

Prospective Study on Utilizing Diffusion-weighted MR Imaging for Non-invasive Evaluation of Acute Ureteral ObstructionChintakunta Gurivi Reddy¹, Rani Tadicherla², Duddu Gowtham Surya³¹Assistant Professor, Department of Radiodiagnosis, Siddhartha Medical College, Vijayawada, India²Assistant Professor, Department of Radiodiagnosis, Siddhartha Medical College, Vijayawada, India³Assistant Professor, Department of Radiodiagnosis, Siddhartha Medical College, Vijayawada, India

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Abstract:**Background:** Diffusion-weighted magnetic resonance imaging (DW-MRI) is a promising non-invasive method for diagnosing acute ureteral blockage. Since water molecules diffuse into tissues, DW-MRI provides detailed images of physiological and pathological conditions in a safer way than previous imaging approaches.**Methods:** A prospective observational research from June 2023 to February 2024 examined DW-MRI's acute ureteral blockage detection accuracy. 120 consecutive individuals with ureteral blockage symptoms were recruited. Within 48 hours of presentation, 1.5T DW-MRI scans were performed. Sensitivity, specificity, PPV, and NPV assessed diagnostic accuracy.**Results:** DW-MRI diagnosed acute ureteral blockage with 94% sensitivity and 90% specificity. Both PPV and NPV were 92% and 93%. DW-MRI was more accurate than ultrasonography and CT scans, but less sensitive. Diagnostic time with DW-MRI was 1 hour, much faster than CT scans. No DW-MRI side effects were recorded.**Conclusion:** DW-MRI proves to be an effective and reliable non-invasive method for diagnosing acute ureteral obstruction. Its high diagnostic accuracy, rapid turnaround time, and safety profile make it a valuable tool in clinical practice. Integration of DW-MRI into routine diagnostic protocols is recommended to expedite diagnosis and improve patient care.**Recommendation:** Clinicians should consider DW-MRI as the initial imaging modality for patients presenting with symptoms suggestive of ureteral obstruction. Further research is warranted to explore DW-MRI's cost-effectiveness and long-term outcomes, ensuring its optimal utilization in clinical settings.**Keywords:** DW-MRI, Acute Ureteral Obstruction, Noninvasive Diagnosis, Medical Imaging.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Diffusion-weighted magnetic resonance imaging (DW-MRI) is a promising non-invasive technique for assessing different health conditions, such as acute ureteral obstruction. Utilizing this imaging technique relies on the movement of water molecules in tissues to generate precise images, granting valuable information about the body's health status [1,2]. Using DW-MRI to diagnose acute ureteral obstruction is a breakthrough in medical imaging. It allows clinicians to evaluate the condition without resorting to invasive procedures or contrast agents, which may be risky for patients with specific health issues [3].

Acute ureteral obstruction, a prevalent urological emergency, may result in intense pain and kidney damage if not quickly identified and addressed. Conventional diagnostic techniques like ultrasound and computed tomography (CT) have been widely used in healthcare, but they have drawbacks, such as radiation exposure and the use of potentially harmful contrast agents in CT scans. On the other hand, DW-

MRI provides a safer option by eliminating these risks, making it a strong candidate for further investigation in cases of ureteral blockage [4].

Recent research has shown the effectiveness of DW-MRI in detecting ureteral blockage, emphasizing its ability to provide quick, precise, and non-invasive diagnosis. As an example, a study conducted by Johnson and fellow researchers in 2022 [5] showed that DW-MRI could effectively differentiate between obstructed and non-obstructed ureters by measuring the apparent diffusion coefficient (ADC) values, which correlate with the degree of obstruction. Furthermore, Lee et al. (2023) [6] conducted a prospective study that confirmed the utility of DW-MRI in the early detection of acute ureteral obstruction, suggesting that it could play a crucial role in patient management and treatment planning.

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The study aims to investigate the effectiveness and reliability of diffusion-weighted MR imaging as a non-invasive method for assessing acute ureteral obstruction prospectively.

Materials and Methods

Study Design: The study was designed as a prospective observational investigation. Carried between June 2023 to February 2024, the main goal of the study was to assess the diagnostic precision of DW-MRI in comparison to traditional imaging methods for identifying acute ureteral obstruction.

Study Setting: The research was conducted at Siddhartha Medical College, Government General Hospital in Vijayawada. We chose this location because of its state-of-the-art radiological resources and the large number of patients with symptoms suggesting acute ureteral obstruction, making it an ideal setting for our research.

Participants: A total of 120 patients presenting with clinical signs suggestive of acute ureteral obstruction, such as severe flank pain, were consecutively recruited for the study. Inclusion criteria encompassed patients aged between 18 and 75 years with symptoms pointing towards ureteral obstruction. Patients were excluded if they had contraindications to MRI, including implanted medical devices not compatible with MRI, a history of allergic reactions to contrast materials used in MRI, or severe claustrophobia.

Bias: To mitigate selection bias, consecutive sampling was employed. Furthermore, the radiologists analysing the DW-MRI results were blinded to the outcomes of other diagnostic tests and patient histories, thereby reducing observer bias. Any potential confounders were controlled through strict inclusion and exclusion criteria, along with comprehensive data collection.

Variables: The primary outcome measured was the diagnostic accuracy of DW-MRI in detecting acute ureteral obstruction, quantified through sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Secondary outcomes included patient throughput time, the occurrence of any adverse effects associated with DW-MRI, and the comparison of DW-MRI findings with the results of conventional imaging methods.

Data Collection: Data collection was structured and systematic, encompassing patient demographics, clinical presentation, history of similar episodes, results from DW-MRI, and findings from other imaging modalities like ultrasound or CT scans if available. All collected data were anonymized to maintain patient confidentiality.

Procedure: Participants underwent DW-MRI scans within 48 hours of presentation. The DW-MRI was performed using a 1.5T scanner, with parameters set to optimally detect signs of ureteral obstruction. Other diagnostic procedures, as clinically indicated, were conducted following the MRI to provide a comparative framework for assessing the efficacy of DW-MRI.

Statistical Analysis: We summarised participant characteristics and clinical data using descriptive statistics. DW-MRI diagnostic performance (sensitivity, specificity, PPV, and NPV) was compared to traditional imaging methods. The Chi-square test or Fisher's exact test was used to compare categorical data, while the t-test or Mann-Whitney U test was used to compare continuous variables. For all analyses, p-values below 0.05 were significant. SPSS 26 was used to analyze the data. This method provided a thorough and impartial evaluation of DW-MRI's acute ureteral blockage detection ability. This study advanced urology and medical imaging patient treatment.

Results

The study included 120 participants, with a balanced gender distribution (60 males and 60 females). The age range of the participants was 18 to 75 years, with a median age of 46 years. The most common symptom reported was flank pain (100% of participants), followed by nausea (55%) and vomiting (30%). A history of kidney stones was present in 65% of the participants.

Assessment of DW-MRI

Accuracy: DW-MRI demonstrated an accuracy of 94% in detecting acute ureteral obstruction.

With a PPV of 92% and an NPV of 93%, the results indicate strong predictive values. When compared to ultrasonography and CT scans, DW-MRI emerges as an extremely accurate non-invasive diagnostic tool. It is somewhat less sensitive than CT scans but offers the advantage of no ionizing radiation.

Time to Diagnosis and Throughput: From presentation to diagnosis, the average time using DW-MRI was about 1 hour (ranging from 45 to 75 minutes), much faster than scheduling and conducting CT scans in the emergency setting, which took an average of 2.5 hours (ranging from 2 to 3 hours).

Adverse Events: No adverse events related to the use of DW-MRI were reported. This was a notable finding, considering the risks associated with contrast material used in other imaging modalities like CT scans.

Statistical Analysis Outcomes: There was a statistically significant difference in diagnostic sensitivity and specificity between DW-MRI and

ultrasonography ($p < 0.01$). Yet, the sensitivity difference between DW-MRI and CT scans was not statistically significant ($p > 0.05$). However, the benefit of avoiding ionizing radiation with DW-MRI

is noteworthy. It was found that DW-MRI led to a significantly quicker time to diagnosis compared to CT scans ($p < 0.001$), indicating its potential to expedite clinical decision-making in emergencies.

Table 1: This table provides an overview of the main demographic and clinical features of the participants who took part in the research on non-invasive evaluation of acute ureteral obstruction using diffusion-weighted MR imaging.

Characteristic	Total (n=120)
Total Participants	120
Age (years)	18-75 (Median: 46)
Gender - Male	60 (50%)
Gender - Female	60 (50%)
Symptom - Flank Pain	120 (100%)
Symptom - Nausea	66 (55%)
Symptom - Vomiting	36 (30%)
History of Kidney Stones	78 (65%)

Discussion

The study carried out at Siddhartha Medical College, Government General Hospital, Vijayawada, on the application of diffusion-weighted MR imaging (DW-MRI) to evaluate acute ureteral obstruction produced convincing results. The study involved 120 participants with an equal distribution of genders and a wide range of ages. It demonstrated that DW-MRI has excellent diagnostic accuracy, with a sensitivity of 94% and a specificity of 90%. This outperformed ultrasonography and was comparable to CT scans but without the risks of ionizing radiation. Highlighting how quickly DW-MRI aids in diagnosis, much faster than conventional methods, emphasizes its ability to speed up patient care in emergencies. It is worth mentioning that the lack of negative effects associated with DW-MRI stands in contrast to the potential dangers of contrast agents utilized in alternative imaging methods, highlighting a major benefit in terms of patient well-being. Statistical analyses supported the effectiveness of DW-MRI, particularly when compared to ultrasonography. They also emphasized the minimal sensitivity associated with DW-MRI and CT scans, despite CT scans using ionizing radiation. The results highlight the reliability and efficiency of DW-MRI, indicating its potential to transform the diagnostic process for acute ureteral obstruction. This calls for greater use and more research into its capabilities [10,11].

Recent research conducted in India has emphasized the benefits of using diffusion-weighted magnetic resonance imaging (DW-MRI) to assess acute ureteral obstruction and other kidney-related issues. When comparing Doppler ultrasonography and DW-MRI, it was observed that there was no significant correlation between resistive index (RI) and apparent diffusion coefficient (ADC) values in cases of acute ureteral obstruction caused by renal

stones. This indicates that Doppler US could be more convenient in specific situations [12].

Another research highlighted the significance of DW-MRI in the prompt identification of diffuse renal conditions and precise description of focal renal lesions, showcasing its wide range of uses in renal imaging [13]. Moreover, a study illustrated the effectiveness of DW-MRI in quantitatively displaying diffusion alterations in the renal parenchyma caused by acute unilateral ureteral obstruction associated with stones [14]. A recent study highlighted the effectiveness of DW-MRI in detecting modifications to renal perfusion and diffusion during acute unilateral ureteral obstruction, particularly in patients with ureteral calculi [15].

Conclusion

This study shows that diffusion-weighted magnetic resonance imaging (DW-MRI) has great potential as a non-invasive method for precisely diagnosing acute ureteral obstruction. With its excellent specificity, positive predictive value, and sensitivity along with quick results and no reported negative effects, DW-MRI proves to be a valuable substitute for conventional imaging techniques. Incorporating DW-MRI into everyday clinical practice has the potential to accelerate diagnoses, enhance patient results, and boost overall healthcare effectiveness.

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