Does Computed Tomography Scan of the Brain in Pediatric Non-head Injury Patients Influence their Management in the Acute Setting?

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ABSTRACT

Brain imaging with computed tomography (CT) is commonly performed in those with suspected intracranial abnormalities. The indications are many, among which trauma is the commonest followed by meningoencephalitis.

We present a retrospective review of 663 pediatric CT scans performed in our secondary care center in the United Kingdom for over three years. The aim of the study was to review (a) indications for CT scan other than trauma, (b) Evaluate the distribution of scan requests during and outside office hours, (c) Correlation of scan findings with ancillary investigations such as lumbar puncture and clinical recordings such as Glasgow coma scale (CGS), and (d) Positive predictive value (PPV) of CT scan with respect to clinical outcomes in diagnosis of meningoencephalitis.

In this study, they found no direct correlation of CT findings with signs of raised intracranial pressure and there was a poor positive predictive value of CT findings in the diagnosis of meningoencephalitis and raised intracranial pressure.

We conclude that in our center, there is a low clinical referral threshold for CT brain imaging in children with suspected meningoencephalitis. The study shows that CT brain scan is valuable in the diagnosis of complications of meningitis but has a poor predictive value for the diagnosis of meningitis/encephalitis and raised intracranial pressure. We recommend that brain imaging with CT should be performed in the appropriate clinical setting and the risk of radiation in children should not be ignored. Magnetic resonance imaging (MRI) may be a more sensitive modality in clinically stable patients when imaging is required.

Keywords: Computed tomography brain, Encephalitis, Brain; Intracranial pressure, Meningitis.


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BACKGROUND

Computed tomography (CT) is a quick and noninvasive test in the investigation of cranial abnormalities although it does come at the expense of ionizing radiation. This is more relevant in the pediatric population where ionizing radiation effects can be significant.

We present findings of a retrospective audit study undertaken in the secondary care District General Hospital, where CT brain was performed for nontraumatic clinical indications in children under the age of 16.

AIM

To assess the appropriateness of acute CT head scans in the setting of non-trauma in children aged 16 and less. We looked at the indications for the acute CT, patient’s GCS at the time of arrival, highlighted any differences in scans requested in and out of hours (after 5 pm) and level of senior review before requesting the scan.

We also looked at ancillary investigations [lumbar puncture (LP), electroencephalogram (EEG), MRI brain] performed, assessed any radiological differences in patients who had both CT and MRI brain and the PPV of CT scans in patients who presented clinically with meningitis/encephalopathic symptoms.

MATERIALS AND METHODS

Six hundred sixty-three pediatric CT scans (0–16 years) performed over three years between January 2015 to December 2017 were assessed. Data collection was mainly from the hospital radiology information systems (RIS), picture archiving and communications system (PACS) and emergency department records.
Exclusion criteria were scans performed for suspected head trauma, craniosynostosis, those querying an intracranial bleed, orbital cellulitis and children with possible complications of ventricular drainage shunts.

After applying exclusion criteria, 136 scans were analyzed where the clinical indication was mainly symptoms under the broad term of encephalopathy and included features such as confusion, seizures, drowsiness, and vomiting.

RESULT

The number of children scanned among different age groups were similar although there was a slightly higher number in the age group of 13–16 (Graph 1).

Scan findings in patients presenting with meningitis/encephalopathic symptoms were mostly normal in 81% (110) of the cases and abnormal in 19% (26). This shows a very low PPV of CT in this subset of patients. Abnormal findings were broadly due to ventricular system abnormalities, intracranial hemorrhage, sinus disease, empyema, tumor, lesion of infective origin, thrombosis, etc (Graph 2).

Of the 26 patients who had abnormal CT findings, 15 (58%) patients had an MRI scan. Of these 14 had abnormal findings. Total 6 patients (23%) had a LP of which one patient had an abnormal result, five being normal. Four patients (15%) had an EEG in which one was abnormal.

Of the 110 patients who had a normal CT scan, 36 patients (33%) had an MRI scan. Thirty-two of these were normal. Abnormal findings seen in four patients were distributed as non-specific white matter changes in two patients, mild cerebral atrophy in one patient and suspicion of a small infarct in one patient. Three patients had coexistent sinusitis. A total of 45 patients (41%) with a normal CT had a concomitant lumbar puncture of which two patients had a failed attempt. Sixty-five patients (59%) did not have a lumbar puncture as they had blood culture positive meningococcemia. Twenty-eight patients (25%) had an EEG of which 10 (36%) had abnormal results.

Twenty (15%) out of the 136 patients had a scan requested specifically for meningitis and queried raised intracranial pressure (ICP) before performing a LP. When the CT scan was reported normal, 11/15 patients had an LP. Four patients did not require LP as they had positive blood cultures for meningococcemia. When CT was abnormal, 2 out of 5 patients only had LP (both of which were normal).

Of the 15 normal scans, no significant MR findings were demonstrated. Of the five abnormal scans, three patients had an MRI scan that demonstrated abnormal findings. Two patients did not have an MRI.

There was no significant difference while comparing CT scan results performed in an out-of-hours, although the scans performed out-of-hours had a slightly higher number of abnormal findings. The level of senior clinical review before the scan was similar both in and out-of-hours (Graphs 3 and 4).
Glasgow coma scale documentation was relatively poor, and 72 (53%) (57 normal and 15 abnormal scan results) of the 136 patients had no documentation. The GCS was 15 in 34 patients (27 normal and seven abnormal scans), less than 15 in 25 patients (22 normal and three abnormal scans) and a fluctuating GCS in 5 patients (4 normal and one abnormal scan) (Graph 5).

CONCLUSION

Our 3-year audit has proved that there is no significant benefit in performing an acute CT brain in pediatric patients presenting with meningitis/encephalopathic symptoms.

Brain imaging is of no value in the immediate diagnosis of meningitis and is an insensitive method for the detection of raised intracranial pressure. This should be guided by clinical signs of raised ICP [(pupillary dilatation (unilateral or bilateral), pupillary reaction to light (impaired or lost), bradyardia (heart rate <60)], hypertension (mean blood pressure above the 95th centile for age), abnormal breathing pattern, abnormal posture or an initial Glasgow coma scale (GCS)≤ 12. This should be guided by clinical signs of raised ICP [(pupillary dilatation (unilateral or bilateral), pupillary reaction to light (impaired or lost), bradyardia (heart rate <60)], hypertension (mean blood pressure above the 95th centile for age), abnormal breathing pattern, abnormal posture or an initial Glasgow coma scale (GCS)≤ 12.4

The role of imaging is to identify complications of meningitis or to exclude focal brain pathology simulating meningitis encephalitis.

For scan requests to exclude raised ICP before LP, it has been shown that coning can occur after LP in children with meningitis even when neuroimaging has been normal. So, the decision to perform LP in children with clinically diagnosed meningitis should be guided solely by clinical signs and should be avoided if consciousness is impaired or there are clinical signs of raised intracranial pressure.5

Close clinical evaluation including GCS assessment is mandatory as it may help determine clinical deterioration or lack of clinical response to treatment that may require further investigation with imaging.

The PPV of CT in meningoencephalitis is also proven to be poor. The sensitivity is better in those that have clinically raised ICP and in those with focal neurological signs as seen in our study.

CLINICAL SIGNIFICANCE

This project has highlighted the lack of any significant benefit in performing premature CT brain in the non-traumatic pediatric patient. Although CT is quick and easily available, the radiation risks should not be ignored, and careful use of this modality is required, particularly in children. It also helps in avoiding unnecessary investigations and associated costs that do not add value to the immediate management of an unwell patient.

Positive indications for CT or MRI are progressive focal neurological signs, prolonged decreased level of consciousness, prolonged or focal seizures, increasing head circumference, evidence of continuing infection or recurrence of symptoms.4 It is useful to consider brain MRI in clinically stable patients when imaging is required.
REFERENCES


