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慢性肾病 (chronic kidney disease, CKD) 是全球重要的公共健康问题, 其进展过程中普遍伴随肾纤维化 (renal fibrosis, RF)。肾纤维化程度与肾功能恶化和不良预后密切相关, 因此, 准确评估 RF 严重程度对疾病分期、疗效监测及个体化管理具有重要意义。目前, 肾穿刺活检仍是评估 RF 的金标准, 但其有创性、取样偏倚及难以重复随访等局限, 限制了临床应用。

体素内不相干运动磁共振成像 (intravoxel incoherent motion, IVIM-MRI) 可同时反映肾脏组织水分子扩散与微循环灌注状态, 在揭示 CKD 相关微循环障碍方面具有独特优势。然而, 传统参数分析难以全面刻画肾纤维化的空间异质性。影像组学技术通过从医学影像中高通量提取定量特征, 为无创评估组织微结构改变提供了新的研究思路。

本研究回顾性分析了 132 例经肾活检证实的 CKD 患者资料, 基于 IVIM-MRI 的 D、D* 和 f 参数图提取影像组学特征, 构建多种影像组学模型, 并进一步联合临床指标建立可视化列线图, 用于区分轻度与中重度肾纤维化。结果显示, 融合影像组学与临床信息的列线图模型在训练集和测试集中均表现出良好的诊断效能、校准度及临床净收益, 显著优于单纯临床模型。该研究表明, 基于 IVIM-MRI 影像组学的列线图模型可实现对 CKD 患者肾纤维化严重程度的无创、个体化评估, 为肾纤维化的动态监测和精准管理提供了一种具有临床应用前景的影像学工具。详见内文第 111 页。

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About the cover

Chronic kidney disease (CKD) is a major global public health concern and is commonly accompanied by renal fibrosis (RF) during disease progression. The severity of RF is closely associated with renal function deterioration and poor prognosis, making accurate assessment of RF essential for disease stratification, treatment monitoring, and individualized management. Although renal biopsy remains the reference standard for evaluating RF, its invasiveness, sampling bias, and limited repeatability restrict its routine clinical application.

Intravoxel incoherent motion magnetic resonance imaging (IVIM-MRI) enables simultaneous assessment of tissue water diffusion and microcirculatory perfusion, providing unique insights into CKD-related microvascular alterations. However, conventional parameter-based analyses are limited in capturing the spatial heterogeneity of renal fibrosis. Radiomics, which extracts high-throughput quantitative features from medical images, offers a novel, noninvasive approach for characterizing tissue microstructural changes.

In this retrospective study of 132 CKD patients with biopsy-proven renal fibrosis, radiomics features were extracted from IVIM-derived D, D*, and f parametric maps to develop multiple radiomics models. A visual nomogram integrating the optimal radiomics model with relevant clinical indicators was further constructed to differentiate mild from moderate-to-severe RF. The nomogram demonstrated favorable diagnostic performance, good calibration, and superior clinical net benefit in both the training and test cohorts, outperforming the clinical model alone. These findings suggest that an IVIM-MRI-based radiomics nomogram provides a noninvasive and individualized tool for assessing renal fibrosis severity in CKD patients, with promising potential for clinical application in disease monitoring and precision management. Please see text page 111.

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