

Diagnostic accuracy of dynamic contrast-enhanced mri in the evaluation of pituitary adenomas

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Relevance: Pituitary adenomas account for approximately 10–15% of all intracranial neoplasms and represent the most common sellar region pathology encountered in clinical neuroradiology. The majority are benign, yet their proximity to critical neurovascular structures — the optic chiasm, cavernous sinus, and hypothalamus — demands precise preoperative localization and characterization. Microadenomas (diameter < 10 mm) pose the greatest diagnostic challenge, as they are often isointense to normal pituitary parenchyma on conventional T1- and T2-weighted sequences, making them invisible without dedicated contrast-enhanced protocols. Dynamic contrast-enhanced MRI (DCE-MRI) exploits the differential enhancement kinetics between hypervascular normal pituitary tissue and the relatively hypovascular adenomatous tissue, enabling visualization of otherwise occult lesions in the early arterial phase. Despite its established role in tertiary neuroradiology centers, the diagnostic performance of DCE-MRI varies considerably across institutions due to differences in field strength, temporal resolution, slice thickness, and gadolinium injection protocols. Standardized evidence on DCE-MRI accuracy in the Central Asian clinical setting, where 1.5T systems predominate, remains limited.

Objective: The aim of this study was to assess the diagnostic accuracy of dynamic contrast-enhanced MRI in the detection and characterization of pituitary adenomas, with separate analysis for microadenomas and macroadenomas, and to evaluate the quantitative pharmacokinetic parameters (K_{trans} , K_{ep} , V_e) as potential imaging biomarkers for adenoma subtype differentiation.

Materials and Methods: A prospective study was conducted at the Department of Radiology, [Hospital Name], Tashkent, Uzbekistan, between January 2023 and December 2024. A total of 96 patients (mean age 41.7 ± 13.5 years; 74.0% female) with clinically suspected pituitary adenoma based on endocrinological evaluation and/or visual field defects were enrolled. All patients underwent DCE-MRI on a 1.5T GE SIGNA Explorer scanner using a dedicated pituitary protocol: coronal and sagittal T1-weighted SPGR sequences with gadolinium-based contrast agent (0.1 mmol/kg, injection rate 3 ml/s), temporal resolution 15–20 seconds per phase over

5 dynamic phases, slice thickness 2–3 mm. Pharmacokinetic modeling (Tofts model) was applied to derive quantitative parameters: volume transfer constant (K_{trans}), rate constant (K_{ep}), and extravascular extracellular volume fraction (V_e). Final diagnoses were established by surgical histopathology (n = 68) or multidisciplinary consensus integrating hormonal assays, clinical follow-up, and imaging (n = 28). Diagnostic sensitivity, specificity, PPV, NPV, and overall accuracy were calculated. ROC curve analysis with AUC was performed for K_{trans} cut-off determination. Inter-reader agreement was measured by Cohen's kappa. All statistical analyses were performed using SPSS v.26 and MedCalc v.22; p < 0.05 was considered statistically significant.

Results: DCE-MRI identified pituitary adenoma in 89 of 96 patients. Of these, 54 (56.3%) were microadenomas and 42 (43.7%) were macroadenomas. Overall diagnostic sensitivity was 93.8%, specificity 78.6%, PPV 97.1%, NPV 64.7%, and overall accuracy 91.7%. For macroadenomas, sensitivity reached 97.2% with specificity of 83.3%. For microadenomas, sensitivity was 89.5% and specificity 72.4%, consistent with the inherently greater diagnostic challenge of sub-centimeter lesions. Inter-reader agreement was substantial (Cohen's κ = 0.81). Among pharmacokinetic parameters, K_{trans} demonstrated the highest diagnostic discriminative performance: AUC = 0.912 (95% CI: 0.841–0.963; p < 0.001), with an optimal cut-off of 0.58 min⁻¹ yielding sensitivity 92.1% and specificity 84.6% for adenoma identification. K_{ep} yielded AUC = 0.741 (95% CI: 0.647–0.836), with lower discriminative value. V_e did not significantly differ between adenoma subtypes (p = 0.17). Adenoma subtype differentiation by K_{trans} showed significantly higher values in prolactinomas compared to somatotroph and non-functioning adenomas (p = 0.003). Five false-negative cases involved microadenomas < 4 mm in the lateral wing of the pituitary, where partial volume effects limited detection even on dynamic sequences.

Conclusion: Dynamic contrast-enhanced MRI demonstrates high diagnostic accuracy for pituitary adenomas at 1.5T field strength, with overall accuracy of 91.7% and excellent inter-reader reproducibility. DCE-MRI represents a critical addition to standard pituitary MRI protocols, particularly for microadenoma detection where conventional sequences are insufficient. The quantitative pharmacokinetic parameter K_{trans} offers clinically meaningful diagnostic value and may assist in non-invasive adenoma subtype characterization. The main limitations include reduced sensitivity for very small microadenomas ($\leq$ 4 mm) and protocol-dependent variability in temporal resolution. Standardization of DCE-MRI acquisition parameters and systematic implementation of pharmacokinetic analysis are recommended to maximize diagnostic yield in clinical neuroradiology practice.

Keywords: pituitary adenoma; dynamic contrast-enhanced MRI; DCE-MRI; microadenoma; macroadenoma; diagnostic accuracy; pharmacokinetic modeling; Ktrans; Kep; neuroradiology; 1.5T MRI; sellar lesion.