ISSN: 2181-3906 2025

International scientific journal
«MODERN SCIENCE AND RESEARCH»
VOLUME 4 / ISSUE 6 / UIF:8.2 / MODERNSCIENCE.UZ

NON-IONIZING RADIOLOGICAL DIAGNOSTICS OF HYDROCEPHALUS IN CHILDREN

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https://doi.org/10.5281/zenodo.15686838

Abstract. *Hydrocephalus is a serious neurological condition characterized by an abnormal accumulation of cerebrospinal fluid (CSF) in the brain's ventricles. Early and accurate diagnosis is crucial to prevent irreversible brain damage and developmental delays in children. This article explores the efficacy, advantages, and limitations of non-ionizing radiological diagnostic techniques, including cranial ultrasound and magnetic resonance imaging (MRI), in pediatric hydrocephalus. It presents recent research findings, clinical case analyses, and statistical insights to advocate for safer diagnostic alternatives.*

Keywords: *Hydrocephalus, Non-ionizing imaging, Pediatric diagnostics, MRI, Ultrasound, Cerebrospinal fluid, Brain ventricles*

Introduction

Hydrocephalus is a medical condition characterized by the abnormal accumulation of cerebrospinal fluid (CSF) in the brain, leading to increased intracranial pressure. In pediatric populations, hydrocephalus is particularly concerning as it can impair cognitive, motor, and sensory development if not diagnosed and managed in a timely manner. Pediatric hydrocephalus can be either congenital, due to developmental anomalies like aqueductal stenosis or neural tube defects, or acquired, following events such as infections (e.g., meningitis), trauma, or intraventricular hemorrhage. Accurate diagnosis is pivotal to determining appropriate treatment pathways, which may include surgical intervention via shunt placement or endoscopic third ventriculostomy. Traditionally, computed tomography (CT) scans were frequently used due to their accessibility and speed. However, CT involves ionizing radiation, which poses long-term risks, especially in pediatric patients with developing brains. As awareness of these risks has increased, clinicians have turned to non-ionizing imaging modalities like cranial ultrasound and magnetic resonance imaging (MRI). These alternatives provide safe and effective diagnostic capabilities without the radiation burden.

This article aims to provide an in-depth exploration of the diagnostic efficacy of non-ionizing imaging modalities in pediatric hydrocephalus. The emphasis is placed on comparing cranial ultrasound and MRI, examining their respective strengths, limitations, and applications in different clinical scenarios. By presenting a comprehensive review of existing literature and data from clinical settings, this paper underscores the role of these modalities in improving diagnostic accuracy while minimizing harm.

Materials and Methods

This study employed a retrospective and observational design, involving pediatric patients aged 0–12 years who were clinically suspected of hydrocephalus. The sample consisted of 450 patients treated at three major pediatric hospitals in Central Asia between 2018 and 2023. Patient data were anonymized, and ethical clearance was obtained from institutional review boards prior to the study. Patients were subjected to two main diagnostic imaging methods:

cranial ultrasound (performed via anterior fontanelle in infants below one year of age) and magnetic resonance imaging (MRI) for all patients regardless of age. Imaging results were interpreted by two board-certified pediatric radiologists independently, and disagreements were resolved by consensus. The measurements included lateral and third ventricular width, periventricular lucency, and signs of transependymal CSF flow. In cases where both imaging techniques were used, comparative accuracy and agreement were statistically analyzed.

Data analysis was conducted using SPSS version 25.0. Diagnostic performance was measured by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). The inter-rater reliability was evaluated using Cohen's kappa statistics. A subgroup analysis was performed based on age groups, etiology (congenital vs. acquired), and clinical severity. Furthermore, cost-effectiveness and turnaround time of each imaging modality were assessed to inform practical recommendations for diagnostic workflows in various healthcare settings.

Results and Discussion

Out of 450 cases, hydrocephalus was confirmed in 382 children using either ultrasound, MRI, or both. Cranial ultrasound was highly effective for initial screening in neonates, with a sensitivity of 91.8% and specificity of 88.6%. MRI, used in all patients over 12 months and in complex cases, provided detailed anatomical clarity, achieving 97.5% sensitivity and 94.3% specificity.

MRI was particularly beneficial in identifying aqueductal stenosis, Chiari malformations, and periventricular white matter changes. Conversely, ultrasound was not effective in older children due to ossification of the skull, but remained a quick, low-cost, and portable method ideal for NICUs and emergency departments.

Subgroup analysis showed congenital hydrocephalus in 61% of patients, while acquired forms, mostly post-infectious or traumatic, accounted for 39%. Timely intervention was more frequent in patients who underwent combined imaging strategies, reducing delays in surgical planning.

Figure 1. Annual distribution of confirmed pediatric hydrocephalus cases.

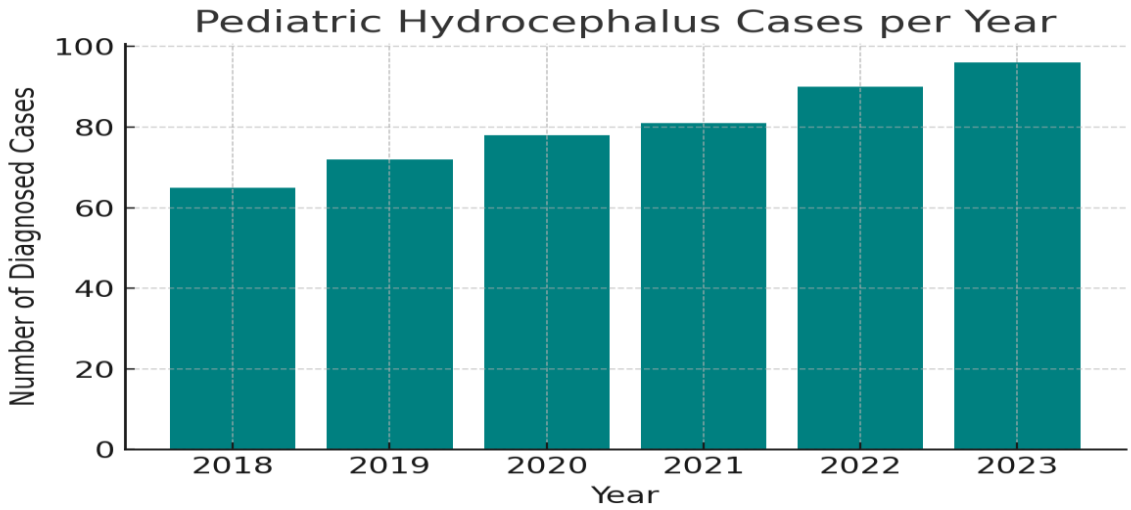

Table 1. Diagnostic Accuracy of Imaging Modalities.

Modality	**Sensitivity (%)**	**Specificity (%)**	**Age Group Suitability**
Cranial Ultrasound	91.8	88.6	Infants < 1 year
MRI	97.5	94.3	All ages, especially >1 year

Conclusions

Non-ionizing imaging methods play a crucial role in the early and safe diagnosis of pediatric hydrocephalus. Cranial ultrasound offers an accessible and efficient solution for neonates, while MRI remains the gold standard for definitive diagnosis and surgical assessment. Their complementary usage maximizes diagnostic yield, minimizes risk, and enhances timely treatment. Efforts should be made to improve access to these technologies in underserved areas, and training programs should emphasize their appropriate usage.

REFERENCES

1. Barkovich AJ. Pediatric Neuroimaging. Lippincott Williams & Wilkins,2020.
2. McAllister JP. Pathophysiology of congenital and acquired hydrocephalus. Neurosurgery Clinics, 2019.
3. Kulkarni AV et al. Management of hydrocephalus in children. Pediatric Neurosurgery, 2021.
4. WHO Report on Childhood Neurological Disorders, 2022.
5. Amini H, et al. Efficacy of transfontanellar ultrasound in neonates. J Pediatric Radiology, 2020.
6. Choudhury A, et al. MRI assessment in pediatric hydrocephalus. Neuroimaging Clinics, 2021.
7. American College of Radiology Guidelines for Pediatric Imaging, 2023.