Computed Tomography in Evaluation of Hydrocephalus

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ABSTRACT

OBJECTIVE: A prospective computed tomography (CT) study to detect, determine the cause, type and severity of hydrocephalus in a study group. To evaluate shunt related complications in hydrocephalus and compare results with other studies.

RESULTS: 80 consecutive patients diagnosed with hydrocephalus on CT were studied over a 2 year period. TB meningitis (32%) followed by tumors (25%), intracranial hemorrhage (20%) and congenital causes (12%) were found to be the most common causes. Hydrocephalus was communicating (60%) and moderate to severe (80%) in majority cases. Displaced shunt and shunt malfunction were found to be the most common shunt related complications.

CONCLUSION: Computed Tomography is a non invasive, readily available, easy to perform, non operator dependent modality with superb spatial resolution, ability to detect calcium and density discrimination. Therefore CT is a valuable tool with a very high diagnostic sensitivity and helps in early detection of hydrocephalus and its management.

INTRODUCTION

Hydrocephalus is a pathological state of diverse causes in which there is increased accumulation of CSF within the cranial cavity. It will develop under the following three circumstances:

1. Overproduction of CSF as seen in tumors of the choroid plexus.
2. Defective absorption of CSF by the arachnoid granulations.
3. Most common cause however is the obstruction in CSF pathways which result in dilatation of channels proximal to the site of obstruction.

Hydrocephalus may be with or without raised pressure. In hypotensive hydrocephalus (hydrocephalus ex vacuo) there is increased intracranial accumulation of CSF secondary to diminished brain volume. In this not only ventricular enlargement but also dilatation of cerebral sulci and basilar cisterns occurs.

Obstructive hydrocephalus is further subdivided into noncommunicating hydrocephalus if the block lies within the ventricular pathway or communicating if the obstruction is distal to the outlet foramina of the fourth ventricle.

CT clearly demonstrates the size and position of the ventricles, level of obstruction and the obstructing lesion, if present, the width of the subarachnoid spaces at the base of the brain and over the cerebral convexities. Pathophysiologic changes in brain substances, periventricular exudation, diminished density of white matter, all these changes are clearly and early perceived with CT.

Several measurement or indices have been utilised in assessing hydrocephalus. The most commonly used indices are:

Ventricular size index: This is the ratio of transverse diameter of forntal horns : Transverse diameter of skull at inner table.

Normal = 16-30%
Mild enlargement = 30-39%
Moderate enlargement = 40-46%
Severe or gross degree of enlargement = >47%.

Temporal horn ratio: Normal width of temporal horn = 3.5 mm. > 5 mm is considered abnormal
Width of third ventricle =4-8mm. Anterior IIIrd ventricle =2mm. Posterior IIIrd ventricle =4.0 mm Anything > than 8mm is abnormal
Maximum width of the fourth ventricle. Normal upto 8mm. > 10mm is abnormal

OBJECTIVES:
1) Detection of hydrocephalus and determining its cause
2) Differentiating Communicating from Non-communicating hydrocephalus.
3) Determining the level of obstruction in patients with hypertensive hydrocephalus
4) Determining the severity of hydrocephalus and to look for complications associated with hydrocephalus.
5) To evaluate shunt associated complications.
6) To compare the results with other studies from literature.

MATERIALS AND METHODS

This prospective study was carried out in the Department of Radiodiagnosis, PBM Hospital, Bikaner, Rajasthan over a two year period during which 80 consecutive cases of hydrocephalus were evaluated.

This study was carried out on SOMATOM ART, CT scanner from SIEMENS, and N X / I Pro dual slice from GE

Selection of Patients

Clinically diagnosed cases of hydrocephalus. Incidentally detected hydrocephalus. Infants with meningomyelocele and other congenital malformations who are suspected to have hydrocephalus to be confirmed by CT imaging. Suspected cases of tubercular and pyogenic meningitis. Patients with shunt in situ to evaluate shunt function.

Routine axial scans were performed taking infraorbito-meatal...
line as the baseline. 5mm slices for posterior fossa with 5mm table increment and 10mm slice for the supratentorial region with 10mm table increment were employed routinely. Thin slices and sagittal and coronal reconstructions were done wherever necessary.

**OBSERVATIONS**

In this study of CT evaluation of hydrocephalus the percentage distribution was overall similar in all age groups with majority of cases occurring under the age of 10 yrs (12%). Male female ratio was 55%(male) to 45%(female).

**Table I: Distribution of causes of Hydrocephalus**

<table>
<thead>
<tr>
<th>Causes</th>
<th>No. of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubercular Meningitis</td>
<td>26</td>
<td>32.5</td>
</tr>
<tr>
<td>Tumors</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Intracranial Hemorrhage</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Congenital</td>
<td>10</td>
<td>12.5</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

This study showed TB meningitis as the major cause of hydrocephalus accounting for 26 (32.5%) of the cases. The next two important causes were tumors 20 (25%) cases and intracranial hemorrhage 16 (20%) cases.

**Table II: Incidence of communicating and Non-communicating hydrocephalus**

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicating</td>
<td>48</td>
<td>60</td>
</tr>
<tr>
<td>Obstructive (non Communicating)</td>
<td>32</td>
<td>40</td>
</tr>
</tbody>
</table>

Major causes of communicating hydrocephalus were TB meningitis(25cases- 52%) and ICH(cases11-23%). Major cause of non communicating hydrocephalus were Tumors (19cases-59%) and ICH(5cases-16%)

**Table III : Distribution of Degree of Hydrocephalus as per ventricular size index**

<table>
<thead>
<tr>
<th>Degree of hydrocephalus</th>
<th>No of Cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I (mild)</td>
<td>15</td>
<td>18.75</td>
</tr>
<tr>
<td>Grade II (Moderate)</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Grade III (Severe)</td>
<td>20</td>
<td>31.25</td>
</tr>
</tbody>
</table>

Moderate and severe degree of hydrocephalus constituted majority of cases in our study (>80%).

**DISCUSSION**

In this study hydrocephalus was more common in the 0-10 year age group accounting for 21 cases (26.25%) with 0-1 year age group accounting for 9 cases (11.25%). This study showed T.B. meningitis as the commonest cause of hydrocephalus 26 cases (32.5%) followed by tumors 20 cases (25%), intracranial hemorrhage 16 cases (20%) and congenital conditions 10 cases (12.5%).

**TB MENINGITIS (TBM):** In this study TBM was the commonest cause of hydrocephalus accounting for 26 cases (32.5%). TBM was more common below the age group of 10 years (54%). In this study moderate to severe hydrocephalus was more common among TBM patients and accounted for 88%. Except for 1 case all cases were of the communicating variety. Basal exudates (81%) and meningeal enhancement (77%) were the commonest CT findings in cases of TBM with hydrocephalus.

**TUMORS:** In this study tumors constituted the second commonest cause of hydrocephalus accounting for 20 cases (25%). Of these 20 cases 13 were primary and 7 were secondary tumors.

All except one case caused obstructive hydrocephalus (95%). 1 case caused hypersecretory hydrocephalus and was proved to be a choroid plexus papilloma.

**FIG1:** TB MENINGITIS: NCCT showing obliteration of basal cisterns with exudates and communicating hydrocephalus

Bullock et al(1982) in their study reported that hydrocephalus was present in 76% of cases of TBM. Bhargav et al(1982) showed hydrocephalus was common, and accounting for 83.05%. Anuja et al(1993) showed hydrocephalus (72.5%) is a common CT finding next to basal exudates in the base of brain. The basal exudates were seen in 80% of cases. Bhargav et al(1982) reported basal exudates were common and 81.66% of cases showed basal exudates. In the present study CT showed tuberculoma in 20% of cases. Anuja et al(1993) study showed tuberculoma in 17% of cases. S. Bhargawa et al (1982) found infarcts in 28.33% comparable to our study.

**FIG 2:** CHOROID PLEXUS PAPILLOMA: CECT showing avidly enhancing mass in left lateral ventricle with gross hydrocephalus
Out of the 20 tumours, 11 (55%) were located in the posterior fossa and 9 (45%) were in the supratentorial compartment.

The level of obstruction was at the level of lateral ventricles in 2 cases (10%), third ventricle in 7 cases (35%) and below third ventricle (aqueduct and 4th ventricle) in 11 cases (55%).

Of the posterior fossa tumors that were encountered the most common were metastasis 7 cases (35%) followed by medulloblastoma, meningioma, Schwannoma and Dermoid. Supratentorial tumors were craniopharygioma, glioblastoma multiforme, suprasellar lipoma, pituitary adenoma, colloid cysts (2), astrocytoma, choroid plexus papilloma and parasellar meningioma.

INTRACRANIAL HEMORRHAGE (ICH): ICH accounted for 16 cases (20%) in this study. Of the 16 cases, 5 cases (31.5%) caused obstructive hydrocephalus which included bleeds involving cerebellum (mass effect on 4th ventricle) and thalami (mass effect on third ventricle). Nine cases (56.25%) caused hydrocephalus which were communicating in nature majority of which were pure intraventricular bleeds. (FIG 3)

Dublin B et al (1977) studied CT features of trauma and concluded that non communicating hydrocephalus was the most common type and in early stages most of the cases are of non communicating type.

CONGENITAL CAUSES: Congenital causes accounted for 10% of cases and this group included congenital aqueduct stenosis 3 cases (3.75%) (FIG 4), congenital communicating hydrocephalus 2 cases (2.5%), Dandy Walker malformation 2 cases (2.5%), one of which had an occipital encephalocele, encephalocele (fronto-nasal) 1 case (1.25%) and Arnold chiari malformation 1 case (1.25%).

OTHERS: Others causes of hydrocephalus included brain abscess 3 cases (3.75%), Pyogenic Meningitis 2 cases (2.5%), normal pressure hydrocephalus 2 cases (2.5%) and post traumatic hydrocephalus 1 case (1.25%).

SHUNT RELATED COMPLICATIONS: 14 patients (17.5%) in our study underwent shunt procedure for treatment of hydrocephalus. Of the 14 cases, 4 had shunt related complications. Three cases had displaced shunt. (FIG 5) One case had no change in ventricular size compared to previous scans probably due to shunt malfunction.

CONCLUSION

In the presence study computed tomography proved to be a valuable tool in the radiological evaluation of hydrocephalus correctly identifying the same, detecting the level of obstruction and determining its severity. CT also proved to be very accurate in determining the cause of hydrocephalus and evaluating shunt related complications.

Computed Tomography is a non invasive, readily available, easy to perform, non operator dependent modality with superb spatial resolution, ability to detect calcium and density discrimination. Therefore CT is a valuable tool with a very high diagnostic sensitivity and helps in early detection of hydrocephalus and its management.

REFERENCE

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