Perspective

Journal of Interventional Nephrology

Renal Artery Imaging Advances: Improving Diagnosis and Treatment of Renovascular Disease

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Received: 01-Dec-2025, Manuscript No. oain-26-184874; **Editor assigned:** 03-Dec-2025, PreQC No. oain-26-184874 (PQ); **Reviewed:** 18-Dec-2025, QC No. oain-26-184874; **Revised:** 20-Dec-2025, Manuscript No. oain-26-184874 (R); **Published:** 31-Dec-2025, DOI: 10.37532/oain.2025.8(6).410-411

Introduction

Renal artery imaging plays a crucial role in the evaluation of renovascular diseases, particularly renal artery stenosis, aneurysms, and congenital vascular anomalies. Accurate visualization of renal arterial anatomy and hemodynamics is essential for diagnosis, risk stratification, and treatment planning. Over recent years, significant advances in imaging technology have enhanced the ability to assess renal arteries with greater precision, reduced invasiveness, and improved safety, especially for patients with impaired kidney function [1,2].

Discussion

Duplex Doppler ultrasound remains the cornerstone of noninvasive renal artery imaging. Advances in transducer technology and signal processing have improved spatial resolution and flow assessment, enabling more reliable detection of hemodynamically significant stenosis. The ability to measure parameters such as peak systolic velocity and resistive index provides valuable functional information without the use of contrast or ionizing radiation [3-5].

Computed tomography angiography has also evolved, offering high-resolution, three-dimensional visualization of the renal arteries and surrounding structures. Modern multidetector scanners and optimized protocols allow rapid image acquisition with lower radiation doses and reduced contrast volume. These improvements make computed tomography angiography particularly useful for evaluating complex anatomy, accessory renal arteries, and pre-procedural planning.

Magnetic resonance angiography represents another major advancement, especially for patients at risk of contrast-induced nephropathy. Non-contrast magnetic resonance techniques and newer gadolinium-based agents with improved safety profiles have expanded its clinical applicability. Magnetic resonance angiography provides excellent soft-tissue contrast and functional assessment of blood flow, aiding in comprehensive evaluation of renovascular disease.

Intravascular imaging techniques, such as intravascular ultrasound, offer detailed assessment from within the vessel lumen. These modalities enhance lesion characterization, guide endovascular interventions, and reduce reliance on contrast-based imaging. Fusion imaging and artificial intelligence–assisted analysis are emerging tools that integrate data from multiple modalities to improve diagnostic accuracy and workflow efficiency.

Conclusion

Advances in renal artery imaging have significantly improved the diagnosis and management of renovascular disease. By combining high-resolution anatomical detail with functional assessment, modern imaging techniques enable precise, patient-centered care while minimizing risk. Continued innovation, including contrast-sparing strategies and intelligent imaging platforms, will further enhance diagnostic accuracy

and therapeutic planning. As imaging technologies continue to evolve, they will remain central to improving outcomes for patients with renal artery disease.

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