CASE REPORT

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Role of flow velocity and transient hyperemic response evaluated by transcranial doppler for assesing brain autoregulation in mild traumatic brain injury: a case report

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ABSTRACT

Head injuries are a common case throughout the world, based on data from the Centers for Disease Control, emergency cases, hospitalization cases, and also deaths due to head injuries have increased in the decade 2001-2010. Cerebral autoregulation (CA) is a mechanism for cerebral blood flow (CBF) regulation if there is a change from cerebral perfusion pressure (CPP). The mechanism of brain autoregulation is negative feedback that holds back the increase in mean arterial pressure (MAP) by reducing the diameter of blood vessels so that CBF returns to normal, whereas if MAP falls, brain autoregulation tends to widen blood vessel diameter so that CBF is normal. Transcranial doppler examination can be one of the modalities of investigation that is very useful in patients with head injuries. Transcranial doppler in patients with a head injury can be used to measure mean flow velocity of cerebral artery media and transient hyperemic response test, both of which can assess the prognosis of a course of head injury.

Keywords: mean flow velocity; transient hyperemic response test; transcranial doppler; head injury

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INTRODUCTION

Head injuries are a very common case throughout the world. The Centers for Disease Control (CDC) reported that emergency, hospitalization, and deaths due to head injuries increased in 2001 to 2010.[1] The World Health Organization (WHO) stated that 1.2 million people died every year due to traffic accidents, with millions more were disabled. It mainly occurs in countries with low-to-moderate income with increased use of motorbike as the primary means of transportation.[2]

CASE REPORT

A 21 years old male was admitted to the emergency department (ED) with mild head injury due to a traffic accident. He was unconscious soon after the accident, then regained his consciousness in about 1-2 minutes. He showed no cranial symptoms like nausea, vomiting or headache. From the physical examination, the Glasgow Coma Scale (GCS) was 15; blood pressure was 121/79 mmHg; heart rate 87 beats per minute; respiratory rate 16 times per minute; and body temperature was 37.1°C.

The routine blood examination was unremarkable. The patient was observed for 2 hours at the emergency room and showed no worsening symptoms. He was not scheduled for a CT scan examination and a transcranial doppler examination (TCD) to examine cerebral blood flow (CBF) performance. From the test, we found that the medial cerebral artery peak systolic velocity, end-diastolic velocity, and mean-flow velocity (MFV) were 62.85 cm/sec, 22.93 cm/sec, and 36.23 cm/sec, respectively. Transient hyperemic response test was negative. From this result, we concluded the CBF was still disrupted, so we observed him for another 24 hours. He was discharged the next day in good condition without any residual symptoms.

DISCUSSION

Head injury is an occurrence of non-degenerative, non-congenital brain injury originating from external pressure, which can cause a temporary or permanent disturbance in cognitive function, psychosocial function, which can also be accompanied by a decrease in consciousness.[3] Head injury is divided by its severity that was mainly based on the level of consciousness assessed by the GCS: severe (GCS <9), moderate (GCS=9-12), and mild (GCS=13-15).[4]

There are several ways to calculate CBF between them, direct intravascular measurement, nuclear medicine, X-ray imaging, MRI, and ultrasonography techniques.[6] Transcranial Doppler Ultrasound (TCD) can provide a picture and measurement of

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CBF in the median cerebral artery (MCA).[7] The technique of measuring CBF through TCD is done by placing the transducer in the temporal region above the zygomatic arch, also called the transtemporal window. TCD provides an overview of CBF through a relative index approach.[8]

A report by van Santbrink *et al.*[9] stated that flow velocity defined as low when the mean flow velocity is ≤35 cm/sec in one or both MCAs within 72 hours after trauma. Bouzat *et al.*[10] described that normal TCD value as the diastolic blood flow velocity is higher than 25 cm/s in the two MCAs. In another study, this threshold limits has the sensitivity of 92% and specificity 76% to predict the patient to be at risk of developing secondary brain injury.[11] TCD provides information about cerebral hemodynamics, which is essential for the prognostication of a patient with traumatic brain injury (TBI). Hypoperfusion occurs when two out of three of the followings are met: the mean velocity of the MCA is less than 35 cm/second, the diastolic velocity of the MCA is less than 20 cm/second, and a pulsatility index is >1.4.[12]

Fatima *et al.*[13] found that in patients with TBI and abnormally TCD (MFV >120 cm/sec in vasospasm state, or <35 cm/sec in hypoperfusion state, and pulsatility index >1.2) have more than threefold the likelihood of having poor clinical outcome compared with patient TBI with normal TCD. In this case, we found that the MFV was 36.23 cm/sec, which is not classified into either of hypoperfusion nor vasospasm state. However, the value was near the low-end of hypoperfusion value.[14]

This patient had a lower end-diastolic velocity (22.93 cm/sec), which means that the cerebral blood flow could be disturbed. This condition played a role in deciding to observe the patient for 24 hours in the hospital to monitor possible developing symptoms.

Intracranial hypertension can be caused by the loss of the autoregulation mechanism. It is one of the factors worsening the outcome of treating patients with head injuries. Autoregulation disorders that occur in TBIs can also be evaluated using TCD.[15] Transient hyperemic response test can reveal the possibility of slow complications in patients with head injuries. Early detection of vasoconstriction from vascularization of blood to the brain is critical to avoid the occurrence of ischemic brain disorders that will occur in the future. TCD focuses on transient hyperemic response can be used to measure brain autoregulation disorders qualitatively.[16-19]

There is a limited study that found the correlation between the evaluation of transient hyperemic response (THR) test to the autoregulation disorder of the brain. Al-Jehani et al.[20] conducted a small retrospective review study to investigate the usability of THR test as a predictor of vasospasm in patients with aneurysmal subarachnoid haemorrhage. They found that 83% patient with clinical and radiological vasospasm had an abnormal THR test in initial TCD test. Smielewski *et al.*[21] found that hyperemic response is lower in patients with poor clinical grade (GCS <6) and poor outcome (Glasgow Outcome Scale 3,4, and 5).

In a prospective observational study found that THR test can predict unfavourable outcome after subarachnoid haemorrhage if cerebral autoregulation impairment was detected.[22,23] In this study, the THR test was found negative, which indicated that the cerebral autoregulation was preserved. Combined with the fact that this patient was in good clinical grade, we may predict that this patient will have a better outcome.

CONCLUSION

The use of TCD in patients with mild head injuries can be useful used to measure the MCA's MFV. Both TCD and THR tests are non-invasive, and they may assess the prognosis of a course of TBI cases. More studies are needed to determine if this method of measurement could navigate the therapy of a patient with TBIs.

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