Investigating the Comparison between MDCT Brain Plain and MRI Findings in Infants Presenting with Hydrocephalus: A Hospital-based Cross-Sectional Study

ABSTRACT

Background and Aims

Hydrocephalus is a disorder characterised by abnormal accumulation of cerebrospinal fluid (CSF) in the brain ventricles, demands accurate diagnosis for effective management. The primary aim of this research was to compare the MDCT Brain Plain and MRI findings in infants presenting with hydrocephalous.

Methods

A cross-sectional investigation of 39 newborns used 64-slice MDCT and 1.5 Tesla MRI, which followed paediatric imaging procedures. Temporal horns, ventricle size, and specific disorders such as spina bifida and encephalitis were studied. Chi-square tests were used to analyse statistical differences.

Results

CT excelled in detecting lateral ventricle involvement (94.9%) compared to MRI (84.6%, $p=0.001$). MRI was more successful in detecting 4th ventricle anomalies (30.8% vs. 12.8%). Temporal horns were identified similarly (CT: 66.7% and MRI: 61.5%, $p<0.001$). Spina bifida (5.1%) was found by MRI but not by CT. MRI revealed no tumours, in contrast to CT, which detected 2.6%.

Conclusion

The researchers discovered that MRI was better at identifying specific illnesses such spina bifida, absence of corpus callosum, Arnold Chiari syndrome, and encephalitis, whereas CT was better at detecting lateral ventricle involvement. However, the incidence of brain tumours was noticeably absent in the CT findings, whilst the prevalence was unclear in the MRI results. The clinical setting, specific diagnostic needs, and radiation exposure factors should all be taken into account when deciding between MDCT and MRI for hydrocephalus assessment. The results of this study reinforce the importance of a multidisciplinary approach, involving radiologists and clinicians, to tailor the choice of imaging modality to each patient's unique circumstances. While MDCT and MRI have distinct advantages, their combined use may increase the diagnostic accuracy and comprehensiveness of hydrocephalus evaluation in newborns, ultimately leading to better patient care and management.

Key words: Computed tomography, Magnetic resonance imaging, hydrocephalus, infants.

Introduction

Hydrocephalus is a disorder characterised by abnormal accumulation of cerebrospinal fluid (CSF) in the brain. This extra fluid causes the ventricles (cavities) in the brain to expand, putting additional strain on the brain's structures. Hydrocephalus can occur during or shortly after birth, or it can develop gradually as a result of damage or injury [1]. The term "hydrocephalus" is derived from the Greek terms "hydro," meaning water, and "cephalus," which means head. Despite its name, the condition is caused by an accumulation of cerebrospinal fluid (CSF), a clear organic liquid that surrounds the brain and spinal cord and performs important tasks such as cushioning, nutrition delivery, and waste disposal [2, 3]. When too much CSF accumulates, it can injure brain tissues and lead to a variety of cognitive and neurological problems [4, 5, 6].

Childhood hydrocephalus is a complex underlying cause, which includes both genetic and acquired diseases. Congenital abnormalities, infections, tumours, and genetic factors are some of the most prevalent causes of hydrocephalus [7-9]. Infants with hydrocephalus may exhibit a wide range of symptoms, many of which are associated with elevated intracranial pressure and reduced brain function. One of the most evident indications of hydrocephalus in neonates is fast growth in head circumference. This is usually linked to the accumulation of cerebrospinal fluid (CSF) in the brain's ventricles [10]. Infants with hydrocephalus might become irritable and fussy, displaying distress and restlessness [3]. Infants' eyes may deviate downward, described as "sunsetting eyes," which can suggest hydrocephalus-induced pressure on the brainstem [11]. Infants with hydrocephalus may experience seizures due to increased pressure on the brain and disturbance of normal brain activity [12], as well as delays in developmental milestones including as head control and turning over. Hydrocephalus can also cause changes in muscle tone, resulting in either stiffness (hypertonia) or floppiness (hypotonia) in the infant's muscles [6, 13].

Hydrocephalus can affect anyone, however it is most frequent in infants and adults over the age of 60 [14, 15]. The frequency of hydrocephalus in babies varies greatly, ranging from 0.2 to 8.2 per 1,000 live births [16]. Infant hydrocephalus is more prevalent in some Asian countries than others. Some communities have greater incidence rates due to variables such restricted access to prenatal care, increasing infection rates, and a lack of awareness [17, 18, 19, 20].

Brain computed tomography (CT) and magnetic resonance imaging (MRI) are important diagnostic tools for paediatric hydrocephalus because they provide high-resolution imaging of cerebral structures and make it easier to characterise ventricular enlargement, parenchymal changes, and other abnormalities. In summary, the available evidence suggests that MRI is more sensitive than MDCT in detecting minor brain abnormalities and developmental anomalies that might cause hydrocephalus in babies [21]. However, MDCT can be useful in detecting brain calcifications, which may indicate underlying diseases. The ultimate imaging modality is chosen by the patient's clinical presentation, the suspected underlying cause of hydrocephalus, and the availability of imaging resources. The comparison of MDCT plain brain and MRI findings in babies with hydrocephalus is critical for early detection, treatment, and decision-making. The choice of imaging modality influences diagnosis accuracy and treatment approaches. Understanding the diagnostic yield of MRI and MDCT can aid in the development of evidence-based guidelines for hydrocephalus diagnosis and management, thereby standardising clinical practice and improving patient outcomes.

Materials and Methods

Study Design, Setting and Participants

This cross-sectional comparative investigation was conducted from September 2024 to January 10, 2025 to compare the MDCT Brain Plain and MRI findings in infants presenting with hydrocephalus. The study included 39 infants who were referred for imaging because they had suspected neurological problems. The imaging data were gathered at The University of Lahore Teaching Hospital with advanced CT and MRI facilities. Ethical approval for this study (Ethical Committee Ref No: REC-UOL-201-09-2024) was provided by the Ethical Committee of the Research Ethics Committee (REC), Faculty of Allied Health Sciences; The University of Lahore on September 13th, 2024. The institutional ethics committee approved the study, and the parents or guardians of all participants supplied signed informed consent.

Infants with clinical indications for both CT and MRI imaging, such as suspected hydrocephalus, spina bifida, meningitis, encephalitis, or other neurological abnormalities, were included in the study; infants with poor-quality imaging results or contraindications to MRI (e.g., metallic implants) were excluded. The study included 39 infants, with a male-to-female ratio of roughly 2:1 (64.1% males and 35.9% females). Participants' ages ranged from five to fourteen months.

Imaging Protocols and Data Collection

Computed Tomography (CT) scans were performed with a cutting-edge 64-slice CT scanner. Axial and coronal slices of the brain were obtained with a slice thickness of 5mm. Standard paediatric imaging methods were followed to achieve high image quality while limiting radiation exposure. The tube voltage and current were adjusted based on the patient's age and weight.

Magnetic Resonance Imaging (MRI) scans were performed on a 1.5 Tesla MRI equipment. T1-weighted, T2-weighted, and fluid-attenuated inversion recovery (FLAIR) imaging sequences were used, as well as diffusion-weighted imaging (DWI) for particular patients. Axial, coronal, and sagittal views were obtained to offer complete anatomical and pathological information. Sedation was given to some infants under the guidance of a paediatric anaesthesiologist to ensure motionless imaging.

After getting the ethical approval from the hospital ethical committee patients were recruited in the study keeping in mind the inclusion and exclusion criteria. Informed consent was taken from each study participants with all possible benefits and expected risks. Basic clinical information was noted down on a pre-designed data collection sheet by the researcher himself. The following variables were recorded ; Age, Gender, and CT/MRI Findings. The study looked at the presence or absence of specific abnormalities such as temporal horn enlargement, ventricular size, 4th ventricle involvement, lateral ventricle involvement, spina bifida, corpus callosum abnormalities, brain tumours, Arnold-Chiari malformations, encephalitis, and meningitis. Each abnormality was classified as present ("Yes") or absent ("No") in both the CT and MRI modalities. To maintain uniformity, all imaging investigations were evaluated separately by two experienced radiologists. Discrepancies in the findings were resolved via consensus. Strict adherence to imaging methods and data documenting rules ensured that results were reliable.

Statistical Analysis

Data was evaluated and analyzed with Statistical Software (SPSS v 27.0). Descriptive analyses was performed to investigate the distribution of data. Frequency and percentages was calculated for categorical variables. Collected data was stored in Microsoft Excel. Chi-square test was applied. P-value <0.05 was considered as significant.

Results

Table 1 displays the gender and age distribution of the 39 neonates with hydrocephalus in the study. In terms of gender, the majority were men (64.1%), with women accounting for 35.9%. The age distribution shows that the majority of newborns were 5 months old (23.1%), followed by those aged 12 months (20.5%). Other age groups, such as 3-9 and 10 months, were less common (7.7% each). Infants aged six, seven, and fourteen months had the lowest prevalence (2.6% each).

Table 1: Gender and Age Distribution of Infants

Distribution of the Gender and Age			
Parameter	**Statistic**	**Frequency**	**Percentage (%)**

Gender	Female	14	35.9%
	Male	25	64.1%
	Total	39	100%
Age (Months)	1	3	7.7%
	2	2	5.1%
	3	4	10.3%
	4	2	5.1%
	5	9	23.1%
	6	1	2.6%
	7	1	2.6%
	8	2	5.1%
	9	3	7.7%
	10	3	7.7%
	12	8	20.5%
	14	1	2.6%
	Total	39	100%

The crosstabulation table compares the CT and MRI findings using a variety of statistics, including frequencies, percentages, and statistical significance (p-values). Temporal horns were detected (Yes) in 66.7% of cases using CT and 61.5% utilising MRI in this study. The two imaging modalities demonstrated excellent agreement (p=0.000). 79.5% of CT scans and 74.4% of MRI images revealed an abnormal third ventricular size of less than 3 mm, however the difference was not statistically significant (p=0.340). Although the p-value (0.110) suggests no discernible difference, the 4th Ventricle Involvement revealed abnormalities in 12.8% of CT scans and 30.8% of MRI scans, with MRI having a higher detection rate. Abnormalities in Lateral Ventricle Involvement were found in 94.9% of CT scans and 84.6% of MRI scans, with a statistically significant difference (p=0.001), indicating that CT may over-report involvement when compared to MRI [Table 2].

CT imaging revealed severe hydrocephalus and significant skull vault deformation (Figure 1A). Additionally, affected infants' ventricular enlargement was highlighted by axial CT scans, which showed a dilated cerebral aqueduct (Figure 1B). A surgical lesion on the third ventricle's floor indicated aqueductal stenosis on sagittal reformatted CT images (Figure 1C). These results highlight how important CT is for identifying structural abnormalities in hydrocephalus. CT imaging correctly indicated important hydrocephalus symptoms, with Figure 2A displaying enlarged lateral and third ventricles, indicating ventricular dilatation. Figure 2B shows transependymal oedema, which indicates higher intracranial pressure, whereas Figure 2C shows a normal-sized fourth ventricle, which serves as a reference to emphasise the anomalies detected in affected regions. These findings emphasise CT's usefulness in detecting ventricular enlargement and accompanying hydrocephalus alterations.

Spina Bifida was detected in 5.1% of MRI scans, while no cases were identified on CT. Similarly, Absence of the Corpus Callosum and Arnold Chiari Syndrome were detected in 7.7% of CT scans and 5.1% of MRI scans, showing minimal differences and non-significant p-values (0.675 for both conditions). While no brain tumors were detected by MRI, 2.6% of CT scans revealed brain tumours. Abnormalities were detected in 15.4% of encephalitis cases by CT and 10.3% by MRI; the difference was not statistically significant (p=0.368). Finally, with a p-value of 0.807, meningitis was identified in abnormalities in 20.5% of MRI images and 46.2% of CT scans, demonstrating significant variability but no clear diagnostic difference between modalities [Table 2].

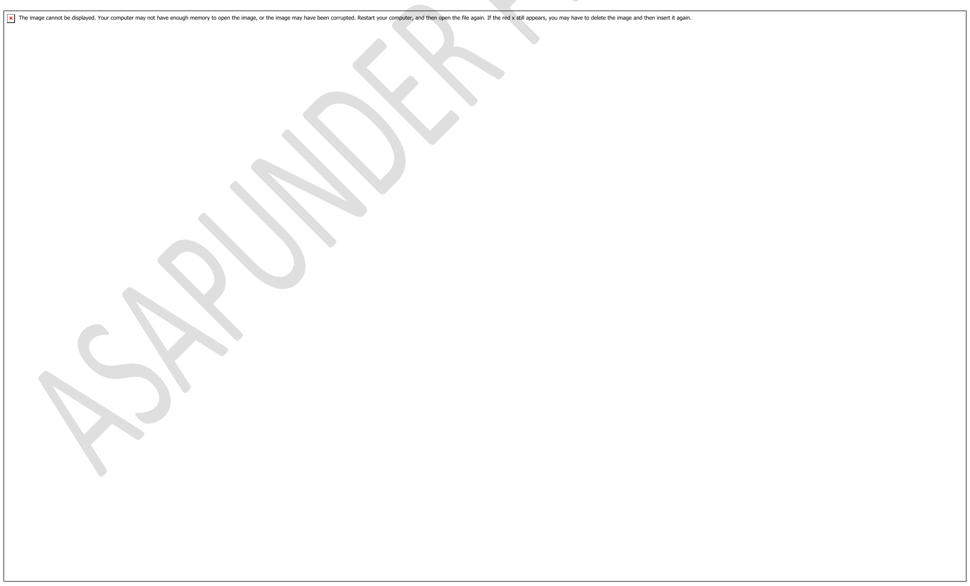
Table 2: Comparative Crosstabulation of CT and MRI Findings

Comparative Crosstabulation of CT and MRI Findings for Neurological and Structural Abnormalities, Including Frequencies, Percentages, and Statistical Analysis				
Parameter	**Statistic**	**CT (Count, %)**	**MRI (Count, %)**	**p-Value**
Temporal Horns	No	13 (33.3%)	15 (38.5%)	0.000
	Yes	26 (66.7%)	24 (61.5%)	
	Total	39 (100%)	39 (100%)	
Size of 3rd ventricle <3mm	No	8 (20.5%)	10 (25.6%)	0.340
	Yes	31 (79.5%)	29 (74.4%)	
	Total	39 (100%)	39 (100%)	

Lateral ventricle involvement	No	2 (5.1%)	6 (15.4%)	0.001
	Yes	37 (94.9%)	33 (84.6%)	
	Total	39 (100%)	39 (100%)	
4th ventricle involvement	No	34 (87.2%)	27 (69.2%)	0.110
	Yes	5 (12.8%)	12 (30.8%)	
	Total	39 (100%)	39 (100%)	
Spina Bifida	No	39 (100%)	37 (94.9%)	0.675
	Yes	0 (0%)	2 (5.1%)	
	Total	39 (100%)	39 (100%)	
Absence of Corpus callosum	No	36 (92.3%)	37 (94.9%)	0.675
	Yes	3 (7.7%)	2 (5.1%)	
	Total	39 (100%)	39 (100%)	
Brain Tumor	No	38 (97.44%)	39 (100%)	-
	Yes	1 (2.56%)	0 (0%)	
	Total	39 (100%)	39 (100%)	
Arnold Chiari Syndrome	No	36 (92.3%)	37 (94.9%)	0.675
	Yes	3 (7.7%)	2 (5.1%)	
	Total	39 (100%)	39 (100%)	
Encephalitis	No	33 (84.6%)	35 (89.7%)	0.368
	Yes	6 (15.4%)	4 (10.3%)	
	Total	39 (100%)	39 (100%)	
Meningitis	No	21 (53.8%)	31 (79.5%)	0.807
	Yes	18 (46.2%)	8 (20.5%)	
	Total	39 (100%)	39 (100%)	

Figure 1

Figure 2



The **Table 3** serves to compare the CT and MRI findings results for a variety of neurological and structural diseases in infants with hydrocephalus. Key differences include a larger percentage of results for 4th Ventricle Involvement in MRI (30.8%) compared to CT (12.8%), and CT has a slightly higher rate of Temporal Horns (66.7%) than MRI (61.5%). Lateral Ventricle Involvement is much higher in CT (94.9%) than in MRI (84.6%), with a p-value of 0.001, indicating statistical significance. For some disorders, such as Spina Bifida and Brain Tumour, either modality or both failed to detect abnormalities consistently. Although, computed tomography is more likely than magnetic resonance imaging to identify meningitis and encephalitis, the difference is not statistically significant. Signs of communicating hydrocephalus were found in the MRI scans; Figure 3 displays increased periventricular and deep white matter signal on FLAIR sequences together with surrounding atrophy. These changes indicate the ability of MRI to identify modest parenchymal and structural changes associated with hydrocephalus. MRI results revealed additional structural abnormalities in hydrocephalus, with Figure 4A showing larger lateral ventricles and Figure 4B showing an enlarged third ventricle. Figure 4C also shows aqueductal compression, demonstrating MRI's utility in detecting substantial structural changes and obstructions that lead to the illness.

Table 3: Comparative Results of CT and MRI Findings

Comparative Results of CT and MRI Findings				
Variables	**CT Results (%)**	**CT p-Value**	**MRI Results (%)**	**MRI p-Value**
Temporal Horns	66.7%	0.000	61.5%	0.000
Size of 3rd Ventricle <3mm	79.5%	0.340	74.4%	0.340
4th Ventricle Involvement	12.8%	0.110	30.8%	0.110
Lateral Ventricle Involvement	94.9%	0.001	84.6%	0.001
Spina Bifida	-	-	5.1%	0.675
Absence of Corpus Callosum	7.7%	0.675	5.1%	0.675
Brain Tumor	2.6%	-	-	-
Arnold Chiari Syndrome	7.7%	0.675	5.1%	0.675
Encephalitis	15.4%	0.368	10.3%	0.368
Meningitis	46.2%	0.807	20.5%	0.807

Figure 3

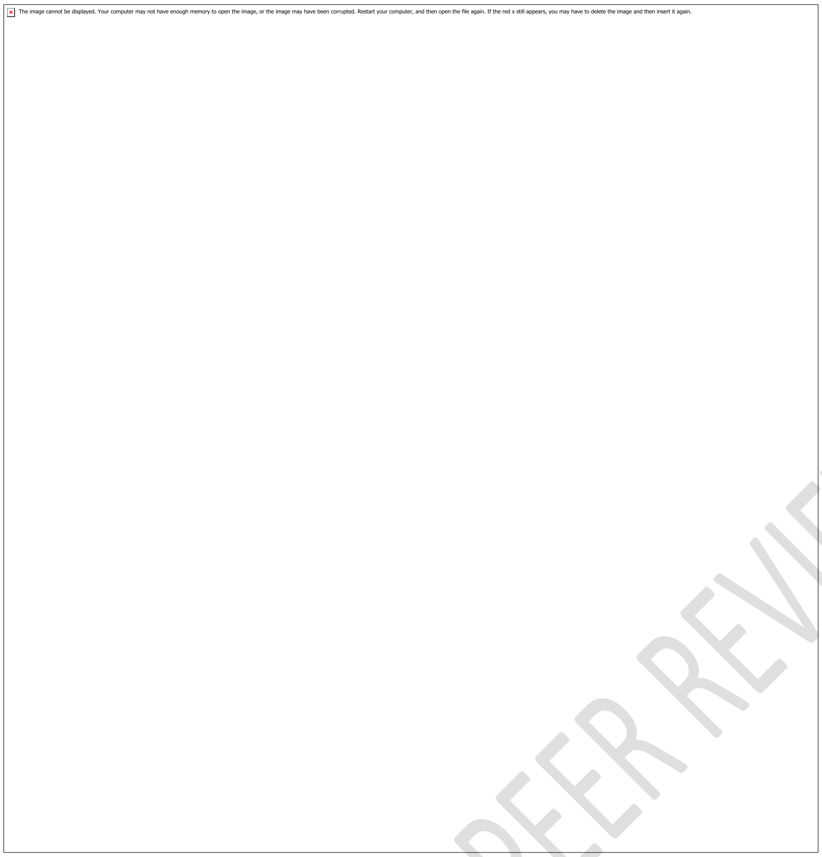


Figure 4

Discussion

The comparison of MDCT brain plain and MRI findings in babies with hydrocephalus exposes each modality's unique diagnostic skills, providing useful insights into the assessment of many variables. Both imaging approaches produced substantial results when assessing temporal horns. CT and MRI both detected temporal horn involvement at 66.7% and 61.5%, respectively, indicating their capacity to identify this component of hydrocephalus ($p < 0.001$). The size of the 3rd ventricle (<3 mm) yielded identical results for CT and MRI, with 79.5% and 74.4%, respectively ($p = 0.340$). However, CT had a higher rate of lateral ventricle involvement (94.9%) than MRI (84.6%), indicating CT's potential benefit in detecting this feature ($p = 0.001$). However, with 4th ventricle involvement, MRI had a higher prevalence of 30.8% than CT (12.8%) ($p = 0.110$). The two modalities produce different results when detecting specific scenarios. Spina bifida was more obvious in MRI data, with a prevalence of 5.1%, while it was not found in CT results ($p = 0.675$). Similarly, lack of corpus callosum, Arnold Chiari syndrome, and encephalitis had comparable prevalence levels in both modalities ($p = 0.675$ and $p = 0.368$, respectively).

The study's findings on the comparison of MDCT brain plain and MRI in newborns presenting with hydrocephalus are consistent with earlier research. A comparison of temporal horn enlargement in CT and MRI scans revealed similarities between the two imaging modalities, which is consistent with the findings of Missori et al. (2022), who observed correlations between temporal horn abnormalities in both techniques [22]. Our findings on gender distribution are consistent with those of Mulugeta et al. (2022), who discovered that hydrocephalus was more common in men (64.1% male, 35.9% female) [23]. In terms of age distribution, our analysis found that the number of hydrocephalus cases peaked around 5 months (23.1%), which is comparable with the findings of Venkataramana et al. (2011), who reported a similar pattern in their study [24].The correlations between lateral ventricle involvement in CT and MRI scans were also comparable with the findings of Alselisly et al. (2021), who discovered the involvement of lateral ventricles in hydrocephalus in their study [25]. Our findings are consistent with prior research that has linked particular anomalies such as spina bifida, lack of the corpus callosum, Arnold Chiari syndrome, and brain tumours to hydrocephalus in babies. This is congruent with the findings of Koo et al. (1991), who discovered comparable anomalies in their research [26]. These studies demonstrate the complimentary functions of CT and MRI in diagnosing hydrocephalus and accompanying newborn illnesses, with each modality providing unique benefits depending on the clinical context.

This study has some limitations, which should be considered. Although adequate for preliminary examination, the extremely small sample size may restrict the findings' application to larger populations. The study's use of a single-center dataset introduces potential biases in patient demographics and imaging procedures. Furthermore, the lack of long-term follow-up data hampered our understanding of how imaging results influence prognosis. The outcomes could have been influenced by differences in the operator's experience. Future multicenter research with larger cohorts and consistent imaging modalities are needed to validate and extend these findings and improve diagnostic strategies for hydrocephalus in infants.

Conclusion

The researchers discovered that MRI was better at identifying specific illnesses such spina bifida, absence of corpus callosum, Arnold Chiari syndrome, and encephalitis, whereas CT was better at detecting lateral ventricle involvement. However, the incidence of brain tumours was noticeably absent in the CT findings, whilst the prevalence was unclear in the MRI results. The clinical setting, specific diagnostic needs, and radiation exposure factors should all be taken into account when deciding between MDCT and MRI for hydrocephalus assessment. The results of this study reinforce the importance of a multidisciplinary approach, involving radiologists and clinicians, to tailor the choice of imaging modality to each patient’s unique circumstances. While MDCT and MRI have distinct advantages, their combined use may increase the diagnostic accuracy and comprehensiveness of hydrocephalus evaluation in newborns, ultimately leading to better patient care and management. Further study and collaboration are needed to fine-tune the selection of imaging modalities in response to the changing clinical scenario and technology improvements.

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