Basrah Journal of Surgery
ISSN: 1683-3589, Online ISSN: 2409-501X

Original Article
Bas J Surg, Dec 29., 2023

VALIDITY OF GLASGOW COMA SCALE AND BRAIN COMPUTED TOMOGRAPHY IN PREDICTING OUTCOME OF PATIENTS WITH ACUTE TRAUMATIC BRAIN INJURY

Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

Thikra Abdul jebbar Hussein
MBChB, PhD / Basrah Health Directorate - Operation and medical emergency service department

Email: thikraalhamdani@yahoo.com

Article ID: BSURG-2306-1053
Receive Date: 16 June 2023
Revise Date: 20 November 2023
Accept Date: 01 December 2023
Publish Date: 30 December 2023

Abstract

Background: The most powerful independent prognostic variables were GCS (Glasgow Coma Scale) and CT characteristics. Since the introduction of CT imaging, the treatment of patients with head injury has improved considerably and it has become a powerful prognostic tool for improving clinical care in TBI (Traumatic Brain Injury), significantly reducing both morbidity and mortality.
Aim of study: To assess the validity of Glasgow Coma Scale and brain computed tomography scan together in predicting outcome of patients presented with traumatic brain injury at emergency department.
Patients and methods: A prospective follow up study carried out in Emergency Department of Baghdad Teaching Hospital in Baghdad Medical city for period from 1st of October, 2015 to 30th of September, 2016 on convenient sample of 244 patients with traumatic brain injury. The diagnosis of traumatic brain injury was based on New Orleans Criteria and Canadian Diagnostic Rules and confirmed by Neurosurgery physician. Glasgow coma scale was measured by researcher and interpretation of Glasgow coma scale was done by both researcher and Neurosurgery physician according to Glasgow Coma Score and computerized tomography scan was interpreted by Radiologist.
Results: The validity results of Glasgow coma scale regarding traumatic brain injury patients' outcome were sensitivity (100%) and specificity (58.9%), while validity results of computerized tomography scan findings regarding traumatic brain injury patients' outcome were sensitivity (66.6%) and specificity (93.6%). The validity results of Glasgow coma scale findings regarding traumatic brain injury patients' morbidity were sensitivity (70.5%) and specificity (99%), while validity results of computerized tomography scan findings regarding traumatic brain injury patients' morbidity were sensitivity (77.7%) and specificity (99%).
Conclusions: The use of both Glasgow coma scale and computerized tomography scan emergency department had valuable results in prediction of morbidity for patients with traumatic brain injury while have no effect for prediction of mortality.

Keywords: Glasgo Coma Scale, Traumatic Brain Injury, Brain CT Scan, Emergency Department.

Introduction:

Traumatic brain injury (TBI) is defined as impairment in brain function as a result of mechanical force. The dysfunction can be temporary or permanent, and may or may not result in underlying structural changes in the brain. The clinical severity ranges from very mild (dazed or momentarily stunned) to profoundly impaired (unresponsive, comatose). [1]TBI is classified based on the clinical assessment of a patient's level of consciousness with little or no regard to the actual underlying injury. Therefore, patients with the same TBI severity classification may have a dramatically different pathophysiology. The current classification system, based on the Glasgow Coma Scale (GCS), divides TBI into severe (GCS score of 3 to 8), moderate (GCS score of 9 to 13), and mild (GCS score of 14 or 15) TBI. Mild TBI makes up a majority of head injuries in the U.S. (approximately 80%). [2] Moderate TBI accounts for approximately 10% of head injuries. Mortality rates for patients with isolated moderate TBI is <20%, but long-term disability is as high as 50%. Overall, 40% of patients with moderate TBI have an abnormal finding on CT scan and 8% require neurosurgical intervention. [3] In severe TBI mortality approaches 40%, with most deaths occurring within the first 48 hours. Fewer than 10% of patients with severe TBI make even a moderate recovery [1]. The Centers for Disease Control and Prevention (CDC) estimates that there are at least 1.7 million cases of traumatic brain injury annually.4 Emergency department (ED) visits for TBI among military members increased from 2008 to 2015. The majority of these cases are mild; 80% of TBI patients who present to an ED are discharged the same day. [4]The morbidity and mortality of TBI is significant: Among severe TBI patients, mortality may range from 39-74% depending on age, and there are 50,000 deaths from TBI in the United States annually. [5-7]Approximately 50% of mortality occurs within the first two hours of injury. [8] The aim of study is to assess the validity of GCS and brain CT scan together in predicting outcome of patients presented with TBI at emergency department.

Patients and Methods

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

A prospective follow up study carried out in Emergency Department of Baghdad Teaching Hospital in Baghdad Medical city for period from 1st of October, 2015 to 30th of September, 2016.

All patients with head injury accompanied by symptoms of traumatic brain injury (TBI) presented to Emergency Department (ED) of Baghdad Teaching Hospital in Baghdad Medical city were the study population.

Inclusion criteria: 1. Head injury in 1st 24 hour.

2. Traumatic brain injury symptoms.

3. Age more than one year.

Exclusion criteria: 1. Pregnancy.

2. Spinal injury.

3. Accident duration more than one day.

4. Lesions of non-traumatic nature.

Sampling: A convenient sample of 244 patients with TBI presented to Emergency Department of Baghdad Teaching Hospital in Baghdad Medical city was selected.

Data collection: The data were collected by researcher through direct interview and filling of a prepared questionnaire. The questionnaire designed by the researcher and Neurosurgeon.

The diagnosis of TBI was based on New Orleans Criteria and Canadian Diagnostic Rules and confirmed by Neurosurgeon. Glasgow coma scale was measured by researcher and interpretation of GCS was done by both researcher and Neurosurgeon according to Glasgow Coma Score (Table 1). A patient is assessed against the criteria of the scale, and the resulting points give a patient score between 3 (indicating deep unconsciousness) and either 14 (original scale) or 15 (the more widely used modified or revised scale). GCS in present study was classified into mild, moderate and severe. CT scan was made by ED Radiology technicians at ED CT scan department at Baghdad teaching Hospital and interpreted by Radiologist on call according to New Orleans Criteria and Canadian CT Head Rule (Table 2).

Management: The TBI patients presented to ED were managed according to Advanced Trauma Life Support (ATLS) course of the American College of Surgeons. The primary objectives of trauma management are:

• Rapid and accurate assessment of the patient's condition,

• Resuscitation and stabilization, and

• Determining whether hospital transfer will be likely. Management is divided into four phases:

• Primary survey.

• Resuscitation.

• Secondary survey.

• Definitive care.

For airway management, rapid sequence intubation should be performed. Some induction agents may cause hypotension, so it is important to maintain blood pressure during the procedure. Etomidate (0.3 mg/kg) and Propofol (1-3 mg/kg IV) were used accordingly. Treat hypotension, if present, as hypotension results in decreased ICP. Use aggressive fluid resuscitation to raise the systolic blood pressure to at least 90 mmHg. If fluid resuscitation is not effective, use vasopressors to maintain a MAP of at least 80 mm Hg in order to preserve CPP.

Additionally, control any sources of bleeding and maintain the hematocrit at or above 30% to avoid anemia. For patients with active seizures, benzodiazepines should be used as first-line anticonvulsants. Use lorazepam (0.05-0.15 mg/kg IV) or diazepam (0.1 mg/kg, up to 5 mg IV, every 5 minutes up to a total of 20 mg). Some neurosurgeons recommend prophylactic antiepileptic agents, and this decision should be made in conjunction with the neurosurgical consultant.

Statistical analysis: All patients' data entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 22 was used.. Statistical analysis of the study was done by the community medicine specialist.

Results

A total of 244 TBI patients were included in this study with mean age of 23.5±15.3 years; 30.7% of them were in age group 20-29 years, 24.2% of them were in age group ≤10 years and 16.8% of them were in age group 30-39 years. Males were more than females with male to female ratio as 5.4:1. All these findings were shown in Table I.

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

Table I: Demographic characteristics of TBI patients

Variable (Age)	Number	%
≤10 years	59	24.2%
11-19 years	33	13.5%
20-29 years	75	30.7%
30-39 years	41	16.8%
40-49 years	19	7.8%
50-59 years	13	5.3%
≥60 years	4	1.6%
Total	244	100.0%
Variable (Gender)	**Number**	**%**
Male	206	84.4%
Female	38	15.6%
Total	244	100.0%

The mechanisms of injury for TBI patients were fall from height (36.1%), RTA (25.8%), blast (16.8%), sports (6.1%) and others (15.2%). The findings of Glasgow coma scale conducted in emergency department (ED) were mild for 58.2% of TBI patients, moderate for 33.6% of patients and severe for 8.2% of patients. The intubation was done for 7.4% of TBI patients in ED. All these findings were shown in Table II.

Table II: History and examination findings of TBI patients.

Variable	No.	%
Mechanism of injury		
Fall	88	36.1%
RTA	63	25.8%
Blast	41	16.8%
Sport	15	6.1%
Others	37	15.2%
Total	244	100.0%
GCS score		
Mild	142	58.2%
Moderate	82	33.6%
Severe	20	8.2%
Total	244	100.0%
Intubation		
Yes	18	7.4%
No	226	92.6%
Total	244	100.0%

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

The validity results of GCS regarding TBI patients' outcome were sensitivity (100%), specificity (58.9%), +ve predictive value (2.9%), -ve predictive value (100%) and accuracy (59.4%). All these findings were shown in Table III.

Table III: Validity test results of GCS findings in comparison to TBI patients' outcome.

Validity test			Outcome		
			Dead	Alive	Total
			No. (%)	No. (%)	No. (%)
GCS	Abnormal	No. (%)	3 (2.9%)	99 (97.1%)	102 (100.0%)
	Normal	No. (%)	0 (0%)	142 (100.0%)	142(100.0%)
	Total	No. (%)	3 (1.3%)	241 (98.7%)	244(100.0%)
Sensitivity		100%			
Specificity		58.9%			

+ve predictive value	2.9%
-ve predictive value	100%
Accuracy	59.4%

The validity results of CT scan findings regarding TBI patients' outcome were sensitivity (66.6%), specificity (93.6%), +ve predictive value (1.8%), -ve predictive value (99.2%) and accuracy (59.4%). All these findings were shown in Table IV.

Table IV: Validity test results of CT scan findings in comparison to TBI patient's outcome.

Validity test			**Outcome**		
			Dead	**Alive**	**Total**
			No. (%)	**No. (%)**	**No. (%)**
CT scan	**Abnormal**	No. (%)	2 (1.8%)	109 (98.2%)	111(100.0%)
	Normal	No. (%)	1 (0.8%)	132 (99.2%)	133(100.0%)

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

	Total	No. (%)	3 (1.3%)	141(98.7%)	244(100.0%)
Sensitivity			66.6%		
Specificity			93.6%		
+ve predictive value			1.8%		
-ve predictive value			99.2%		
Accuracy			54.9%		

Discussion

Early management of patients with severe TBI is among the most challenging issues in trauma. Traumatic brain injury is the leading cause of death, but more relevant to this work is that up to 50 % of those with severe TBI will have long-term sequelae and up to 30 % develop devastating long-term neurological deficits. Furthermore, it is notoriously difficult to identify patients that will have a poor neurological recovery during the early phases of resuscitation. [9]

Our study reported that validity results of Glasgow coma scale in predicting mortality outcome of patients with TBI in emergency department were 100% sensitivity, 58.9% specificity and 59.4% accuracy. These findings are close to Rizoli et al [10] study in Canada which found higher sensitivity of GSC in predicting mortality outcome of TBI. Tien et al [11] retrospectively reviewed a series of 173 patients who suffered blunt head trauma and had a GCS score of 3. They reported in-hospital mortality rates 100% in patients with bilateral fixed, dilated pupils (104 patients) and 42% in patients with reactive pupils (69 patients). The overall mortality rate was 76.8%. Admittedly, patients with bilateral fixed, dilated pupils were treated less aggressively despite the fact that they were more likely to have a surgically treatable hemorrhage. It is well known that the GCS score at hospital admission has prognostic value. [12] and it is an important factor in all prognostic scores. [13] The most detailed analysis of the effects of GCS scores on outcomes after severe TBI was done in the IMPACT study [12]. This IMPACT study explored the prognostic quality of the individual segments of GCS and understudy reactivity to Glasgow Outcome Score (GOS) at 6 months post-

damage. It found that the review doctor's facility enlistment GCS and understudy reactivity be utilized for prognostic investigation. [13]

Present study revealed that CT scan had low sensitivity (66.6%) and high specificity (93.6%) in predicting TBI mortality. These findings are similar to results of Jerstad et al [14] study in Norway which showed that CT scan had low sensitivity in predicting TBI mortality. The dynamic nature of TBI can be characterized by taking serial CT examinations. Marshall et al [15] developed a more discrete classification of head injury, not only for prognostic purposes, but also as a tool to assist in the diagnosis and treatment of secondary injuries, which are avoidable and can occur at variable times after the initial injury. Approximately 10% of the patients with initial Marshall 1 - 2 lesions developed new changes on the second CT scan performed within 24 h post-injury, which is in accordance with a study by Lagares et al [16]. The increasing severity of brain injury is indicated on the CT by indirect evidence of brain stem compression, the size of the perimesencephalic cisterns and a midline shift.[15] In fifty-nine per cent of patients monitoring with an ICP during the acute hospitalization was regarded necessary, and may indicate that the percentage of newly developed lesions in our study was underestimated. CT also seems to underestimate the severity of cerebral injuries and has low sensitivity in visualizing DAIs and especially nonhaemorrhagic lesions. [17]

Current study found a low sensitivity (70.5%) of GCS and high specificity (99%) in predicting TBI patients' morbidity. This is consistent with results of Grote et al [18] study in Germany which reported low sensitivity of GCS in predicting morbidity of TBI. Similarly, our study showed that CT scan had low sensitivity (77.7%) and high specificity (99%) in predicting TBI patients' morbidity that coincides with results of Zhu et al study in China.[19] However, the accuracy measures of both GCS and CT scan separately were relatively good (82.5%, 86.7%). Many studies have reported on the univariate association between predictors and outcome after TBI. The IMPACT study group, which analyzed individual patient data from over 9000 patients with severe or moderate TBI from 11 studies, confirmed age, GCS motor score, pupillary response, and CT characteristics as the most powerful independent prognostic variables. [20].

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

Our study revealed that validity results of combined GCS & CT scan in predicting TBI mortality were 100% sensitivity, 52.7% specificity and 52,8% accuracy. This means that using both GCS & CT scan together won't increase the specificity of GCS in predicting TBI mortality. This is similar to results of Morgado et al [21] study in Brazil which reported a statistically significant correlation between GCS and CT scan findings in predicting TBI mortality. In Morgado et al study [21], low GCS scores were considered as a severity risk factor in association with a greater number of tomographic findings. Patients with TBI and low GCS scores are affected by cerebral injuries with more devastating effects and present with a tendency for hemodynamic instability as observed in other studies [11,22,23].

A few recent studies assessed correlation between GCS score and CT scan to assess brain lesions. In a study by Lee et al [24] the change in CT scans was compared with the GCS the day of the scan showed a positive correlation between the two modalities.

Present study found that when used both GCS & CT scan together, the validity results in predicting TBI patients' morbidity were acceptable (sensitivity 79.8%, specificity 97% and accuracy 87.1%). This finding agreed with results of Nayebaghayee et al [25] study in Iran which concluded that use of GCS score for assessing the level of injury may not be sufficient and thus considering CT findings as the gold standard, the combination of this scoring system and other applicable scoring systems may be more applicable to stratify brain injury level. Farshchian et al [26] showed that only three lesions of extra-axial hematoma, subarachnoid hemorrhage, and hemorrhagic contusion might be associated with low GCS scores. In a study by Joseph et al [27] a mild GCS score (GCS 13–15) in patients with an intracranial injury does not preclude progression on repeat head CT and the need for neurosurgical intervention. Melo et al [28] also indicated that of patients with mild brain injury, neurosurgery was performed in 6.7% and 9.2% had neurological disabilities. In fact, mild brain injury based on GCS score may be associated with significant abnormalities in CT scan, require of neurosurgical procedure and Intensive Care Unit admission. Moreover, Chieregato et al [29] showed that the GCS scoring system was not enough for assessing brain injury, and, therefore, it should be combined with other systems such as traumatic brain injury classification.

Our study showed a significant association between TBI patients with severe GCS and

long duration since accident (p=0.02). This is consistent with reports of Ribbers study in Netherlands [30]. Inconsistently, Sharma et al [31] study in India showed that patients with longer duration (time since injury) of TBI and higher GCS had better QOL. Patients with insomnia had significantly poor QOL compared with those with TBI without insomnia. This difference might be attributed to difference in sample design and size.

Study limitations

1. Loss to follow up.
2. Single center study.
3. Inter-personal variability in estimating GCS and interpreting CT scan.

Conclusion

• The use of both Glasgow Coma Scale and CT scan in emergency department had valuable results in prediction of morbidity for patients with traumatic brain injury.

• The use of both Glasgow Coma Scale and CT scan has no effect in predicting mortality for patients with traumatic brain injury.

• The Glasgow Coma Scale had high sensitivity in predicting mortality and low sensitivity in prediction of morbidity for patients with traumatic brain injury.

• The CT scan had high specificity in prediction of mortality and morbidity for patients with traumatic brain injury.

References:

1. Wright DW, Merck LH. Chapter 254: Head trauma in adults and children. In: Tintinalli JE, Stapczynski JS, Cline DM, et al, eds. Tintinalli's Emergency Medicine: A Comprehensive Study Guide. 7th ed. New York: McGraw-Hill; 2011.

2. Menon DK, Schwab K, Wright DW, Maas AI. Position statement: definition of traumatic brain injury. Arch Phys Med Rehabil 2010; 91: 1637. https://doi.org/10.1016/j.apmr.2010.05.017.

3. Langlois JA, Rutland-Brown W, Thomas KE: Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths. CDC Publication: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2004. Available on: http://www.cdc.gov/ncipc/pubres/TBI_in_US_04/00_preliminary.htm .

4. Langlois JA, Rutland-Brown W, Thomas KE. Traumatic brain injury in the United States: Emergency department visits, hospitalizations, and deaths. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2006. https://stacks.cdc.gov/view/cdc/12294. https://doi.org/10.1037/e721222007-001.

University of Basrah, Bas J Surg, Dec 29, 2023,
Document Type : Original Article Doi: https://doi.org/10.33762/bsurg.2023.137570.1053

5. Armed Forces Health Surveillance Center (AFHSC). Surveillance snapshot: Emergency department visits for traumatic brain injury. MSMR 2011; 18(5):15. https://www.health.mil/Reference-Center/Reports/2011/01/01/Medical-Surveillance-Monthly-Report-Volume-18-Number-5 .

6. Andriessen TM, Horn J, Franschman G. Epidemiology, severity classification, and outcome of moderate and severe traumatic brain injury: A prospective multicenter study. J Neurotrauma 2011; 28(10):2019-2031. https://doi.org/10.1089/neu.2011.2034.

7. Hukkelhoven CWPM, Steyerberg EW, Rampen AJJ. Patient age and outcome following severe traumatic brain injury: An analysis of 5600 patients. J Neurosurgery 2003; 99(4):666-673. https://doi.org/10.3171/jns.2003.99.4.0666.

8. Dewall J. The ABCs of TBI. Evidence-based guidelines for adult traumatic brain injury care. JEMS 2010; 35(4):54-61; quiz 63..

9. Wong GK, Teoh J, Yeung J, Chan E, Siu E, Woo P, et al. Outcomes of traumatic brain injury in Hong Kong: validation with the TRISS, CRASH, and IMPACT models. J Clin Neurosci 2013; 20:1693-1696. https://doi.org/10.1016/j.jocn.2012.12.032.

10. Rizoli S, Petersen A, Bulger E. Early prediction of outcome after severe traumatic brain injury: a simple and practical model. BMC Emergency Medicine 2016; 16(1):32. https://doi.org/10.1186/s12873-016-0098-x.

11. Tien HC, Cunha JR, Wu SN, Chughtai T, Tremblay LN, Brenneman FD, et al. Do trauma patients with a Glasgow Coma Scale score of 3 and bilateral fixed and dilated pupils have any chance of survival? J Trauma 2006; 60:274-278. https://doi.org/10.1097/01.ta.0000197177.13379.f4.

12. Marmarou A, Lu J, Butcher I, McHugh GS, Murray GD, Steyerberg EW, et al. Prognostic value of the Glasgow Coma Scale and pupil reactivity in traumatic brain injury assessed pre-hospital and on enrollment: an IMPACT analysis. J Neurotrauma 2007; 24:270-80. https://doi.org/10.1089/neu.2006.0029.

13. Steyerberg EW, Mushkudiani N, Perel P, Butcher I, Lu J, McHugh GS, et al. Predicting outcome after traumatic brain injury: development and international validation of prognostic scores based on admission characteristics. PLoS Med 2008; 5:e165; discussion e165. https://doi.org/10.1371/journal.pmed.0050165.

14. Jerstad T, Roe C, Ronning P, Sigurdardottir S, Nakstad P, Andelic N. Predicting Functional Outcome One Year after Traumatic Brain Injury with CT and MRI Findings. J Neurol Res 2012; 2(4):134144. https://doi.org/10.4021/jnr133w.

15. Marshall LF, Marshall SB, Klauber MR, Van Berkum Clark M, Eisenberg H, Jane JA, Luerssen TG, et al. The diagnosis of head injury requires a classification based on computed axial tomography. J Neurotrauma 1992; 9 (1):S287-292..

16. Lagares A, Ramos A, Perez-Nunez A, Ballenilla F, Alday R, Gomez PA, et al. The role of MR imaging in assessing prognosis after severe and moderate head injury. Acta Neurochir (Wien) 2009;151(4):341-356. https://doi.org/10.1007/s00701-009-0194-8.

17. Marquez de la Plata C, Ardelean A, Koovakkattu D, Srinivasan P, Miller A, Phuong V, Harper C, et al. Magnetic resonance imaging of diffuse axonal injury: quantitative assessment of white matter lesion volume. J Neurotrauma 2007;24(4):591-598. https://doi.org/10.1089/neu.2006.0214.

18. Grote S, Böcker W, Mutschler W, Bouillon B, Lefering R. Diagnostic value of the Glasgow Coma Scale for traumatic brain injury in 18,002 patients with severe multiple injuries. J Neurotrauma 2011; 28(4):527-534. https://doi.org/10.1089/neu.2010.1433.

19. Zhu GW, Wang F, Liu WG. Classification and prediction of outcome in traumatic brain injury based on computed tomographic imaging. J Int Med Res 2009; 37(4):983-995. https://doi.org/10.1177/147323000903700402.

20. Murray GD, Butcher I, McHugh GS, Lu J, Mushkudiani NA, Maas AIR, et al. Multivariable prognostic analysis in traumatic brain injury: results from the IMPACT study. J Neurotrauma 2007; 24: 329-337. https://doi.org/10.1089/neu.2006.0035.

21. Morgado FL, Rossi LA. Correlation between the Glasgow Coma Scale and computed tomography imaging findings in patients with traumatic brain injury. Radiol Bras 2011; 44(1):35-41..

22. Schreiber MA, Aoki N, Scott BG, et al. Determinants of mortality in patients with severe blunt head injury. Arch Surg 2002; 137:285-290. https://doi.org/10.1001/archsurg.137.3.285.

23. Wardlaw JM, Easton VJ, Statham P. Which CT features help predict outcome after head injury? J Neurol Neurosurg Psychiatry 2002; 72:188-192. https://doi.org/10.1136/jnnp.72.2.188.

24. Lee TT, Aldana PR, Kirton OC, Green BA. Follow-up computerized tomography (CT) scans in moderate and severe head injuries: Correlation with Glasgow Coma Scores (GCS), and complication rate. Acta Neurochir (Wien) 1997; 139:1042-1047. https://doi.org/10.1007/BF01411558.

25. Nayebaghayee H, Afsharian T. Correlation between Glasgow Coma Scale and brain computed tomography-scan findings in head trauma patients. Asian Journal of Neurosurgery 2016; 11(1):46-49. https://doi.org/10.4103/1793-5482.165780.

26. Farshchian N, Farshchian F, Rezaei M. Correlation between Glasgow Coma Scale and brain CT-scan findings in traumatic patients. J Inj Violence Res 2012; 4(3): 44..

27. Joseph B, Pandit V, Aziz H, Kulvatunyou N, Zangbar B, Green DJ, et al. Mild traumatic brain injury defined by Glasgow Coma Scale: Is it really mild? Brain Inj 2015; 29:11-16. https://doi.org/10.3109/02699052.2014.945959.

28. Melo JR, Lemos-Júnior LP, Reis RC, Araújo AO, Menezes CW, Santos GP, et al. Do children with Glasgow 13/14 could be identified as mild traumatic brain injury? Arq Neuropsiquiatr 2010; 68:381-384. https://doi.org/10.1590/S0004-282X2010000300010.

29. Chieregato A, Martino C, Pransani V, Nori G, Russo E, Noto A, et al. Classification of a traumatic brain injury: The Glasgow Coma Scale is not enough. Acta Anaesthesiol Scand 2010; 54:696-702. https://doi.org/10.1111/j.1399-6576.2010.02234.x.

30. Ribbers GM. 2010. Brain Injury: Long term outcome after traumatic brain injury. In: JH Stone, M Blouin, editors. International Encyclopedia of Rehabilitation. Available on: http://cirrie.buffalo.edu/encyclopedia/en/article/338/.

31. Sharma A, Jain A, Sharma A, Mittal RS, Gupta ID. Study of Quality of Life in Traumatic Brain Injury. IJNT 2015; 12(01): 002-009. https://doi.org/10.1055/s-0035-1554948.

Acknowledgements: Nil
Conflicting interests: No conflict of interest
Funding: None
Informed consent: Written informed consent was obtained from all the patients companion.
Ethical Approval: Approved by the institutional review board committee
The author certifies that the article is original, is not under consideration by any other journal, and has not been previously published.
Availability of Data and Material:
The author is prompt to supply datasets generated during and/or analyzed during the current study on wise request.

Cite this article: Hussein, T. Validity of Glasgow coma scale and brain computed tomography in predicting outcome of patients with acute traumatic brain injury. *Basrah Journal of Surgery*, 2023; 29(2):99 -112. doi: 10.33762/bsurg.2023.137570.1053