STUDY OF COMPUTED TOMOGRAPHY PERFUSION IN TRAUMATIC CEREBRAL CONTUSION

by

DR. AHMAD HELMY BIN ABDUL KARIM

Dissertation Submitted In
Partial Fulfillment Of The
Requirement For The Degree Of
Master Of Medicine
(Radiology)

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ACHIEVEMENT

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To

My beloved parents,

Haji Abdul Karim Abu Bakar

Hajjah Laili Hanim Haji Tak

Thanks for your 'doa' , loves and continuous moral support

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ABBREVIATIONS

CBF	Cerebral Blood Flow
CBV	Cerebral Blood Volume
CT	Computed Tomography
CTP	Computed Tomography Perfusion
GE	General Electric company
GCS	Glasgow Coma Scale
GOS	Glasgow Outcome Score
HU	Hounsfield Unit
HUSM	Hospital Universiti sains Malaysia
MRI	Magnetic Resonance Imaging
MTT	Mean Transit Time
NECT	Non-enhanced Computed Tomography
PET	Positron Emission Tomography
SPECT	Single Positron Emission Computed Tomography
ROI	Region Of Interest

ABSTRAK

TAJUK

Kajian imbasan perfusi tomografi berkomputer terhadap traumatik kontusi cerebrum otak akibat kecederaan otak.

PENGENALAN

Kecederaan kepala merupakan penyebab utama yang ke-lima kematian di dalam hospital Kementerian Kesihatan Malaysia (KKM) dengan kadar 6.07% (Statistik KKM, 2004). Imbasan tomografi berkomputer tanpa menggunakan kontras (NECT) adalah alat yang sensitif dalam pengimejan diagnostik pesakit yang mengalami kecederaan kepala dan prevalen kontusi otak sebanyak 15.0% di perolehi daripada imbasan awal (Wintermark et al., 2004).

Kawasan hipodensiti di sekeliling kontusi cerebrum otak menunjukkan pembengkakan tisu otak atau edema dan sebarang gangguan perfusi otak tidak dapat di kaji dengan menggunakan NECT. Imbasan perfusi tomografi berkomputer (CTP) dapat memberikan maklumat mengenai perfusi otak di kawasan hipodensiti berkenaan berdasarkan analisa parameter CTP. Perfusi otak yang tidak normal akan memburukkan keadaan pesakit dan analisa awal terhadap perfusi otak dapat membantu perawatan pesakit seterusnya meningkatkan tahap kesembuhan pesakit.

OBJEKTIF

Kajian ini bertujuan untuk menentukan tahap perfusi otak di kawasan sekeliling kontusi cerebrum otak dan kaitannya dengan tahap kesembuhan pesakit.

BAHAN DAN PESAKIT

Dari Julai 2007 sehingga November 2008, seramai 10 pesakit telah dianalisa apabila semua criteria penyertaan di penuhi.

Semua pesakit terlibat dalam kemalangan jalan raya dan mengalami kecederaan kepala.

Imbasan NECT di jalankan untuk memastikan diagnosis kontusi otak kemudian CTP dilakukan. Data di analisa di kaunter kerja imbasan tomografi berkomputer atau 'CT workstation'. Saiz dan jarak kontusi dari tempurung kepala yang berdekatan akan di ukur berdasarkan imbasan NECT. Kawasan hipodensiti di sekeliling kontusi di bahagi kepada 4 bahagian berdasarkan jarak dari tempurung kepala. Kawasan yang di kaji berdasarkan hipodensiti dan peta warna CTP. Setiap parameter perfusi dihasilkan oleh perisisan dan dianalisa samada kawasan tersebut mempunyai perfusi normal, kurang perfusi atau 'ischaemia' dan tiada perfusi atau 'infarct'. GOS akan di nilai pada minggu ke-enam selepas kecederaan kepala.

KEPUTUSAN

Perhubungan Spearman yang ketara pada tahap 0.05 (2-tailed) di antara jarak kontusi dari tempurung kepala dan status perfusi otak di dalam kawasan hipodensiti; status perfusi otak di kalangan kawasan hipodensiti; saiz kawasan hipodensiti dan status perfusi di dalam kawasan hipodensiti yang berdekatan; saiz kontusi dan saiz kawasan hipodensiti; dan saiz sesama kawasan hipodensiti.

KESIMPULAN

CTP adalah kaedah yang cepat, berguna dan bersesuaian untuk menilai tahap perfusi otak di dalam kawasan hipodensiti di sekeliling kontusi serebrum otak. Ketiadaan hubungan di antara status perfusi otak dan tahap kesembuhan berkemungkinan disebabkan oleh jumlah pesakit yang sedikit. Kurang perfusi di dapati dalam setiap kawasan hipodensiti dan ini menunjukkan kepentingan CTP dalam merawat pesakit yang mengalami kecederaan kontusi otak.

ABSTRACT

TOPICS

Study of computed tomography perfusion (CTP) in traumatic cerebral contusion.

INTRODUCTION

Head injury is listed as the 5th principle cause of death in Ministry of Health (MOH) hospitals with percentage of 6.07% (Health Statistics MOH, 2004). The prevalence rate of cerebral contusion was recorded as 15.0%(Wintermark *et al.,* 2004). Non-enhanced CT (NECT) brain is a sensitive primary diagnostic tool in the evaluation of patients with head injury.

On NECT brain, pericontusional hypodensity area represents oedema. However, its perfusion disturbance could not be determined from plain CT scan. CTP provides information regarding ischaemic injuries related to the trauma and able to determine any evidence of pericontusional ischaemia. Reduction of perfusion can lead to unfavourable outcome.

OBJECTIVE

This study aims to determine perfusion status of pericontusional hypodensity area and correlation with clinical outcome.

MATERIAL AND METHOD

Ten patients involved in motor vehicle accidents (MVA) fulfilled the inclusion and exclusion criterias and hence enrolled in this study from July 2007 to November 2008.. NECT scan of the brain was done on admission to confirm presence of contusion and followed by CTP. The data were analyzed at the CT workstation. Pericontusion areas were divided into four sections in relation to distance from the skull. Distance and size of contusion were measured from NECT scan. The region of interest were drawn based on hypodensity and CTP colour map. Each parameters of perfusion were produced by the perfusion software and were analyzed. CTP results were categorized as normal, ischaemia or infarct. Clinical outcome was evaluated using GOS after 6 weeks post trauma.

RESULT

Significant statistical Spearman correlation at the 0.5 level (2-tailed) found between the distance of the contusion from the nearest skull vault and the perfusion status in the pericontusional hypodensity area of that distance; perfusion status among pericontusinal hypodensity area; size of pericontusional hypodensity area with perfusion status of adjacent pericontusional hypodensity area; size of contusion and size of pericontusional hypodensity; and size of pericontusional hypodensity among each ROI.

CONCLUSION

CTP is a useful, fast and appropriate method in evaluating perfusion of pericontusional hypodensity area. However no correlation found between perfusion and clinical outcome in this study due to small sample size. Ischaemia was present in all pericontusional hypodensity area. This suggests importance of doing CTP in managing the traumatic contusion patient.

1. INTRODUCTION

Injury to the brain is the leading factor in mortality and morbidity of traumatic brain injury (TBI). The devastating personal, social, and financial consequences of traumatic brain injury are compounded by the fact that most people with TBI are young and previously healthy.

With a current management of traumatic brain injury which includes advancement in brain imaging, these individuals are surviving injuries that would previously have been fatal (Klimczak *et al.*, 1997).

Because brain function is exceedingly complex, brain injury and recovery are also complex (Rao & Lyketsos, 2002). Therefore imaging for diagnosis and clinical implication is extremely important for these group of patients.

Although it is desirable to have cranial computed tomography (CT) scan for all patients with TBI, it is not available everywhere. Performing CT scan not just involve only medical and legal issues but also cost . To make things even more complex, an early CT scan does not identify who will develop neurological deficits even after minor head injury. Therefore, some authors advise CT scan only for subsets of patients considered at higher risk for developing intracranial lesions.

Over recent years, CT scanner has became available nearly worldwide in emergency departments, and its importance to manage patients with traumatic brain injury has been extensively reported. Although there is no settlement regarding which patients should be scanned, authors agree that an abnormal result has a major impact on patient management (Nagy KK *et al.*, 1996).

Computed tomography (CT) is a sensitive diagnostic tool in the evaluation of acute head injury as it can detect intracranial lesion which might need intervention. Unfortunately, the prognostic value of the patient based on the conventional CT has limited value.

Structurally, cerebral contusions are characterized by an area of haemorrhagic necrosis which is surrounded by perilesional hypodensity area in plain CT scan of brain. This contusions have a tendency to enlarge over the time and becoming significant space-occupying lesion which exerting mass effect to surrounding brain parenchyma. This mass effect will lead to increase intracranial pressure with subsequent clinical deterioration or worsening neurological condition.

Survey by TBI European Brain Injury Consortium in 729 patients with TBI found that cerebral contusions alone (44%) or in association with subdural hematoma (29%) were the most frequent causes for delayed surgical intervention (Compagnone *et al.*, 2005).

In addition, ultrastructural studies have provided the evidence of progressive neuronal damage leading to growing area of necrosis, enhancing the role played by cerebral contusions as a vector of secondary brain damage (Katayama *et al.*, 1990).

Therefore, cerebral contusion can become a major therapeutic challenge as it has a potential to become growing mass mixed with presumably viable tissue, which may be of critical functional importance whenever surgical removal of the lesion is contemplated in neurologically eloquent areas (Soustiel *et al.*, 2007).

Hyperdense area in the contusions which representing haemorrhagic necrosis can be safely evacuated but the effect of surrounding hypodensity area is still a controversy as it can represent area of oedema without alteration of surrounding blood perfusion or presence of any element of perfusion disturbance.

Several studies on ischaemic stroke revealed hypodensity area in plain CT scan of brain has regional alteration of the perfusion.

Computed tomography perfusion (CTP) has been shown to be useful in acute stroke and other cerebrovascular disorders as it can detect infarct and penumbra (ischaemic) area. If ischemia is detected by CTP, perfusion can be improved by increasing the systemic blood pressure.

Therefore, the purpose of this study was to evaluate the pericontusional hypodensity area regarding the perfusion whether the hypodensity reflects oedema with or without perfusion disturbance. At the same time, patient's clinical outcome was assessed to evaluate whether alteration in perfusion in pericontusional hypodensity area is attributable to patient's outcome.