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Reliability of cerebral edema interpretation on head computed tomography scan in mild and moderate traumatic brain injury

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ABSTRACT

Introduction: Cerebral edema could be caused by mild or moderate traumatic brain injury. The primary modality for cerebral edema is head computed tomography (CT), however the interpretation could be different between radiologists which could be due to subjectivity. The purpose of this study is to determine the radiologist interobserver and intraobserver reliability in the interpretation of cerebral edema on head CT of mild and moderate traumatic brain injury in Sanglah General Hospital, Denpasar, Bali.
Methods: Retrospective study design with interobserver and intraobserver reliability test of two radiologists in interpreting cerebral edema on head CT of patients with mild and moderate traumatic brain injury
Results: 35 head CT scans of patients with clinical history of mild or moderate traumatic brain injury, shows that significant differences (bias) intraobserver and interobserver in the interpretation of cerebral edema.
Conclusion: Head CT scan could not be reliable to determine cerebral edema in patients with mild and moderate traumatic brain injury due to high subjectivity between radiologists.

Keywords: brain edema, head injury, head CT
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INTRODUCTION

Traumatic brain injury is a trauma within the structure of the cranium which cause structural and/or functional damage to the brain.[1] One of the complications caused by traumatic brain injury is diffuse cerebral edema. Diffuse cerebral edema is a generalized response of various traumatic brain injuries, one of them is due to mild and moderate traumatic brain injury. This condition is due to increase of intracranial pressure, which then cause decreased brain perfusion, resulting in brain ischemia. Therefore, quick and precise diagnosis of diffuse cerebral edema should be made in patients with mild to moderate traumatic brain injury.[2-4]

CT Scan and MRI are widely used to determine the severity of traumatic brain injury. Accurate diagnosis of diffuse cerebral edema could prevent further complications. In our daily practice in Sanglah General Hospital, Denpasar, Bali, we occasionally found discrepancy in interpretation of diffuse cerebral edema in head CT between radiologists in the case of mild and moderate traumatic brain injury, so we would like to conduct interobserver and interobserver study between radiologists. Reliability in interpreting cerebral edema is very important in determining patient management and shows the consistency of radiologists in making a diagnosis in health care centers.

METHODS

This study is a retrospective study with interobserver and interobserver reliability tests by consecutive sampling. The samples were patients with mild or moderate traumatic brain injury who had undergone a head CT scan, inclusion criteria were patients older than 19 years old with acute mild to moderate traumatic brain injury (severity according to Glasgow Coma Scale), exclusion criteria were over 60 years of age, findings of intracranial hemorrhage, having previous brain parenchymal abnormalities such as meningitis, encephalitis, tumors, degenerative diseases, stroke, intracranial surgery, and have received previous medications to lower intracranial pressure. Imaging of the eligible patients were then evaluated according to compression of the ventricles, narrowing sulci, narrowing sylvian fissure, narrowing perimesencephalic cistern, and brain parenchymal density. After that, blind scoring by interobservers and intraobservers were carried out. Agreements of the scores were assessed by Bland-Altman statistical analysis.

Our study was performed according to the ethical standards of the Declaration of Helsinki (1964) and its later amendments. Acknowledgements by the Research Ethics Committee Faculty of Medicine Udayana University/Sanglah General Hospital Denpasar, with letter number: 886/UN14.2.2.VII.14/LT/2021.

RESULTS

Sample Characteristics

Among 35 eligible samples, male was more than female, with the average of 22 years of age. The rest of the data were shown in Table 1.

Results of intra-observer analysis of cerebral edema

Intra-observer evaluation was performed in 35 samples by blinded same radiologists in different time, then analyzed by using Bland-Altman limits of agreement. The results showed there was significant difference (bias) between different time of examination ($p<0.001$). There was maximal difference in 95% Bland-Altman limits of agreement between the examination respectively -4.859-1.888 with the mean difference of -1.486. This could be seen in Table 2 and Figure 1.

Results of inter-observer analysis of cerebral edema

Inter-observer evaluation was performed twice in 35 samples by two blinded radiologists with more than 5 years of experience and then analyzed with Bland-Altman's limits of agreement.

The results of the assessment showed that there was a significant difference (bias) between radiologist A and radiologist B with p-value <0.001. Data from the results of the inter-observer test for the assessment of cerebral edema (Table 3), the maximum difference in the assessment results in the 95% limits of agreement Altman Band between radiologists A and B respectively was -4.799-9.199 with a mean difference of 2.2.

DISCUSSION

In traumatic brain injury, cerebral edema (CE) is related a poor prognosis and the due to intracranial hypertension. CE is the primary cause of in-hospital death, affecting more than 60% of patients with mass lesions and 15% of those with normal first computed tomography scans. Following the treatment of mass lesions in severe TBI, diagnose, and manage the secondary damage process of CE and the resulting intracranial hypertension is an important focus of acute neurocritical care.[7]

Table 1. Sample Characteristics

Characteristics	n=35
Age (years), median (IQR) (minimum-maximum)	22(12) 16-49
Gender n (%)	
Male	23 (65.7)
Female	12 (34.3)
Traumatic brain injury severity n(%)	
Mild	7(20)
Moderate	28(80)

Table 2. Results of intra-observer analysis of cerebral edema in head CT

	n= 35	p-value
Correlation coefficient (r)	0.697	<0.001
Mean difference	-1.486	<0.001
95% *Limits of Agreement* (*Bland&Altman*, 1986)	-4.859-1.888	

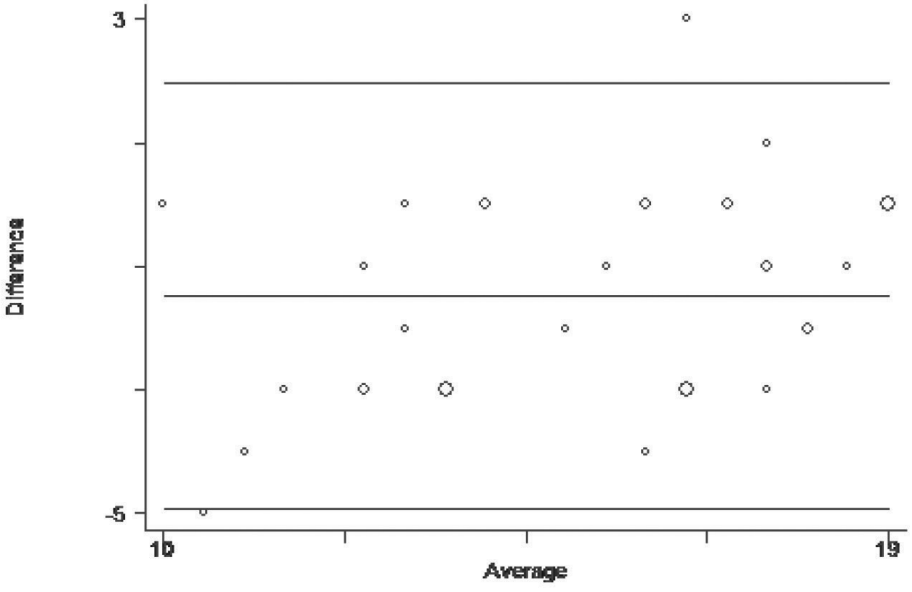

Figure 1. Intra-observer Bland-Altman Plot Graph

Table 3. Results of inter-observer analysis of cerebral edema on CT-scan images

	n= 35	p-value
Correlation coefficient (r)	0.535	<0.001
Mean difference	2.2	<0.001
95% *Limits of Agreement* (*Bland&Altman*, 1986)	-4.799-9.199	

Nonenhanced head CT is one of modalism and classified class I recommendation for patients with moderate to severe TBI.[8] Consider the usefulness and sensitivity of the image for representing brain lesions that require neurosurgical intervention. Other consensus such as Orleans Criteria, the Canadian Head CT Rule, and the National Emergency X-Radiography Utilization Study II (NEXUS-II) also stated same evidence to support CT scan as clinical decision-making tool of TBI mild case.[9] Which in this study predominantly by severe case of TBI. Other mechanism that may explained this, the initial edematous of cytotoxic edema insult is vasogenic. The white matter is affected by the progression of vasogenic edema. According to a previous study, a drop in white matter density of more than 5 HU is linked to symptoms of cerebral edema. However, such a subtle decrease is nearly impossible to perceive with the human eye.[10,11]

This study after validation tests were carried out on cerebral edema scoring, then intra- and inter-observer reliability tests were performed, there was a significant difference (bias) in the assessment of cerebral edema both intra- and inter-observer with a maximum and significant mean difference. This showed that there was still high subjectivity between radiologist in determining cerebral edema on head CT in patient with mild and moderate traumatic brain injury. The contribution, if any, of higher-quality pictures produced by newer and more adaptable CT machines in reducing inter- and intraobserver variability has not been investigated in detail, though it may be significant.

CONCLUSION

Head CT scan could not be reliable to determine cerebral edema in patients with mild and moderate traumatic brain injury due to high subjectivity between radiologists. For this reason, it is necessary to match the findings with the patient's clinical history, or to perform additional clinical investigations if needed.

DISCLOSURE

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Conflict of Interest

The author declares no conflict of interest related to material presented in this article.

Ethical Consideration

Ethical research has approved by Research Ethics Committee Faculty of Medicine Udayana University/Sanglah General Hospital Denpasar, with letter number: 886/UN14.2.2.VII.14/LT/2021.

Author Contribution

All authors contributed equally contribute to the study.

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