Original Research Paper

Volume - 11 | Issue - 08 | August - 2021 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Radio Diagnosis

CORRELATION OF RADIOLOGICAL FINDINGS WITH SHORT-TERM CLINICAL OUTCOME IN PATIENTS OF TRAUMATIC BRAIN INJURY AT A PUBLIC HOSPITAL IN NORTH INDIA.

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ABSTRACT

BACKGROUND: Traumatic brain injury is defined as an aggression to the brain caused by an external physical force producing a state of diminished or altered consciousness leading to decreased cognitive abilities and physical functioning. The Glasgow Outcome Scale (GOS) is a general measure widely used in TBI management and surgery outcome studies. The Rotterdam Computed Tomography (CT) score of traumatic brain injury is a relatively recently described classification aimed at improving prognostic evaluation of patients admitted with acute traumatic brain injuries.

OBJECTIVE: Aim of our study is to correlate the severity of traumatic brain injury using CT Rotterdam criterion with clinical outcome at 3 months using Glasgow Outcome Scale (GOS).

MATERIAL AND METHODS: This was a hospital based observational study conducted in Department of radiology from May 2020 to February 2021. All patients with history of traumatic brain injury who underwent NCCT in department were contacted telephonically 3 months after the date of CT scan and a verbal questionnaire in vernacular language was asked telephonically to calculate the nature of their disability after the inciting event of trauma. The CT severity score was then correlated with GOS at 3 months.

RESULTS: GOS and CT Rotterdam score are negatively related to each other with a value of -0.284 but are significantly associated to each other with p value of 0.009 thereby indicating that the patients with a higher modified Rotterdam score demonstrated poorer recovery 3 months after the traumatic insult in form of lower Glasgow outcome score.

CONCLUSION: Use of CT based Rotterdam criteria in routine reporting is critical in the initial evaluation and can also predict the prognosis of patients with TBI.

KEYWORDS :CT Rotterdam, TBI, GOS, EDH, SAH

BACKGROUND

Traumatic brain injury (TBI) is a major disease with a significant impact at the global level.[1] Globally, traumatic brain injury is one of the leading cause of death in the younger age group of age less than 40 years and India accounts for one-fourth of global deaths due to TBI.[1,2] Traumatic brain injury is defined as an aggression to the brain caused by an external physical force producing a state of diminished or altered consciousness leading to decreased cognitive abilities and physical functioning. It can be temporary or permanent and can cause partial or total impairment of such functions. [2-5]

The Glasgow Outcome Scale (GOS) is a general measure widely used in TBI management and surgery outcome studies. [6]. Due to wide availability of Computed Tomography, it is suited to evaluate patients immediately after trauma and Non Contrast Computed Tomography (NCCT) is highly effective in detecting acute insults. [7]

The Rotterdam CT score of traumatic brain injury is a relatively recently described classification aimed at improving prognostic evaluation of patients admitted with acute traumatic brain injuries. This classification includes four independently scored elements, 1) degree of basal cistern compression and 2) degree of midline shift. It does not, however, include contusions, but rather restricts mass lesions to 3) epidural hematomas, and adds 4) intra-ventricular and/or subarachnoid blood. Each of these is given a score, and these scores are tallied, with the addition of 1 to the total. In other words, a completely normal appearing scan has a Rotterdam score of 1 and the worse possible score is 6. [8]

Traumatic brain injury is a heterogeneous disease with respect to cause, pathology, severity, and prognosis. Because of this, there is considerable uncertainty in the expected outcome of the individual patient. To help ease this uncertainty in these patients, several outcome prediction models have been developed for the prognosis of TBI patients.[9] Most widely used measure is Glasgow Outcome Scale (GOS) used for management and surgery outcome.[7] Initially described by Teasdale and Jennet in 1974, GOS classifies TBI as mild, moderate and severe.[10-12]

This study is planned to investigate such findings and establish the correlation of severity of traumatic brain injury on NCCT using Rotterdam criterion with short term clinical outcome using Glasgow Outcome Scale. Glasgow outcome scale ranges from a score of 1 to 5 with the following parameters: Score 1= Death, Score 2 = Neuro - vegetative state, Score 3= Severe disability; patient dependent for daily support, Score 4=Moderate disability; patient independent in daily life, Score 5=Good recovery with resumption of normal life with minimal neurological deficit.

In 2005, Maas *et al*.[8] introduced the Rotterdam score. They concluded that Rotterdam scores predict post-trauma 6-month mortality rate as follows: score 1, 5%; score 2, 7%; score 3, 16%; score 4, 26%; score 5, 53%; and score 6, 61%. Stenberg M [13] in their study on 37 patients observed that Rotterdam CT was significantly correlated with GOS at three months. [14] Our study will help to know about short term clinical outcome of the patients with traumatic brain injuries of varying severity and correlating them with the radiological findings in preliminary scans, as we attempt to fill the lacunae in the existing literature.

METHODOLOGY:

This was a hospital based observational study conducted in department of radiology at from May 2020 to February 2021. All the patients with traumatic brain injury coming to Radiology department for cross sectional imaging (NCCT head) from February 2020 to November 2020 were included in the study. All patients underwent non-contrast computed tomography on 64 – slice Multi Detector CT (MDCT) machine (Ingenuity CT, Philips)

All patients were contacted telephonically 3 months after the date of CT scan and a verbal questionnaire in vernacular language was asked telephonically to the patient/closest attendant and their input was used to calculate the nature of their disability after the inciting event of trauma.

INCLUSION CRITERIA: All patients with history of trauma coming for evaluation in radiology department from the time period of February 2020 to November 2020.

EXCLUSION CRITERIA: Patients with history of previous neurological insult and Patients with radiological findings due to previous non related neurological insult.

***End Point*:** Correlate the severity of traumatic brain injury using CT Rotterdam criterion with clinical outcome at 3 months using Glasgow Outcome Scale (GOS) obtained after telephonic conversation with the patient/closest attendant and to study the pattern of injury on cross-sectional imaging conducted for the patients included in the study.

***Statistical analysis*:** Data was analyzed using EpiInfoTM software. CT Rotterdam criterion, cross-sectional radiological findings and 3 months GOS was recorded for all patients. Correlation of the severity of traumatic brain injury on computed tomography with clinical outcome was done. P values less than 0.05 was considered significant.

RESULTS:

A total (n) of 85 patients were included in the study out of which 73 (85.88%) were males with mean age of 34.63±14.11 years and 12 (14.11%) were females with mean age of 36.92±18.25 years. The main mechanism of injury came out to be RSA in 57(67%) patients followed by direct assault to the skull in 20 (23.52%) and fall from height in 7 (8.23%). (Table 1)

Table 1: Table showing mechanism of injury in study subjects		
Injury mechanism	Frequency	Percentage
RSA	57	67
Direct assault	20	23.52
Fall from height	7	8.23
Fall while walking	1	1.17

Upon admission to emergency room, 38 (44.7%) patients presented with one or more episodes of seizure and 56 (65.88%) patients suffered from an episode of loss of consciousness. On the suspicion of traumatic brain injury, all these patients underwent a single NCCT head (trauma protocol) and the imaging findings were evaluated for presence / absence of hemorrhage (EDH/ SDH/ SAH/ Intraparenchymal), Midline shift (< or > 5mm) and Basal cistern effacement (Yes/No) (Table 2). With these presets, a Rotterdam Score was calculated ranging from the lowest possible score of 1 to the highest score of 6. Site of maximum impact of trauma was also noted and is described in order of decreasing frequency below. Additional findings such as presence/absence of hemosinus/ hemotympanum/ associated fractures were also noted.

Finally, using a questionnaire in vernacular language, 3 month follow up of patients' condition was taken telephonically from which the GOS was calculated and scored from a minimum score of 1 to a maximum score of 5.

Table 2: Radiological imaging findings in study subjects		
	Frequency	Percentage
EDH	11	12.9
SDH	13	15.3
SAH	36	42.4
Intraparenchymal Haemorrhage	25	29.4
Midline shift	7	8.2
Basal cistern effacement	1	1.2

Keeping in accordance with the Rotterdam score, a significant midline shift (>5mm) was demonstrated on imaging in 7/85 patients (8.2%) while the rest 78/85 (91.8%) had either none or insignificant midline shift. Only one patient out of the total sample size of the study demonstrated complete basal cistern effacement, while the rest demonstrated none or strikingly insignificant cistern effacement. On the basis of the above presets a modified Rotterdam score was calculated and demonstrated the following statistics. None had a score of 6. (Table 3)

Table 3: Rotterdam CT score in study subjects		
Rotterdam Score	Frequency	Percentage
1	4	4.7
2	50	58.8
3	29	34.1
4	1	1.2
5	1	1.2
6	0	0

The site of maximum impact on imaging came out to be left frontal region (12/85) with a cumulative percentage of 14.1% followed in decreasing order by right temporal (11/85), right frontal (10/85) and left parieto-temporal region (8/85). Rest of the patients demonstrated no discernible single site of maximum impact. Ancillary findings such as hemosinus was demonstrated in 31/85(36.5%) of the cases while only 1/85 patients (1.2%) showed hemorrhagic contents within the tympanic cavity.After their discharge from the emergency room, 3 month follow up was conducted telephonically as per questionnaire attached in the annexure and it was used to calculate the Glasgow outcome score. 65 (76.5%) patients demonstrated an outcome score of 5 thus providing us with the conclusion that they had good recovery post trauma and were able to perform their daily activities without any limitations. Score of 4 was observed in 10 (11.8%) patients while 2 (1.2%) had a score of 3, 1 (1.2%) had score of 2 and 7 (8.2%) demonstrated score of 1. (Table 4) (Figure 1)

Table 4: GOS score of study subjects as evaluated after 3 months		
GOS Score	Frequency	Percentage
1	7	8.2
2	1	1.2
3	2	2.4
4	10	11.8
5	65	76.5

Upon comparison between the GOS and the Rotterdam Score we observed the following. (Table 5) There was statistically significant association between modified Rotterdam score and GOS score with a p value of 0.002.

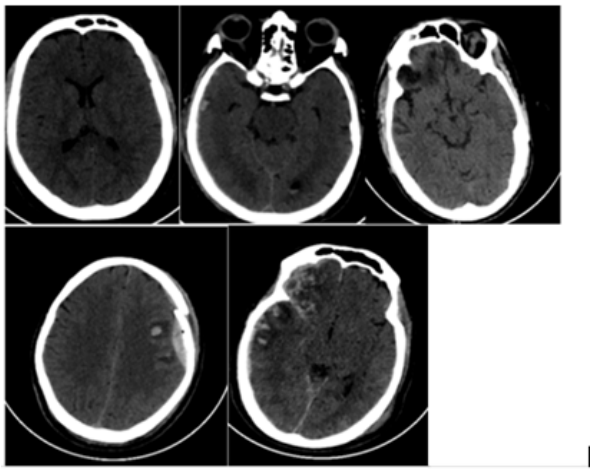
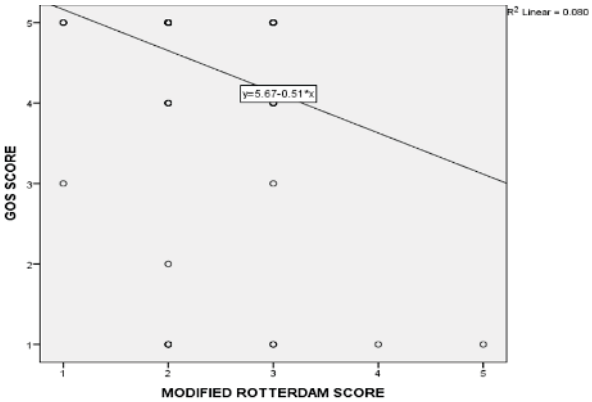


Figure 1: NCCT showing radiological findings in TBI patients with GOS 5 to 1 (right to left) respectively

Table 5: Comparison of GOS Score with Modified Rotterdam Score							
	Modified Rotterdam Score						Chi value; df; p value
GOS Score	1	2	3	4	5	Total	37.23;16;0.002
1	0	3	2	1	1	7	
2	0	1	0	0	0	1	
3	1	0	1	0	0	2	
4	0	4	6	0	0	10	
5	3	42	20	0	0	65	
Total	4	50	29	1	1	85	

Thus, the results of correlation of GOS with Modified Rotterdam score can be extrapolated on a Cartesian graph as follows:



Graph 1: Correlation between GOS score and modified Rotterdam score

Table 6: Rotterdam score and GOS correlation	Correlation	p value
CT Rotterdam score	-0.284	0.009

It was observed that GOS and CT Rotterdam score are negatively related to each other with a value of -0.284 but are significantly associated to each other with p value of 0.009, meaning that if one parameter changes the other will definitely change.

Thereby indicating that the patients with a higher modified Rotterdam score which is a marker of severity of head injury, demonstrated poorer recovery 3 months after the traumatic insult in form of lower Glasgow outcome score.

DISCUSSION:

Traumatic brain injury is an important public health problem. International mortality statistics show that accidents are accountable for 3% to 10% of all deaths from all causes, and the problem has greater impact socially [15].

In the present study, 85.88% of the patients with TBI were males. Similar statistics were observed in another study by Morgado FL et al where 80.4% of patients were males[16]. Such a fact is attributed to a greater exposure of male individuals to risk factors for TBI such as accidents with motor vehicles and violence. In general, the number of men with access to automobiles is higher than the number of women, and more men work away from home than women, thus being more exposed to risk conditions. Also, the higher incidence of TBI in male individuals is related to locations with higher urban violence rates. [17]

Most of the studies state that majority of TBI patients are either adolescents or young adults. [18-24] Similarly, in our study 83.7% of patients were younger than 50 years of age. In age group >50 years, there has been a decreased incidence of TBI reported which can be attributed to the lesser exposure to external factors, such as violence and traffic accidents. [17-20] In our study, the most common cause of TBI was road side accidents in 67% of cases followed by direct assault in 23.52% cases. Similarly, a prospective observational study conducted by Anwarul et al[25] comprising of 92 patients revealed that the main cause of TBI in that particular study group was RTA followed by fall from height.

Subarachnoid hemorrhage (SAH) is a common finding in TBI. One large European series found evidence of SAH in 40% of patients with moderate-severe head injury. [26,27] Similarly, we observed that SAH was present in 42.4% of cases in our study, being the most common radiological abnormality seen. EDH was observed in 12.9% of cases in our study while a study by Liew TYS et al reported EDH in 15.38% of cases. [28]

Our study, states that the Rotterdam score is significantly associated with the outcome of traumatic brain injury. In another study conducted by Hamid Reza et al in 2017[29], it came to pass that the sensitivity and specificity of RS in predicting the outcome of TBI was 86.4% and 97.9% respectively.

We observed in our study that CT Rotterdam score had statistically significant correlation with GOS at three months follow-up with a p value of 0.009 meaning that the higher the Rotterdam score after TBI, poorer the outcome at 3 months GOS. Similarly, Bobinski L [14] in a study on 48 subjects reported significant correlation of the initial Rotterdam classification and GOS at 3 and 12 months. In a study by Stenberg M [13] on 37 patients of TBI in 2017, reported that Rotterdam CT was significantly correlated with GOSE at three months.

With initial CT scanning, the post traumatic hemorrhagic lesions can be revealed and it also provides essential diagnostic information for surgical intervention and hence it plays an important role in rapidly assessing acute-phase TBI. Huang et al.[12] indicated that the worst Rotterdam CT score prior to decompressive craniectomy (DC) was an independent predictor of an unfavourable outcome and not of mortality at the end of follow-up as determined by multi-variate logistic regression analysis.

However despite the promising results, we concur that there are some limitations in our study. First, the sample size was small, but this was partly influenced by the presiding condition of lockdown during the COVID pandemic. Second, since ours is a tertiary care centre in the north zone of the country, we are more likely to miss out on a wide spectrum of TBI due to referral of more complicated cases and loss of trivial cases. Hence we would like to advocate conduction of a similar study with higher sample size in order to deliver promising results with higher confidence interval.

CONCLUSION:

In the present study, statistical significance was observed between GOS and the CT findings as per Rotterdam criteria. The more severe were the TBI and CT findings, lower the GOS score. Thus, it is concluded that the use of CT based Rotterdam criteria is not only critical in the initial evaluation of patients with TBI but also adequately predicts short term prognosis of these patients.

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