MAGNETIC RESONANCE IMAGING IN THE DIAGNOSIS AND CLINICAL EVALUATION OF BRAIN TUMORS: A STUDY BASED IN UZBEKISTAN

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Abstract: Brain tumors present complex diagnostic and therapeutic challenges, necessitating an integrated approach that combines clinical expertise with advanced neuroimaging techniques. Magnetic Resonance Imaging (MRI) has emerged as a cornerstone modality for the evaluation of intracranial neoplasms, offering non-invasive, high-resolution visualization of brain structures. This study, conducted at the Republican Specialized Neurosurgery Scientific and Practical Medical Center in Tashkent, Uzbekistan, aimed to evaluate the diagnostic accuracy of MRI, with a focus on advanced imaging modalities such as Dynamic Contrast-Enhanced MRI (DCE-MRI) and Diffusion-Weighted Imaging (DWI), in differentiating benign from malignant brain lesions. Over a one-year period (2023–2024), MRI scans of 129 patients were reviewed. Results demonstrated high sensitivity (92%) and specificity (86%) for malignant tumor detection. Enhanced diagnostic precision was achieved through DCE-MRI and DWI, which improved tissue characterization by assessing perfusion dynamics and cellular density. These findings support the vital role of MRI in early detection, treatment planning, and prognosis evaluation in neuro-oncology.

Keywords: MRI, Brain Tumors, DCE-MRI, DWI, Glioblastoma, Meningioma, Diagnosis, Neuroimaging, Uzbekistan, Tumor Perfusion, Tumor Cellularity

Aim: The primary aim of this study was to evaluate the diagnostic utility of Magnetic Resonance Imaging (MRI) in identifying and characterizing brain tumors in a clinical setting in Uzbekistan. Specific objectives included assessing the effectiveness of MRI in differentiating between benign and malignant intracranial neoplasms and determining the added diagnostic value of advanced imaging techniques—namely Dynamic Contrast-Enhanced MRI (DCE-MRI) and Diffusion-Weighted Imaging (DWI). These modalities were chosen for their ability to assess tumor vascularity, perfusion dynamics, and cellular density, which are critical parameters in tumor grading and classification. The study also aimed to establish the correlation between radiological findings and histopathological results where available, thus reinforcing the role of MRI as a reliable, non-invasive diagnostic tool in neuro-oncological practice.

Materials and Methods**:**This was a prospective, observational study conducted between January 2023 and January 2024 at the Republican Specialized Neurosurgery Scientific and Practical Medical Center, Tashkent, Uzbekistan. A total of 129 patients (male: 43%, female: 57%), aged 3 to 73 years, who presented with neurological symptoms indicative of intracranial masses, were included. Patients were included in the study based on clinical suspicion of a brain tumor following neurological assessment and provision of informed consent for participation and imaging. All MRI scans were performed using a 1.5 Tesla Siemens Magnetom Avanto system. The imaging protocol comprised conventional sequences, including T1-weighted, T2-weighted, FLAIR, and contrast-enhanced T1, along with advanced techniques such as dynamic contrast-enhanced MRI (DCE-MRI) to evaluate perfusion characteristics and diffusion-weighted imaging (DWI) to assess tissue cellularity. Image analysis was conducted using Vidar DICOM software, and histopathological correlation was obtained in cases where surgical excision or biopsy was performed.

Results**:** Out of 129 patients, benign tumors were identified in 30.7% of cases, including meningiomas (20.9%), pituitary adenomas (2.3%), and schwannomas or other benign types (7.5%), while malignant tumors accounted for 38.6%, comprising diffuse astrocytomas (16.3%), glioblastomas (13%), and anaplastic ependymomas or metastases (9.3%). MRI demonstrated strong diagnostic performance with a sensitivity of 92%, specificity of 86%, positive predictive value (PPV) of 89%, and negative predictive value (NPV) of 88%. Advanced imaging techniques further enhanced diagnostic accuracy: DCE-MRI achieved a sensitivity of 92% for malignant and 85% for benign tumors, with specificity rates of 86% and 88%, respectively, and provided detailed perfusion maps and permeability indices (Ktrans, Ve). Additionally, diffusion-weighted imaging (DWI) effectively differentiated high-grade gliomas characterized by lower apparent diffusion coefficient (ADC) values from low-grade tumors, showing a strong correlation with tumor cellularity (Zhou M et al., 2014, p. 1900; Mabray MC et al., 2015, p. 10).

Conclusion **:** This study underscores the pivotal role of Magnetic Resonance Imaging (MRI) in the diagnosis, classification, and clinical evaluation of brain tumors in a clinical setting in Uzbekistan. The findings demonstrate that MRI, particularly when enhanced with advanced imaging modalities such as Dynamic Contrast-Enhanced MRI (DCE-MRI) and Diffusion-Weighted Imaging (DWI), provides high diagnostic sensitivity and specificity in distinguishing between benign and malignant intracranial neoplasms.The high-resolution anatomical detail offered by conventional MRI sequences facilitates precise localization and morphological assessment of tumors, while DCE-MRI contributes critical information about tumor perfusion and vascular permeability parameters that are often elevated in malignant lesions. Furthermore, DWI, through analysis of tissue diffusion characteristics and Apparent Diffusion Coefficient (ADC) values, effectively differentiates high-grade gliomas from low-grade or benign tumors, reflecting differences in tumor cellularity.The integration of these advanced imaging techniques not only improves diagnostic accuracy but also enhances preoperative planning and prognostic evaluation. For instance, glioblastomas identified in a significant portion of malignant cases displayed characteristic imaging features on both DCE-MRI and DWI that correlated well with histopathological findings. Similarly, meningiomas and other benign lesions were more reliably diagnosed based on their perfusion profiles and diffusion characteristics.Importantly, the study highlights the clinical utility of a multimodal MRI approach in resource-constrained settings, demonstrating that even with 1.5 Tesla systems, high-quality diagnostic imaging can be achieved. This has substantial implications for early diagnosis and timely intervention, particularly in regions where access to histopathology may be limited or delayed.Looking forward, the incorporation of artificial intelligence (AI)-driven image analysis, machine learning algorithms, and radiomic feature extraction holds promise for further refining diagnostic workflows. These technologies could enable automated lesion characterization, risk stratification, and prediction of treatment response, thereby personalizing neuro-oncological care.In conclusion, MRI augmented by DCE-MRI and DWI is a reliable, non-invasive, and indispensable modality in the diagnostic armamentarium for brain tumors. Its continued development and clinical integration will play a crucial role in enhancing outcomes for patients with intracranial neoplasms in Uzbekistan and beyond.

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