High-resolution MRA of the renal arteries using parallel acquisition techniques: value of isotropic cross-sectional reformats compared to digital subtraction angiography and intravascular ultrasound

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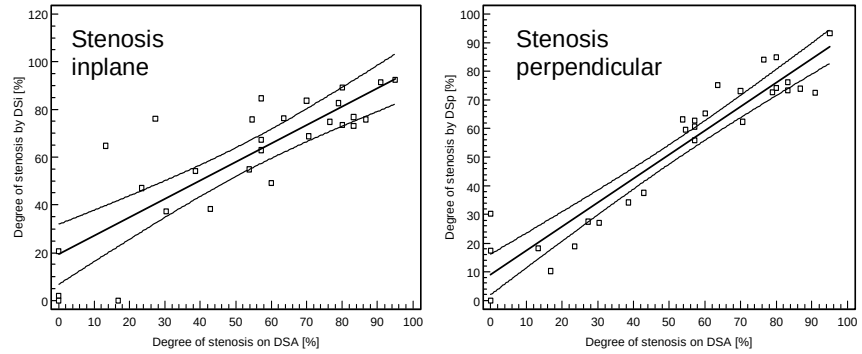
Introduction: After initial encouraging results, recent studies have shown that 3D contrast-enhanced MR-angiography (3D-Gd-MRA) still has substantial limitations in terms of accuracy and interobserver variability for grading of renal artery stenosis (**1, 2**). Due to the eccentricity of atherosclerotic disease, measurements of diameter stenosis along the vessel axis is often unreliable (**3**). The recently introduced intravascular ultrasound (IVUS) technique is considered the goldstandard method to determine the true vessel area stenosis (**4**). High-resolution 3D-Gd-MRA with isotropic sub-millimeter voxel size using integrated parallel acquisition techniques (iPAT) now also allows to reconstruct cross-sectional cuts for measurements of vessel area. The purpose of this study was to determine the diagnostic value of diameter and area stenosis measurements on cross-sectional cuts compared to current goldstandard methods of digital subtraction angiography (DSA) and IVUS.

Material & Methods: 45 patients with suspected renal artery stenosis underwent 3D-Gd-MRA on a 1.5T MR system (Magnetom Sonata, Siemens Medical Solutions, Erlangen, Germany). A 3D data set was acquired with an isotropic spatial resolution of $0.8 \times 0.8 \times 0.9\ mm^3$ in 23 seconds breath-hold using iPAT with a generalized partially parallel acquisition algorithm (GRAPPA, **5**). The degree of inplane diameter stenosis DS_i was measured in reformats along the vessel axis. The degree of perpendicular diameter stenosis DS_p and area stenosis AS_p were assessed orthogonal to the vessel axis on cross-sectional cuts. Interobserver variability for DS_i, DS_p and AS_p was assessed between two radiologists. Results were compared to selective DSA and IVUS for comparison of vessel stenosis and reduction of vessel area.

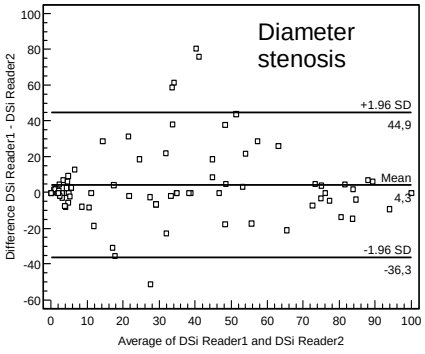
Results: Discrepancies in the exact measurements of the degree of stenosis as compared to DSA were reduced from $39.3 \pm 78.4\%$ in the inplane view to $12.6 \pm 9.5\%$ in the cross-sectional view ($p<0.05$, figure **A**). Interobserver agreement was significantly better for the stenosis-grading by AS_p (mean discrepancy for AS_p $15.2 \pm 24.2\%$) compared to DS_i (mean discrepancy $54.9 \pm 186.9\%$, $p = 0.002$, figure **B**). Measurements of area stenosis AS_p on 3D-Gd-MRA correlated well to the IVUS data ($r^2 = 0.91$, figure **C**).

Conclusion: The evaluation of cross-sectional cuts reconstructed from high-resolution renal 3D-Gd-MRA using iPAT significantly increases diagnostic accuracy and decreases interobserver variability. Cross-sectional MRA reformats should therefore be routinely used for grading of renal artery stenosis on 3D-Gd-MRA.

A



B



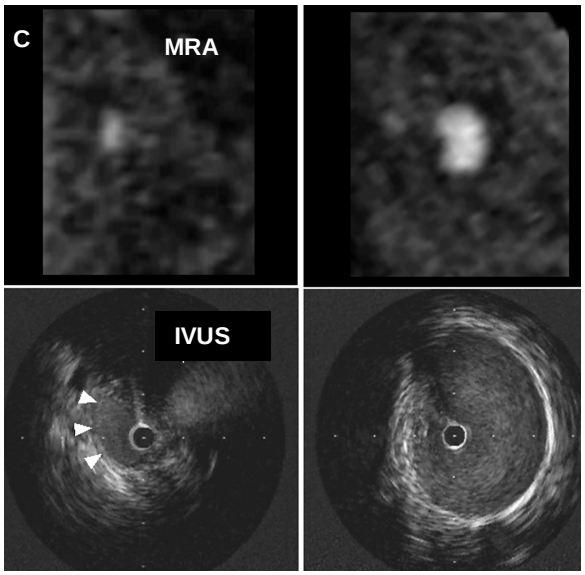
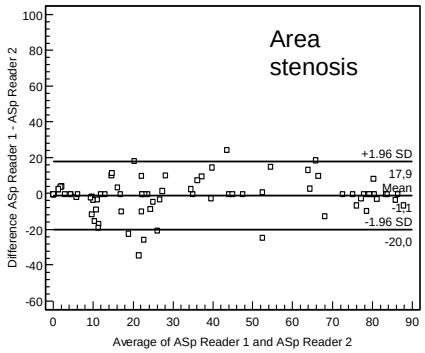


Figure C: Measurements of area stenosis on cross-sectional MRA (top) and IVUS images (bottom). Note the good agreement between both techniques concerning the eccentric shape of the vessel lumen.



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