounting for 2.9% of cases.

Diffuse axonal injury also called shear injury is one of the most frequent types of primary injury that is seen in patients with severe head trauma. Pathologically, it leads to a brain injury with features of axon swelling, axon breaking and ball retracting.[18]

Most DAIs are caused by high-velocity auto accidents and are non-impact injuries resulting from the inertial forces of rotation generated by sudden changes in acceleration/deceleration. The cortex moves at different speed in relationship to underlying deep brain structures (white matter, deep grey nuclei). This results in axonal stretching, especially where brain tissues of different density intersect, i.e., the grey-white matter interface. The cortex is typically spared; it is the subcortical and deep white matter that is most commonly affected.

Lesions in compact white matter tracts such as the corpus callosum, especially the genu and splenium, fornix, and internal capsule are frequent. The midbrain and pons are less common sites of DAI.

In this study, 3 out of 50 patients had diffuse axonal injury accounting for 6% and it was observed in subcortical white matter, corpus callosum and brainstem in these cases. Two of them had only diffuse axonal injury as a finding on the initial CT scan and the other one was associated with SDH and SAH.

The two patients who had only DAI as the exclusive finding on CT had a low GCS score at presentation with mean GCS of 4.5. All 3 patients had poor neurological outcome with some amount of residual disability. Diffuse axonal injury can be suspected when the GCS score is persistently low despite an apparently normal appearing CT brain. In patients with other associated extra/intra-axial haemorrhages, the diagnosis is often not suspected until later, when patients fail to recover neurologically as expected. Though this study did not include MRI correlation for DAI, there are many studies in the literature which assert that the MRI is a better modality of choice for investigating a suspected case of DAI.

Rest of the findings other than haemorrhages in this study included, skull fractures – linear (displaced and undisplaced) and depressed fractures, cerebral and cerebellar tonsillar herniations, cerebral oedema and pneumocephalus. These entities also played an important role in the patient outcome.

CONCLUSIONS: Traumatic Brain Injury is a major cause of mortality and morbidity in India. CT is the investigation of choice as it is widely available, cost effective, faster and most of the life supporting systems are compatible with CT. Based on the observations made in this study, it was concluded that the initial GCS score played a major role in quick and reliable assessment of neurological status of the patient. The GCS score also correlated with the haematoma volume as seen on the CT. Both GCS score and haematoma volume assessment were most crucial indicators for the surgical management of the patients in this study. Another important factor was midline shift. Immediate surgery for patients with large haematomas was associated with positive outcome.

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