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Role of MRI: A Perspective on the Differentiation of Fibroids from Sarcomas

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Uterine smooth muscle tumor is a disease with a broad spectrum ranging from benign leiomyomas to malignant leiomyosarcomas, with smooth muscle tumors of uncertain malignant potential (STUMP) lying in between. Accurate preoperative differentiation is of paramount importance, as the therapeutic approach and prognosis vary substantially among these entities. Misclassification may result in either unnecessary or, conversely, undertreatment of aggressive disease.

Magnetic resonance imaging (MRI) has emerged as the most powerful non-invasive modality for characterizing uterine masses. Conventional MRI sequences provide valuable morphological and signal intensity clues, while advanced techniques such as diffusion-weighted imaging (DWI), apparent diffusion coefficient (ADC) mapping, and dynamic contrast-enhanced (DCE) imaging contribute to more refined assessments. Leiomyomas typically demonstrate well-defined margins, homogeneous low signal on T2-weighted images, and variable degenerative changes such as cystic, hyaline, or hemorrhagic patterns. In contrast, leiomyosarcomas often present with ill-defined margins, irregular contours, heterogeneous T2 hyperintensity, hemorrhagic foci on T1-weighted images, and heterogeneous or non-enhancing necrotic areas on post-contrast sequences. Central non-enhancement and restricted diffusion with low ADC values have been shown to be among the most reliable features in predicting malignancy.

Recent studies have introduced MRI-based scoring systems and radiomics approaches, integrating multiparametric features to increase diagnostic confidence. Radiomic texture analysis of T2-weighted images and ADC maps, as well as machine learning-based models, have demonstrated diagnostic performance comparable to or exceeding experienced radiologists. These advancements highlight the potential role of artificial intelligence in assisting with challenging differential diagnoses.

Nevertheless, overlap remains a clinical challenge, as atypical leiomyoma variants and infarcted leiomyomas may mimic sarcomas. Thus, MRI findings must be interpreted in the context of clinical presentation, growth dynamics, and adjunctive diagnostic modalities. The integration of multiparametric MRI, quantitative imaging biomarkers, and emerging AI tools is expected to further enhance diagnostic accuracy, guide individualized management, and ultimately improve patient outcomes.

This lecture will review the characteristic MRI features of fibroids and sarcomas, summarize the current evidence for advanced imaging techniques, and discuss the role of radiomics and artificial intelligence in bridging diagnostic gaps. Through illustrative cases, practical imaging algorithms will be presented to aid radiologists in daily clinical practice when confronted with the complex task of differentiating fibroids from sarcomas.

Keywords: Leiomyoma, Leiomyosarcoma, MRI