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A Study on Outcome of Head Injury in Correlation with Glasgow Coma Scale and Ct Scan Findings

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Abstract:
Background: *Head injuries contribute most deaths in trauma fatalities and extent of it could be assessed by both Glasgow coma scale and CT scan of brain. Prognosis of head injuries depends on various factors including which type and time of intervention is done.*
Aim: *The aim of this study is to correlate GCS and CT scan finding in head injury patients with a view to evaluate their prognosis. The study also aims to assess the relationship between computed tomography (CT) scan findings and Glasgow Coma Scale (GCS) score with the purpose of introducing GCS scoring system as an acceptable alternative for CT scan to clinically management of brain injuries in head trauma patients.*
Material and methods: *This prospective study was carried out on 464 head injury patients in the Department of Neurosurgery, RIMS, Ranchi from January 2024 to December 2025. All the patients were advised for CT scan. They were followed up after 6 months.*
Results: *In this study, outcome was statistically significantly associated with GCS (x^2= 9.886, p = 0.002) in patients without CT scan of brain and (2 - 45.537, p- 0.000) in patients with CT scan of brain showing lesions. In case of normal CT scan of brain, outcome was statistically not significant associated with GCS (x^2 = 3.499, p = 0. 128).*
Conclusion: *Though a multitude of factors collectively are decisive in the outcome of head injury patients. the simplest and most effective is GCS scoring system. GCS coupled with CT scan evaluation of prognosis become more accurate and management of head injury patient become more streamline. In our study outcome was significantly associated with GCS in patients without CT scan of brain and in patients with CT scan of brain showing lesion.*
Keywords*: Computed tomography, Glasgow Coma Scale, Head injury, Extradural hematoma, Intracerebral hematoma, Subdural hematoma.*

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I. INTRODUCTION

Head injury is an important public health problem not only because of high mortality morbidity and mortality but also because it is preventable. In 2022, there were 461,312 road accidents in India, resulting in 168,491 deaths and 443,366 injuries. Recent data for 2023 indicated an increase in road accidents to over 480,000, with more than 172,000 fatalities [1.2].

Head injury may not only lead to physical and physiological impairment but may lead to intellectual impairment as well. Loss of young people at their reproductive age is a serious burden on the family as well as on the country [2.4]. For the effective management of head injury an emergent systemic evaluation of the patient is required. Though investigations do provide an accurate diagnosis but repeated clinical examination remains an indispensable, inexpensive and rapid means for diagnosis, prognosis and subsequent monitoring of the patients. Level of consciousness the single most important clinical parameter in a patient of head injury for assessment of outcome [5,6,7]. Many pathological processes which impair consciousness level and numerous terms like super, semi coma and deep coma have been used to describe the various clinical states [8,9]. These terms result in ambiguity an inconsistency when used by different observers. Therefore, a search for uniformly acceptable scale wherein patients could be assessed in such a manner that clinical information word transparent an easily transferable between the observer. Jennett and Tesasdale proposed Glasgow Coma Scale in 1974 and then revised it by adding of another motor response level in 1977 and has been adopted worldwide. In Glasgow coma scale 3

important behavioural aspects were taken in account namely eye-opening (E), best verbal response (V) and best motor response (M) and the total value of scale indicate the level of consciousness.

Despite its wide acceptance the Glasgow coma scale has been criticised on accounts of that there is no consideration for pupillary size and reactivity, pulse rate, respiration and blood pressure [11,12,13]. Eye movement another brain system reflexes have also not been considered. Beside there is difficulty in recording of findings in aphasic or dysphasic patients and patients having bilateral ecchymosis of the eye lids. It has limited usefulness in children particularly those below 3 years of age. In addition to assessing the level of consciousness it predicts the prognosis of the patient to a greater extent [14,15]. Patient with GCS score between 3 to 8 have poor prognosis and those with GCS above 9 have low mortality except when complications like an intracranial hematoma arises. To assess outcome of head injury and to facilitate comparison, in 1975 Jennett and Bond introduced a five-point Glasgow coma scale comprising a good recovery 5 moderate disability- 4, severe disability 3, persistent vegetative state- 2 and death-1.

A new chapter was unfolded in the management of head injury with the invention of CT scan by Hounsfield and Ambrose in 1972. In conjunction with the clinical features, the serial CT scan findings serve as an important predictor of prognosis in head injury. It has been seen that the mortality of extradural hematoma in pre-CT era has reduced at present from approximately 30% to 12% [16,17,18]. CT scan has helped us in understanding of acute SDH and diffuse axonal injury as well. Patients with acute SDH and GCS 3-5 has grave prognosis with mortality rate of about 74% while those with diffuse axonal injury with similar GCS had 51% mortality. Since its introduction in the early 1980s MRI was found to be better than CT scan at detecting traumatic lesions of the brain as regards intracerebral lesions [19,20]. Despite the success of MRI, CT scan has remained the primary imaging modality in an acute head injury patient because of its sensitivity to acute intracranial haemorrhage, low cost and high speed [21,22]. There are multiple factors affecting outcome in head injury which includes clinical features (age of patient, mechanism of injury, motor response, eye sign, etc), physiological parameters (intracranial pressure, cerebral blood flow) and radiological findings (CT scan and MRI findings), etc [23,24]. Thus, aim of this study is to assess the correlation of clinical features and outcome in light of GSC score and CT scan findings of head injury patients

II. MATERIALS AND METHODS

This prospective observational study was carried out on 464 head injury patient who were admitted within 24 hours of head injury with impaired level of consciousness and outcome was recorded at 6 months in the department of neurosurgery, RIMS, Ranchi from January 2024 to December 2025. Their GCS score and CT scan was collected and evaluated. Head injury patients with significant extracranial injuries like chest injuries, abdominal injury and spinal injury were excluded from the study. For the purpose of conclusive opinion, the cases were divided into two groups: GCS 3-8 (mild to moderate head injury) and 9-14 (severe head injury). Detailed history at time of admission was taken. Conservative management like maintenance of airway by intubation and repeated suction, maintenance of proper position by raising the head end of the bed by 30° to facilitate venous drainage and maintenance of fluid, electrolyte and blood pressure. Intracranial hypertension was controlled by hyperventilation, sedation and diuretics. Anticonvulsants and antibiotics were administered. Surgical interventions like craniotomy, craniectomy, dural repair, decompression, etc was done according to the need. Follow up was done after 3rd month and 6th month and GCS at 6th month was recorded. Prognosis has been graded by the criteria of Glasgow coma scale as death-1, persistent vegetative state-2, severe disability-3, moderate disability-4, and good recovery-5. Outcome was further graded as favourable (GR/MD), unfavourable (SD/PVS/death). The outcome of the patients has been categorized on GCS admission alone and GCS on admission combined with CT scan findings and correlated with GCS at 6th month.

III. RESULT

In this study, out of 464 cases, the peak incidence of head injury was found between 21 to 30 years of age constituting 122 cases (26.29%) and the next common age group was between 31 to 40 years of age group constituting 88 cases (18.97%) with male (364) to female (100) ratio of 3.64:1. Road traffic accident 242 cases (52.16%), fall from the height 166 cases (35.78%), assault 44 cases (9.48%) and fall of heavy object over the head 12 cases (2.59%) contributed to head injury. Out of 464 patients, CT scan was done in 388 patients and X RAY was done in 96 patients, 122 patients had skull fracture.

TABLE NO.01: Incidence of types of skull fracture and CT findings

Type of skull fracture	No. of cases	CT done	CT scan findings	
			Normal	Intracranial lesion
Linear fracture	82	62	26	36
Depressed fracture	30	24	6	18
Fracture of base of skull	8	6	2	4
Burst fracture	2	2	34	2

Total	122	94	34 (36.17%)	60 (63.83%)

Table no. 01 depicts that out of 122 patients, CT scan was done on 94 patients, among which 60 patients had intracranial lesions. Among these 60 patients, 36 patients had linear fracture, 18 had depressed fracture, 4 had fracture of base of skull and 2 had burst fracture.

TABLE NO.02: The GCS score of the patients and their outcome

GCS score	No of cases	Favourable outcome GR/MD	Unfavourable outcome	
			SD/PVS	Death
3-8	122	46(37.70%)	20(16.39%)	56(45.90%)
9-14	342	302(88.30%)	16(4.68%)	24(7.02%)
Total	464	348(75%)	36(7.76%)	80(17.24%)

Table no. 02 depicts that on the basis of GCS scoring, among 122 patients with GCS score 3-8, 46 had favourable outcome and 76 had unfavourable outcome (SD/PVD= 20 and 56 mortality) and among 342 patients with GCS score 9-14, 302 had favourable outcome and 40 had unfavourable outcome (16 SD/PVS and 24 mortality).

TABLE NO.03: Correlation of GCS score and CT scan findings with outcome

CT scan	GCS score	No of cases	Favourable outcome GR/MD	Unfavourable outcome	
				SD/PVS	Death
CT scan not done	3-8	30	4(13.3%)	6(20%)	20(66.67%)
	9-14	46	30(65.2%)	6(13.04%)	10(21.74%)
Total		76	34	12	30
Normal CT scan	3-8	14	10(71.4%)	2(14.29%)	2(14.29%)
	9-14	46	44((5.7%)	0	2(4.35%)
Total		60	54	2	4
CT scan of brain showing lesions	3-8	78	32(41%)	12(15.38%)	34(43.59%)
	9-14	250	228(87.7%)	10(4%)	12(4.80%)
Total		328	260	22	46

Table no. 03 depicts that CT scan could not be done in 76 patients. Management was done on the basis of GCS score only. Among 30 patients with GCS score 3-8, 4 had favourable outcome and 26 had unfavourable outcome (SD/PVD= 6 and 20 mortality) and among 46 patients with GCS score 9-14, 30 had favourable outcome and 16 had unfavourable outcome (6 SD/PVS and 10 mortality). In patients with normal CT scan of brain, among 14 patients with GCS score 3-8, 10 had favourable outcome and 4 had unfavourable outcome (SD/PVD= 2 and 2 mortality) and among 46 patients with GCS score 9-14, 44 had favourable outcome and 2 had unfavourable outcome (0 SD/PVS and 2 mortality). In patients with CT scan showing lesion, among 78 cases with GCS score 3-8, 32 had favourable **outcome** and 46 had unfavourable outcome (SD/PVD=12 and 34 mortality) and among 250 cases with GCS score 9-14, 228 had favourable outcome and 22 had unfavourable outcome (10 SD/PVS and 12 mortality).

TABLE NO.04: Incidence of different types of lesion on CT scan in relation to GCS score

GCS score	No. of cases	DBI	EDH	SDH	Contusion/ICH	Mixed	IVH	SAH	Pneumoencephalocele
3-8	78	0	10	10	44	8	4	2	0
9-14	250	24	30	34	112	34	2	8	6
Total	328	24(7.32 %)	40(12.20 %)	44(13.41 %)	156(47.56%)	42(18.80 %)	6(1.83%)	10(3.05 %)	6(1.83%)

Table no. 04 depicts that on CT scan, there were 156 haemorrhagic contusion, 44 SDH, 42 mixed lesion, 40 EDH, 24 DBI, 6 IVH, 10 SAH and 6 pneumoencephalocele. Among these cases 78 had 3-8 GCS score and 250 had 9-14 GCS score.

TABLE NO.05: Outcome with GCS score and CT scan of brain showing DBI only

GCS score	No of cases	Favourable Outcome GR/MD	Unfavourable outcome	
			SD/PVS	Death
3-8	0	0	0	0
9-14	24	22 (91.67%)	0	2 (8.33%)

Total	24	22(91.67%)	0	2(8.33%)

Table no. 05 depicts that in 24 patients with DBI on CT scan, conservative management was done. None has GCS score 3-8, 0 and among 24 patients with GCS score 9-14, 22 had favourable outcome and 2 had unfavourable outcome (0 SD/PVS and 2 mortality).

TABLE NO.06: Outcome and GCS score in patients with extradural haematoma

GCS score	No of cases	Management		Favourable outcome GR/MD	Unfavourable outcome	
		Operation	Conservative		SD/PVS	Death
3-8	10	10(100%)	0	8(80%)	0	2(20%)
9-14	30	26(86.6%)	4(13.33%%)	30(100%)	0	0
Total	40	36(90%)	4(10%)	38(95%)	0	12(5%)

Table no. 06 depicts that in 40 patients with EDH, among 10 cases with GCS score 3-8, 8 had favourable outcome and 2 had unfavourable outcome (SD/PVD=0 and 2 mortality) and among 30 cases with GCS score 9-14, 30 had favourable outcome and 0 had unfavourable outcome (0 SD/PVS and 0 mortality).

TABLE NO.07: Outcome and GCS score in patients with contusion and intracerebral haematoma

GCS score	No of cases	Management		Favourable outcome GR/MD	Unfavourable outcome	
		Operation	Conservative		SD/PVS	Death
3-8	44	32(72.7%)	12(27.3%)	24(54.54%)	6(13.64%)	14(31.82%)
9-14	112	38(33.90%)	74(66.10%)	98(87.5%%)	8(7.14%)	6(5.36%)
Total	156	70(44.87%)	86(55.13%)	122(78.21%)	14(8.97%)	20(12.82%)

Table no. 07 depicts that in 156 patients with contusion and intracerebral hematoma, among 44 cases with GCS score 3-8, 24 had favourable outcome and 20 had unfavourable outcome (SD/PVD= 6 and 14 mortality) and among 112 cases with GCS score 9-14, 98 had favourable outcome and 14 had unfavourable outcome (8 SD/PVS and 6 mortality).

TABLE NO.08: Outcome and GCS score in patients with acute subdural hematoma (SDH)

GCS score	No of cases	Management		Favourable outcome GR/MD	Unfavourable outcome	
		Operation	Conservative		SD/PVS	Death
3-8	10	6(60%)	4(40%)	0	4(40%)	6(60%)
9-14	34	16(47.06%)	18(52.94%)	32(94.12%)	2(5.88%)	0
Total	44	22(50%)	22(50%)	32(72.73%)	6(13.64%)	6(13.64%)

Table no. 08 depicts that in 44 patients with SDH, among 10 cases with GCS score 3-8, 0had favourable outcome and 10 had unfavourable outcome (SD/PVD= 4 and 6 mortality) and among 34 cases with GCS score 9-14, 32 had favourable outcome and 2 had unfavourable outcome (2% SD/PVS and 0% mortality).

TABLE NO.09: Outcome and GCS score in patients with mixed lesion (EDH,SDH, Contusion, etc)

GCS score	No of cases	Management		Favourable outcome GR/MD	Unfavourable outcome	
		Operation	Conservative		SD/PVS	Death
3-8	8	4(50%)	4(50%)	0	2(25%)	6(75%)
9-14	34	12(35.29%)	22(64.71%)	30(88.23%)	0	4(11.77%%)
Total	42	16(38.10%)	26(61.90%)	30(71.43%)	2(4.76%)	10(23.81%)

Table no. 09 depicts that in 42 patients with mixed lesions (EDH, SDH, contusion, etc), among 8 cases with GCS score 3-8, 0had favourable outcome and 8 had unfavourable outcome (SD/PVD= 2 and 6 mortality) and among 34 cases with GCS score 9-14, 30 had favourable outcome and 4 had unfavourable outcome (0% SD/PVS and 4% mortality).

TABLE NO.10: Miscellaneous lesions on CT scan and their relation to GCS score and outcome

Type of lesion	No of cases	GCS score		Favourable outcome GR/MD	Unfavourable outcome	
		3-8	9-14		SD/PVS	Death
IVH	6	4(66.67%)	2(33.33%)	2(33.33%)	0	4(66.67%)
SAH	10	2(20%)	8(80%)	8(80%)	0	2(20%)
Pneumoencephalocele	6	0	6(100%)	6(100%)	0	0

Table no. 10 depicts that in 6 patients with IVH, 4 had GCS score 3-8 and 2 had GCS score 9-14, 2 had favourable outcome and 4 had unfavourable outcome (0% SD/PVS and 4 mortality). In 10 patients with subarachnoid haemorrhage, 2 had GCS score 3-8 and 8 had GCS score 9-14, 8 had favourable outcome and 2 had unfavourable outcome (0 SD/PVS and 2 mortality). In 6 patients with pneumoencephalocele, 0 had GCS score 3-8, 6 had GCS score 9-14, 6 had favourable outcome and 0 had unfavourable outcome (0 SD/PVS and 0 mortality).

Outcome was statistically significantly associated with GCS (x^2= 9.886, p = 0.002) in patients without CT scan of brain and (2 - 45.537, p- 0.000) in patients with CT scan of brain showing lesions. In case of normal CT scan of brain, outcome was statistically not significant associated with GCS (x^2 = 3.499, p = 0. 128).

IV. DISCUSSION

In our study the peak incidence of head injury was found between 21 to 30 years of age 26.29% similar to study by Sambasivan (1977). The maximum injuries were seen in young people which was probably due to more outdoor and physical activity among young people while children below 10 years of age constituted 15.95%. There were 364 male and 100 female patients in our study, thus male to female ratio was 3.64:1. In this study head injury was more prevalent was male owing logically to their association with outdoor activity.

In this study commonest cause of head injury was found to be road traffic accidents 52.16% followed by fall from the height comprising 35.78%. Ramamurthy (1971) reported 42% of head injuries are due to road traffic accidents. In this study, assault constituted 9.48%, fall of heavy object over the head like tree break, wall, etc constituted 2.59%. Predominance of RTA can be due to voluminous rise in number of vehicles, mixture of fast-slow moving traffic, violation of traffic rules and not wearing of helmets.

In this study, out of 122 patients with evidence of skull fracture, CT scan of brain was done in 94 patients. Out of these 94 patients, 63.83% had intracranial lesions. Teasdale G et al (1990) had shown that at all the ages skull fracture and impaired consciousness indicates the risk of a subsequent intracranial haematoma. Level of consciousness is the most significant feature in deciding the ultimate prognosis in head injury. GCS score at the time of admission (after resuscitation) is the highly predictive of outcome. Accuracy of prediction may further be increased by subsequent recording of GCS score at a regular interval. In this study, patient with impaired consciousness i.e. GCS score of 14 and below have been selected and divided into two groups. Those with GCS score 8 and below has much less favourable outcome than those with GCS score of 9-14. 26.29% of head injury patients in our series had GCS score 3-8. In this group 37.70% had favourable outcome, 16.39% had severe disability and 45.90% had death. In patients with GCs 9-14, 88.30% had favourable outcome 4.68% had severe disability and only 7.02% had mortality. Thus, in our study, 75% had favourable outcome, 7.76% had severe disability and overall mortality was 17.24%. patients with GCS score 3-8 compared with International Date Bank series is as follows:

Study	No of severe head injury cases 9GCS 3-8)	Death	SD/PVS	GR/MD
Present data	122	45.90%%	16.39%	37.70%
International data Bank series	125	4702%	13.6%	39.2%

In our series out of total 464 patients, CT scan of brain was available in 388 patients. Rest 76 patients were managed on clinical guidelines alone. 30 of these 76 patients belonged to GCS score of 3-8 of which 66.67% expired while 46 patients belonged to GCS score of 9-14 of which only 21.74% expired. In this group overall mortality was 39.47%. Out of a total 388 patients in whom CT scan of brain was done, 60 patients had normal CT scan of brain, 6.67% of them expired. Among 7 patients with GCS score 3-8 had 71.4% favourable outcome and 28.58% had unfavourable outcome (14.29% SD/PVS and 14.29% mortality) compared with 95.65% favourable outcome and 4.35% mortality (0% SD/PVS) in 23 cases with GCS score 9-14 Thus normal CT scan of brain is a pointer to good prognosis. Friedman (1983) supported this view.

In this study, positive CT scan findings in 328 patients reveals cerebral contusion and intracerebral haematoma as the predominant lesions in 47.56% followed by SDH 13.41%, mixed lesion 2.80%, EDH 12.2%, DBI 7.32% and others including intraventricular haemorrhage, subarachnoid haemorrhage and pneumoencephalocele 6.71%. Out of 328 patients with positive CT scan, 24 patients had diffuse brain injury

(DBI). All were managed conservatively. There was 8.33% mortality and 91.67% had favourable outcome. In our study, favourable outcome in diffuse brain injury group is more because most of our patients belonged to GCS score 9-14 and that too in younger age group. EDH was detected in 40 patients of which 10 belonged to GCS score 3-8. Out of these 20% expired and 80% had favourable outcome. Rest 30 patients with GCS score 9-14 had no mortality. In intracranial haematoma, GCS score correlates to the mortality statistics of the individual lesion except EDH which has good outcome following operative intervention in spite of having GCS score below 8. In our study, out of 156 patients of cerebral contusion and intracerebral haematoma, 44 patients had GCS score 3-8 of which 31.82% expired and 54.54% had favourable outcome. 112 patients belonged to GCS score 9-14 of which 5.36% mortality and 87.5% had favourable outcome. In our study, 10 patients with GCS score 3-8, of which 60% expired, 40% had severe disability. Patients with GCS score 9-14 had 5.88% severe disability and 94.12% favourable prognosis. In present series mixed lesion was detected in 42 patients of which 71.43%, had favourable outcome and 23.81% expired. Intraventricular haemorrhage was detected in 6 patients of which 66.67% had mortality and 33.33% had favourable outcome. There were 6 patients of pneumoencephalocele with GCS score 9-14. All had favourable outcome. This is produced either through dural tear in penetrating head trauma, or through fracture of air sinuses. Limited pneumoencephalocele had minimal clinical abnormalities without death (Zimmerman et al, 1978). Out of 464 patients, 23.7% were operated and rest were managed conservatively. In the group of 144 operated patient mortality was 16.66%, (9.72% had severe disability and 73,62% had favourable outcome).

In this study probability of death on considering of GCS score without CT scan findings was high but further improved on correlation with CT scan findings. In this study, out of 464 patients, CT scan could not be done in 76 patients. CT scan done in 388 patients of which CT scan was normal in 60 patients. Rest 328 patients showed different types of lesions. 76 patients in which CT scan was not done, 30 patients had GCS score 3-8. In this group favourable outcome was in 13.3%, severe disability in 20% and mortality in 66.67%. 38 patients belonged to GCs score 9-14, of which favourable outcome was in 65.2%, severe disability in 13.04% and mortality in 21.74%. In group of patients with normal CT scan of brain, 14 patients had GCS score 3-8, of which 71.4% had favourable outcome, 14.29% had severe disability and 14.29% mortality. Out of 46 patients with GCS score 9-14, 95.79% had favourable outcome none had severe disability and mortality was 4.35%. Out of 164 patients with CT scan with lesions, 78 had GCS score 3-8, of which 4 1% had favourable outcome, 15.38% had severe disability and 43.59% mortality. Out of 250 patients with GCS score 9-14, of which 87.7% had favourable 4% had severe disability and 4.80% mortality. In this study, outcome was statistically significantly associated with GCS ($x^2 = 9.886$, $p = 0.002$) in patients without CT scan of brain and $x^2 = 45.537$, $p= 0.000$) in patients with CT scan of brain showing lesions. In case of normal CT scan of brain, outcome was statistically not significant associated with CCS ($x^2 =3.499$, $p= 0.128$).

Narayan R.K. et al (1981) analysed a clinical sign individually in combination in 133 severely head injured patients and concluded that the GCS score alone was accurate in 80% of predictions but a low level of confidence. CT scan in isolation proved to be poor prognostic indicants. When combined with clinical data, however they increased the number of predictions made with over 90% confidence to 52%. Though a multitude of factors collectively are decisive in the outcome in head injury patients. Simplest and most effective is the GCS scoring system. GCS coupled with CT-scan, evaluation of prognosis becomes more accurate and management of head injury patients become streamlined.

V. CONCLUSION

From the analysis of this study, we conclude that GCS is a simple clinical scale for the evaluation of state of consciousness in head injury patients with high degree of accuracy and CT scan of brain further improves the programmatic efficacy of GCS in head injury patients. Thus, Glasgow score even on admission can prognosticate the outcome of head injury patients.

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