Role of MRI in Evaluation of Hydrocephalus

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Abstract

Aim: The aim of study was to evaluate the most common congenital/developmental and acquired etiologies that cause Hydrocephalus and their MRI evaluation and the importance of precise diagnosis for pre-treatment and help to plan surgical treatment and follow-up.

Material & Methods: The study was carried out on patients with signs and symptoms of hydrocephalus referred from clinical departments and OPD. And an observational study was conducted on a total of 65 patients for this study. A detailed history was taken. All patients were evaluated by MRI scan.

Result: In our study most common age group was 0-10 years with 23 patients comprising 21.53% from the total of 65 patients. And the age group of the patient ranged from 2 weeks upto 67 years. From the total of 65 patients; 35 were male (53.84%) and 30 were female (46.15%) with male: female ratio being 1.16: 1. In this study neoplastic etiologies were the most common etiology comprising 53.8% (35 patients) followed by inflammatory causes comprising 16.9% (11 patients) followed by congenital etiologies comprising 10.7% (7 patients).

Conclusion: This study evaluated role of MRI in evaluation of patients with hydrocephalus which is considered as a treatable result to any underlying pathology: Different sequences of MRI is very useful in evaluation of hydrocephalus, its types and it's underlying cause. MRI is useful for further classification of hydrocephalus into obstructive vs non-obstructive and communicating vs non-communicating type along with evaluation of its underlying etiology causing hydrocephalus.

Keywords: MRI, Hydrocephalus, CSF

Introduction

Hydrocephalus comes from the Greek words hydro meaning water and cephalus meaning head.[1] Hydrocephalus occurs when there is an abnormal accumulation of cerebrospinal fluid (CSF) within cavities in the brain called ventricles. Hydrocephalus results when there is an imbalance between the amount of CSF that is produced and the rate at which it is absorbed. As the volume of CSF increases, it causes the ventricles to dilate and the pressure also raises inside the head.[2] It circulates through the ventricular system in the brain and is absorbed into the Bloodstream.[3] The CSF volume is approximately 150 ml in adults; 125 ml is distributed in the cranial and spinal subarachnoid spaces and 25 ml is found in the ventricles [3]. A volume of 400–500 ml is secreted and approximately 330–380 ml of CSF enters the venous circulation daily Dilatation of the ventricular system may lead to loss of brain cells resulting in a variety of neurological symptoms, stroke, and sometimes even death due to pressure applied on the brain parenchyma.[4] The causes of CSF increase are often obstructive diseases such as cystic lesions, tumors or obstructive membranes [5,6] Rarely, it may be the result of excessive CSF production, which may be due to pathologies at the sites where CSF production takes place. More frequently, it is be due to an obstruction in the ventricular system (obstructive or non-communicating type) or interrupted CSF absorption or flow (communicating type). [7] In young adults and children, obstructive-type hydrocephalus is the most common type. [8,9,10] In some instances, such as meningitis, both absorption and flow may be interrupted, which is defined as complex-type hydrocephalus. [11]

Progressive developments in magnetic resonance imaging (MRI) technologies allow us to better assess CSF circulation. Therefore, MRI aids in the diagnosis of diseases that result from alterations of the CSF circulation. Hydrocephalus, which constitutes a major CSF-related disorder, is well demonstrated using MRI. MRI also helps to discriminate the aetiology of the disease.[12] The provided data are important for planning the management as well as follow-up of the patients. Hence the aim of study was to evaluate the most common congenital/developmental and acquired etiologies that causes Hydrocephalus and their MRI evaluation and the importance of precise diagnosis for pre-treatment and help to plan surgical treatment and follow-up.

Materials and Methods

The observational study (cross sectional study) was carried out on 65 patients with signs and symptoms of hydrocephalus referred from clinical departments and OPD of Dhiraj Hospital, in the Department of Radio diagnosis, SBKS Institute Of Medical Sciences, Vadodara, Gujarat was conducted in the time period of one and half year.

Inclusion Criteria

- Only those patients who are willing to participate in study will be included.
- Patients referred to the Radio-diagnosis department for MRI and found to have positive findings, will be included in this study.

- An already diagnosed case of hydrocephalus which needed follow up radiological investigations and were referred to our Radio-diagnosis department was included in study.

Exclusion criteria

- Patients having cardiac pacemaker or MR incompatible implants where MR could not be performed.
- Patients having normal MR study without any detectable abnormality.

For every case a thorough relevant clinical history was taken. It included the clinical symptoms, their duration with associated past history. History of contrast allergy was asked. Details of clinical examination and patient's weight in kg were obtained for every patient. Any previous radiological investigations were asked for, and obtained, for comparison. Patient was kept nil by mouth for 4 hours minimum whenever sedation was given along with hemogram and urine analysis tests. Serum creatinine (renal function test) was conducted in every patient who needed contrast study.

MRI Scan:

Non contrast MRI examination was performed using 1.5 Tesla Philips. Though in general protocol, all the study specific sequences were taken

- T1 WI (axial, sagittal)
- T2 WI
- FLAIR, Axial, Coronal,
- GRE
- DWI
- ADC.

These above-mentioned MRI sequences were obtained. Contrast MRI was done in any case needed using gadolinium IV injection at dose of 0.2 ml/kg as required.

Results

Table 1: Distribution according to age, gender, etiology and lesion location

Age (Years)	Number of Patients	Males	Females
<10	23	14	9
11-20	9	3	6
21-30	4	2	2
31-40	9	6	3
41-50	7	4	3
51-60	6	2	4
>60	7	4	3
Total	65	35	30
Etiology			
Neoplastic		35	53.8%

Congenital	07	10.7%
Infectious/Inflammatory	11	16.9%
Others	12	18.4%
Presenting Symptoms	**Number**	
Headache	42	
Vomiting	27	
Seizures	17	
Fever	10	
Others	20	
Lesion Location		
Intra-ventricular	18	
Extra-ventricular	47	
Total	65	

Most common age group in our study is 0-10 yrs (21.53%) followed by 31-40yrs (9.23%). The incidence of male and female in our study is 53.8% and 46.1% respectively. Neoplastic etiologies were the most common etiology amongst this group comprising 53.8% followed by inflammatory (16.9%) & congenital etiologies (10.7%) in the study. The most common presenting complaint in these group of patients was headache (42 patients) followed by vomiting (27 patients), seizures (17 patients) & fever (10 patients). Other symptoms includes visual disturbance, altered consciousness, enlargement of head, tinnitus, ataxia, hypotonia, paucity of movement, hypertelorism & dysmorphic faces in the study. Extra ventricular lesions causing hydrocephalus were 47 cases out of 65; comprising 72% and intraventricular lesions causing hydrocephalus were 18 cases out of 65; comprising 28% from the total.

Table 2: Incidence of different lesions

Anomaly number of Patients	
Medulloblastoma	5
Meningioma	5
Ependymoma	3
Choroid Plexus Papilloma	2
Central Neurocytoma	1
Lissencephaly	2
Corpus Callosal Agenesis	2
DWM	2
Arnold Chiari Malformation	2
Tuberculoma	4
Pontine Glioma	2
Craniopharyngioma	3
High Grade Glioma	4
Schwannoma	4
Hypertrophic PACHY Meningitis	1
Wallerian Degeneration	3
Meningitis	4
Colloid CYST	3
SSS Thrombosis	2
Pilocytic Astrocytoma	3

Hemangioblastoma	2
Cystic Encephalomalacia	2
Epidermoid CYST	2
Sega	2
Total	65

The most common lesion causing hydrocephalus amongst 65 patients were medulloblastoma (5 pts) and meningioma (5 pts). Other lesions causing hydrocephalus which were found in the study were ependymoma, choroid plexus papilloma, central neurocytoma, lissencephaly, corpus callosal agenesis, DWM, Arnold chiari malformation, tuberculoma, pontine glioma, craniopharyngioma, high grade glioma, schwannoma, hypertrophic pachy meningitis, wallerian degeneration, meningitis, colloid cyst, SSS thrombosis, pilocytic astrocytoma, hemangioblastoma, cystic encephalomalacia, epidermoid cyst & SEGA.

Table 3: Associations with contrast enhancement and according to location of the lesion

	N	**%age**
Enhancing Lesions	46	70.7%
Non-Enhancing Lesions	19	29.3%
Total	65	100%
Location of the Lesion		
CP Angle	11	16.9%
4th Ventricle	8	12.3%
Lateral Ventricle	5	7.6%
Corpus Callosum	2	3.07%
Temporal Lobe	8	12.3%
Pons	2	3.07%
Supra Sellar Region	2	3.05%
Meninges	5	7.6%
3rd Ventricle	3	4.6%
Superior Sagittal Sinus	2	3.07%
Others	17	26.1%
Total	65	100%

In the study enhancing lesions causing hydrocephalus were 46 cases comprising 71% and non-enhancing lesions causing hydrocephalus were 19 cases comprising 29%. Different lesions from different sites were found in my study causing hydrocephalus. Out of the total of 65 cases; Lesions at CP angle: 11 cases (16.9 %). Lesions in 4th ventricle: 8 cases (12.3%). Lesions in lateral ventricle: 5 cases (7.6%). Lesions of corpus callosum: 2 cases (3.07%). Temporal lobe lesions: 8 cases (12.3%). Pontine lesions: 2 cases (3.07%). Lesions seen at supra-sellar region: 2 cases (3.07%). Meningeal causes: 5 cases (7.6%). Lesions in 3rd ventricle: 3 cases (4.6%). Superior sagittal sinus causes: 2 cases (3.07%). And other site comprises about 17 cases (26.1%) out of the total of 65 cases.

Table 4: Ventricles involved in hydrocephalus, incidence of obstructive vs non-obstructive type of HC and incidence of communicating vs non-communicating type of HC

Ventricles involved in hydrocephalus	**N**
Lateral	42
Lateral & 3rd	10
Lateral, 3rd & 4th	13
Total	65
Type of Hydrocephalus	
Obstructive HC	54
Non-Obstructive HC	11
Total No of Cases	65
Type of Hydrocephalus	
Communicating Hydrocephalus	10
Non-Communicating Hydrocephalus	55
Total	65

In the study of total 65 cases; 42 cases (65%) were found causing dilatation of lateral ventricles; 10 cases (15 %) were found causing dilatation of lateral & 3rd ventricle and 13 cases (20%) were found causing dilatation of lateral, 3rd & 4th ventricle. 54 cases (83%) were found to cause obstructive hydrocephalus and 11 cases (17%) were found to be causing non-obstructive hydrocephalus. 10 cases (15%) presented as communicating hydrocephalus and 55 cases (85 %) presented as non-communicating hydrocephalus.

Discussion

In our study most common age group was 0-10 years with 23 patients comprising 21.53% from the total of 65 patients and the age group of the patient ranged from 2 weeks upto 67 years. In our study total 5 meningiomas were observed amongst which 4 of them were found in males and only 1 of the meningioma was found in a female. The age group involving these five meningioma ranges between 30 – 50 years of age. Other study reported that meningioma is common in middle-aged adults and were more common in female than in men.[13,14]

In other study headache was reported as the most common presenting symptom in 36%.[15] Amirjamshidi Areported that signs of increased cranial pressure (nausea, headache, vomiting) are found in 50% of the patients.[16] In our study also headache was found in 42 patients from total of 65 patients. Followed by vomiting (27 patients), seizures (17 patients) & fever (10 patients). Other symptoms included visual disturbance, altered consciousness, enlargement of head, tinnitus, ataxia, hypotonia, paucity of movement, hypertelorism & dysmorphic faces in my study. Various studies reported that on T1-W images, meningiomas are isointense or mildly hypointense to normal gray matter, hyperintense on T2WI and shows intense post contrast enhancement.[17-19] In our study meningiomas were found to be isointense to hypointense on T1WI and hyperintense on T2WI & FLAIR and shows intense post

contrast enhancement. Various studies reported that most common locations of meningiomas in descending order were: convexity meningiomas (20-34%,) parasagittal (18-22%), sphenoid and middle cranial fossa (17-25%), frontobasal (10%) and posterior fossa (9-15%) 29. In our study most common location for meningioma was found to be CP angle followed by sub-frontal region being the second most common.

In study carried by Arbelaez, Schwannoma were the second most common extra axial tumors. The peak incidence was between the 3rd to 6th decade. Most commonly it involved the vestibular division of the eighth nerve. The fifth cranial nerve was the second most common nerve. No necrosis was found in any lesion.[20] In our study total of 4 cases were found from the total of 65 patients. The peak incidence was between 5th and 6th decade. And in my study also most commonly involved cranial nerve was the vestibular division of 8th cranial nerve. And no necrosis was found in any of the lesions with intense contrast enhancement. Age distriburion of craniopharyngioma is bimodal (5-14, 65-74 year) and more common in male.[21] Craniopharyngioma represented 56% of suprasellar region tumor in study carried out by Stamm.[22] It shows T1 hypointensity, T2 hyperintensity, and avid enhancement.[23] In our study craniopharyngioma was found in the age group of 1st decade patients and a total of 3 patients were positive with craniopharyngioma from 65 patients. All the lesions were found in suprasellar region in our study. And in our study it showed T1 hyperintensity, T2 hyperintensity and vivid enhancement.

Epidermoid cyst was found in 8 patients (15.75) in our study. Two studies reported that cerebellopontine angles were the most common location followed by the parasellar.[24,25] In study carried out by Yasargil, median age was 37.3, with a male to female ratio of 1.5:1. All were of low signal on T1- and of increased signal on T2-weighted images. On DWI, all showed high intensity.[26] In our study epidermoid cyst was found in 2 patients from the total of 65 patients. And the location of both this epidermoid cyst were CP angle. All lesion showed hypointensity on T1WI, hyperintensity on T2WI and showed restricted diffusion on DWI.

Conclusion

Different sequences of MRI is very useful in evaluation of hydrocephalus and its underlying cause. For further classification of hydrocephalus into obstructive vs non-obstructive and communicating vs non-communicating type along with evaluation of its underlying etiology causing hydrocephalus. MRI is also useful for grading the tumor according to its characteristic features on MRI when there is presence of neoplastic etiology. MRI is useful in differentiating the lesion from the surrounding oedema so that the extent and exact size of the tumor can be evaluated. It also serves as a guide to highly cellular area for stereotactic biopsy. MRI also acts as an important tool in planning for surgical management of neoplastic lesions since they paint an accurate anatomic picture of the lesion and also helps to pin-point it’s exact size, location & extent. MRI is also used as a diagnostic tool in evaluation of reduction of previously dilated ventricles after VP shunt insertion and also to see the location of the tip of the VP shunt.

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