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Fallacies of Routine CT Scan in Identifying Lesions in Severe Head Injury

(Preliminary findings of an autopsy study)

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Abstract: Though CT scan is a common and reliable tool for diagnosis in severe head injury, may a times there is no detectable lesion seen in the CT scan of a patient with severe head injury to explain the neurological status. Literature search did not reveal any study which has systematically analyzed the failures of CT scan in identifying traumatic lesions in a qualitative and quantitative manner. The present study is a preliminary attempt to correlate the CT scan and autopsy findings in patients of fatal head injury. The study highlights fallacies of CT scan in detecting lesions close to the bone, for instance, SDH, SAH, basal contusions. The linear fractures at the vault and the basal region are also likely to be missed in majority of the cases in routine CT scan. The study tries to suggest some modification in the technique of CT scan, which might pick up hitherto undiagnosed traumatic lesions in the brain.

Keywords: head trauma, head injury, diagnostic imaging, CT

INTRODUCTION

Computerised tomographic (CT) scanning remains the commonest modality of investigations for acute head injury (HI) patients worldwide. In many patients, CT scan might look normal, yet the patient may have a poor Glasgow Coma Scale (GCS). This complicates the therapy as the underlying physiological changes leading to poor sensorium are not anatomically discernable. Though MRI scan is a better radiological tool in this situation, however, it is not routinely feasible in an acute head trauma patient. There is paucity of information in the literature regarding the shortcomings of routine CT scan in picking up the lesions in CT scan of patients with severe HI. Therefore a study was aimed to:

- Find the discrepancy between CT scan and autopsy findings in cases of fatal HI
- Identify the traumatic lesions of skull and brain which are prone to be non visualised on CT scan
- Suggest means for better CT detection of traumatic lesions of brain

MATERIAL AND METHODS

Medicolegal autopsy records of sixty patients who had died of head injury were analyzed. The study included 49 males and 11 females, in the age range of 7 to 65 years (mean 41.84 years). Clinical details were noted followed by recording of the ante-mortem CT scan findings as described in the case files. Subsequently the autopsy findings were recorded by the prosector and these were compared with the radiological findings. The discrepancy in the autopsy finding and the CT observations were then tabulated and the various lesions missed on CT scan were identified.

RESULTS

Traumatic subarachnoid hemorrhage which was detected in CT scans of only 10 patients was found in 33 cases at autopsy. Whereas CT revealed thin subdural hematoma (SDH) in 5 cases, autopsy however showed the same in 15. Four cases were found to have extradural hematoma at autopsy, though it was detected on CT scan in 3 cases. Autopsy revealed contusions in temporal region in 26, frontal region in 16, occipital region in 5 and in the cerebellum in 2 patients. However CT scan was able to diagnose the same in 16 cases in temporal and 10 cases in the frontal region. In one patient, CT scan over-diagnosed a parietal contusion which was not evident at autopsy. Autopsy of the brain stem revealed contusion in 30 patients; however only 6 patients could show the same on CT scan. Contusions involving the thalamus and hypothalamic region were detected in 9 patients at autopsy but the same was revealed on CT in 2 patients. Although petechial haemorrhages in corpus callosum were observed in 11 patients, CT showed this finding in only one patient. None

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of the 4 patients who had evidence of uncal herniation on autopsy could be diagnosed to have the same on CT scan (Table 1).

Table 1: Comparison of lesions – CT vs autopsy

Lesion	CT	Autopsy
SDH	5	15
EDH	3	4
Contusions		
Frontal	10	16
Temporal	16	26
Parietal	01	00
Occipital	00	05
Cerebellar	00	02
Brain stem	06	30
Thalamus/ hypothalamus	01	09
Basal ganglia	02	02
Corpus callosum	01	11
Uncal herniation	00	04

Fractures running through the basi-spenoid, orbito-sphenoid or the occiput were detected in only 3 occasions, whereas 24 such fractures were detected autopsy. The same was true for vault fractures (1 in CT versus 7 at autopsy). However fractures in the frontal or temporal region had a better pick-up rate on CT (Table 2).

Table 2: Fractures of skull - CT versus autopsy

Fractures	CT	Autopsy
Vault	01	07
Speno-orbital	00	05
Basi-spenoid	01	11
Occiput	02	08
Temporo-occipital	03	07
Temporal	04	07
Frontal	02	02

The above findings show that routine CT scan, which is the commonest tool for diagnosis in acute HI does have various short comings. SDH and SAH were detected in only 33% of patients on CT scan though EDH was better delineated on the CT. Small contusions or petechial haemorrhages on the brain stem, cerebral peduncles, corpus callosum or thalamic/hypothalamic areas are also missed in great numbers in CT. The linear fractures of the skull specially the vault fractures are difficult to detect even on bone window and same is the fact for basal fractures of the skull.

DISCUSSION

CT scan remains the gold standard as the diagnostic

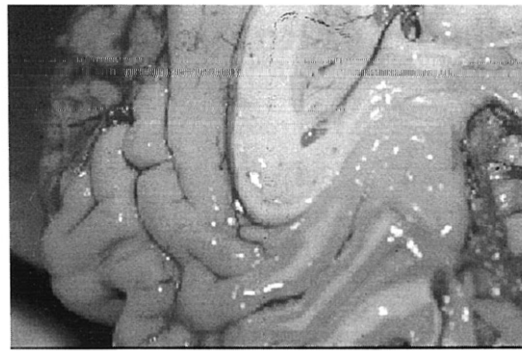

Fig 1a: Autopsy specimen showing punctate haemorrhage anterior corpus callosum

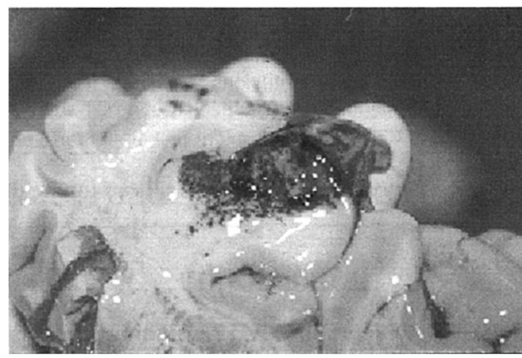

Fig 1b: Autopsy specimen showing contusion temporal region

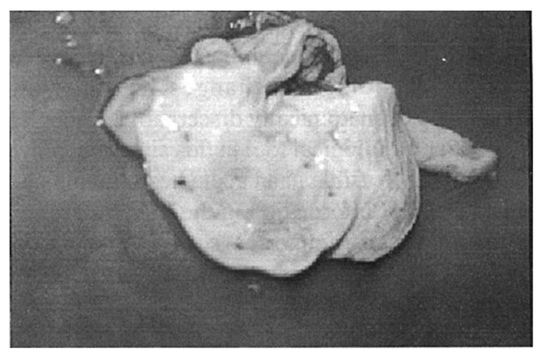

Fig 1c: Autopsy specimen showing petechial hemorrhage in pons

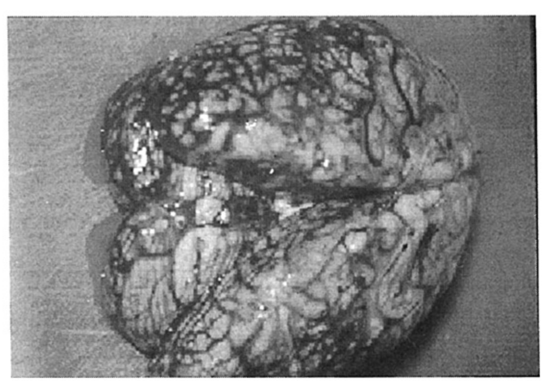

Fig 1d: Autopsy specimen showing diffuse subarachnoid hemorrhage

Fig 2a: Autopsy specimen showing temporal contusion and mild subarachnoid hemorrhage

Fig 2b: Autopsy specimen showing fracture left temporal bone extending across basi-sphenoid to the left side

investigation for HI as it is a rapid investigation, readily available and cost effective though MRI is a more sensitive and accurate tool. It also has been utilized for temporal correlation of HI in a selected sub group of patients[1]. However small hematomas, parenchymal injuries or vault fractures near the bone may be missed. Apart from primary changes, delayed (secondary) changes in the brain in the form of infarction, hemorrhage and diffuse swelling also lead to changing pattern of lesion in the CT scan done at different intervals[2].

Non-visualisation of lesions in CT scan in fatal cases can be due to a too early imaging done in a critically ill patient. An apparently normal CT scan should in a patient of low GCS should prompt the clinician for a repeat CT scan provided it is logistically feasible as injury progression is a known phenomenon in HI[1]. However it is known that CT scan has some of its inherent fallacies. Acute traumatic SDH and SAH are definite indicators of severity of HI. However, thin SDH being close to the bone might be missed on CT scan similarly SAH can also go undetected on CT scan. The same reason explains the fallacies of CT in detecting small traumatic lesions of the brain stem or posterior fossa structures and also the thalamic and hypothalamic areas. Linear fractures and the basal fractures are also likely to be missed as they are undisplaced and even a bone window image would be unable to detect them.

Correlation of CT scan findings with clinical evaluation and surgical findings show overall sensitivity, specificity and diagnostic accuracy of CT to be 85%, 70% and 82% respectively, that of neurological examination to be 66%, 45% and 61%, 79% and 29 % for acute cerebral infarction, and 65% and 13% for intracranial bleeding [3]. However the study was carried out on non-fatal cases in which deep-seated lesions in the brain close to the base or lesions close to the vault have not been highlighted as was commonly seen to be missed in the present study.

The above finding brings home several important points when dealing with a severe HI patient. In an unconscious patient of HI with 'Normal CT' a repeat CT after 6-8 hours is mandatory with soft tissue and bone window. A normal CT scan does not rule out a delayed intracerebral haematoma. The CT should be taken with special zoom cuts for the posterior fossa so that bony artifact is avoided the maximum. The CT should be done with thin slices along with coronal sections and bone window in order to have the best possible depiction of various lesions. However there is no doubt that an MRI definitely has an edge over CT scan in detecting brain lesions better that CT. Superadded to that, if feasible, a three dimensional CT scan probably can elucidate and identify undiagnosed fractures of the skull in a better way[4]. In a restless patient a volume-artifact reduction technique by spiral CT can be helpful in reducing artifacts in the anterior, middle and posterior fossa[5].

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