# SonoVue renal wash-in/wash-out curve analysis detects cortical perfusion defects in patients with significant renal artery stenosis and renin activation

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# Purpose

Doppler testing is a well standardized method for an accurate diagnosis of significant Renal Artery Stenoses (RAS); little experimental data is available on the ability of US techniques in evaluating side differences in the renal kinetics of a contrast agent in RAS. The purpose of the study was to compare the contrast enhancement ultrasound (CEU) technique with renal scintigraphy in detecting renal hemodynamic asymmetry in renovascular hypertensives.

**Images for this section:**

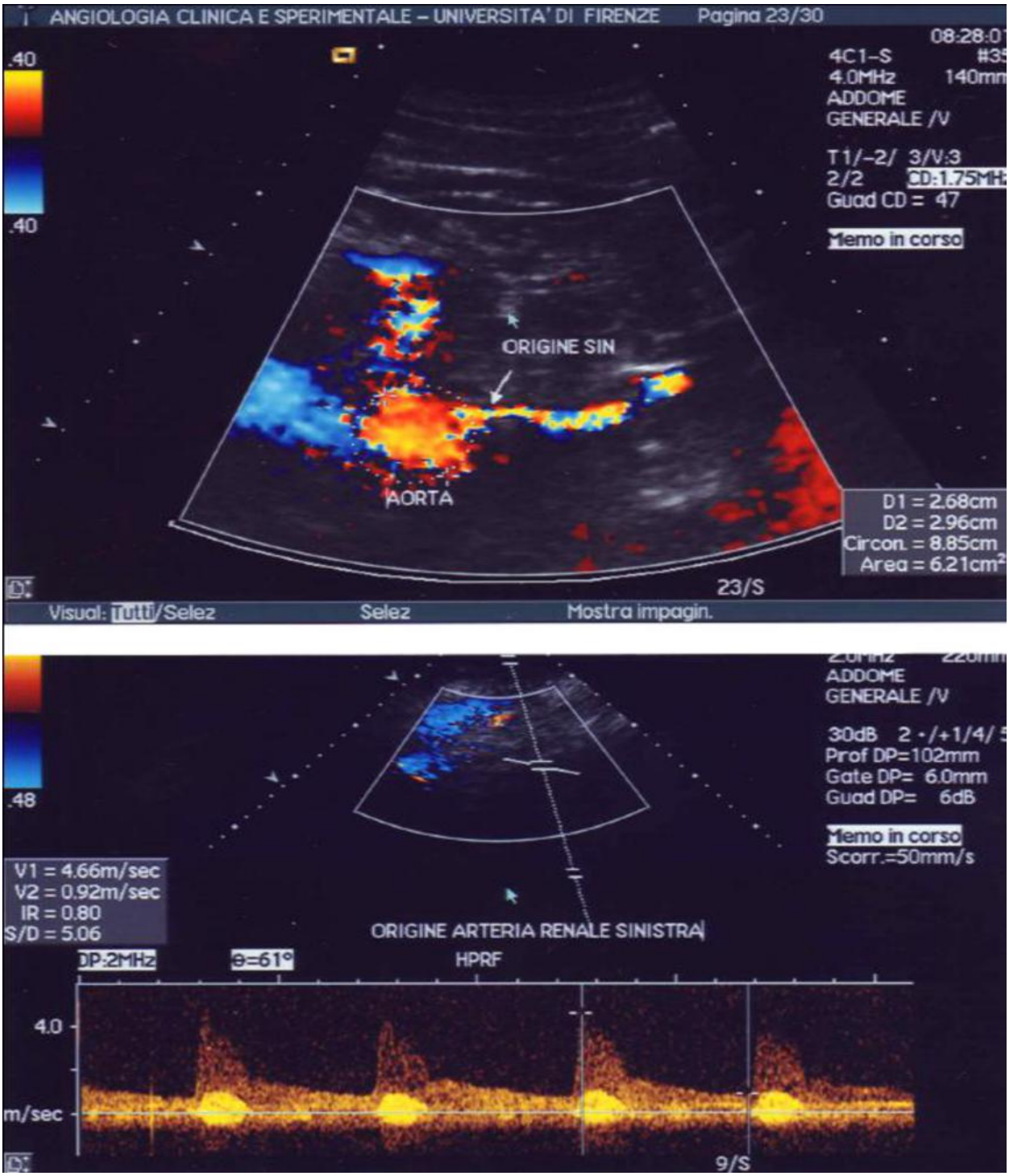


**Fig. 1:** Color and doppler velocity characterization of an hemodynamic stenosis of the left renal artery.

## Methods and Materials

13 hypertensive patients (54 to 88 years; mean 74 ± 10) with significant (>60%) RAS (Doppler examination, renal angioCT) underwent renal CEU ("wash-in/wash-out" curve analysis of an iv 2,5 ml sulphur hexafluoride bolus injection followed by 5 ml saline solution) and Sequential Renal Scintigraphy (SRS) with Captopril test. The sulphur hexafluoride renal kinetic was calculated by measuring the following parameters: Time to Peak (TTP), Regional Blood Volume (RBV), Regional Blood Flow (RBF), Mean Transit Time (MTT) and percentage of contrast intensity to peak (PEAK SI). Effective renal plasma flow (ERPF) was computed by Hippuran clearance and glomerular filtration rate (GFR) by DTPA clearance using an uptake method and proprietary program validated at our institution. The method is based on time-activity curves measured on the heart and kidney areas by the region-of-interest technique. Mean parenchymal transit time (MPTT) was calculated for each kidney by deconvolution analysis, using ROI technique by mean a proprietary software running under Windows MatLab 6.1.The time-activity curve from a precordial ROI over the left ventricle is used as the input function and the activity-time curve from renal parenchymal ROI, excluding calyceal and pelvic regions, is used for deconvolution analysis by matrix algorithm method according to Britton.

**Images for this section:**

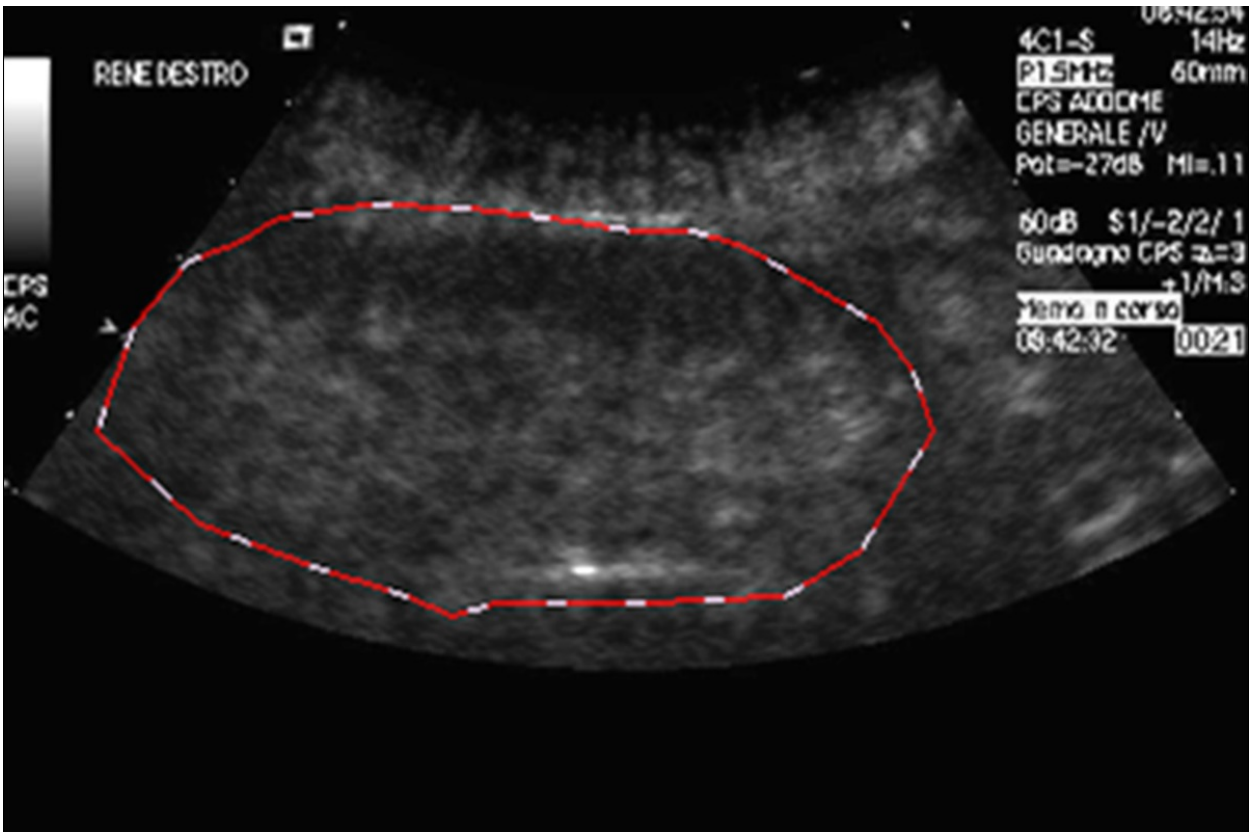


**Fig. 1:** The red dashed line outlines the area analyzed by the software on a pixel by pixel basis.

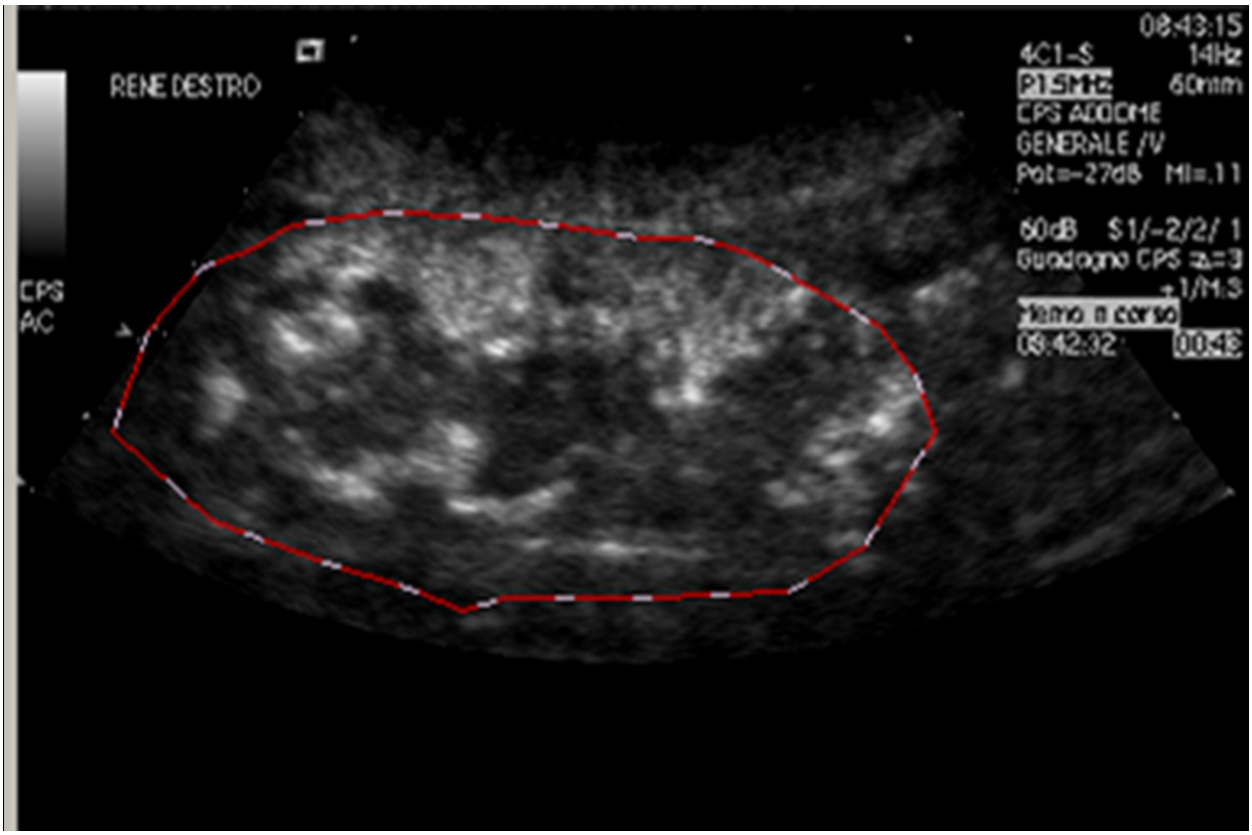


**Fig. 2:** Renal parenchyma appearance following contrast adiministration.

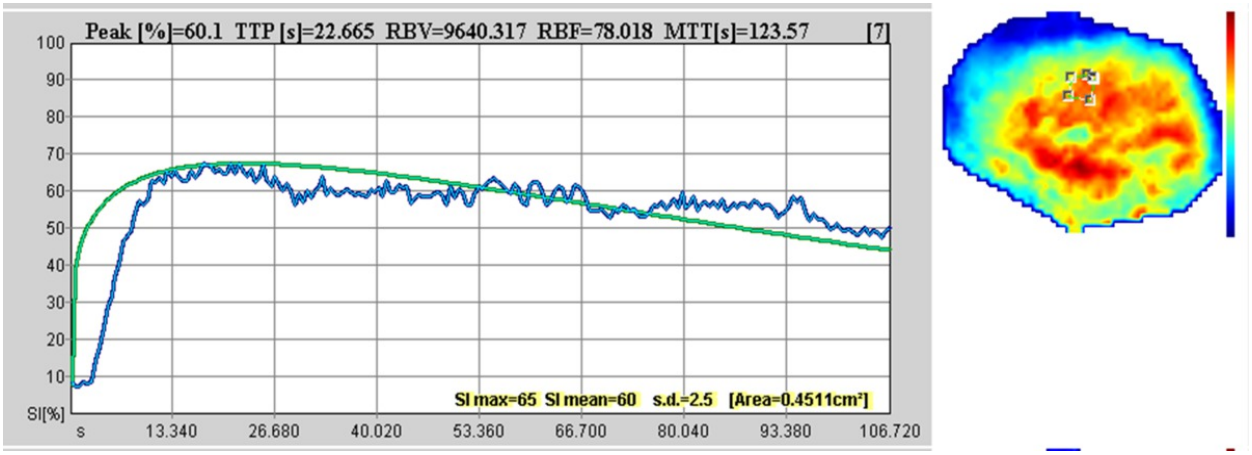


**Fig. 3:** Normal renal kinetics of the contrast agent.

# Results

In all patients, at SRS examination, the renal plasma flow of the affected kidney was signficantly lower than in the contralateral one ($p<0.01$). The glomerular filtration rate showed a significant reduction after Captopril administration only in the affected kidney ($p<0.01$), consistent with significant ipsilateral renin activation. In all patients, at CEU examination, the TTP values of the affected kidney were significantly greater than in the contralateral one ($p<0.01$). No significant differences were found in MTT, RBF and RBV between the two sides.

**Images for this section:**

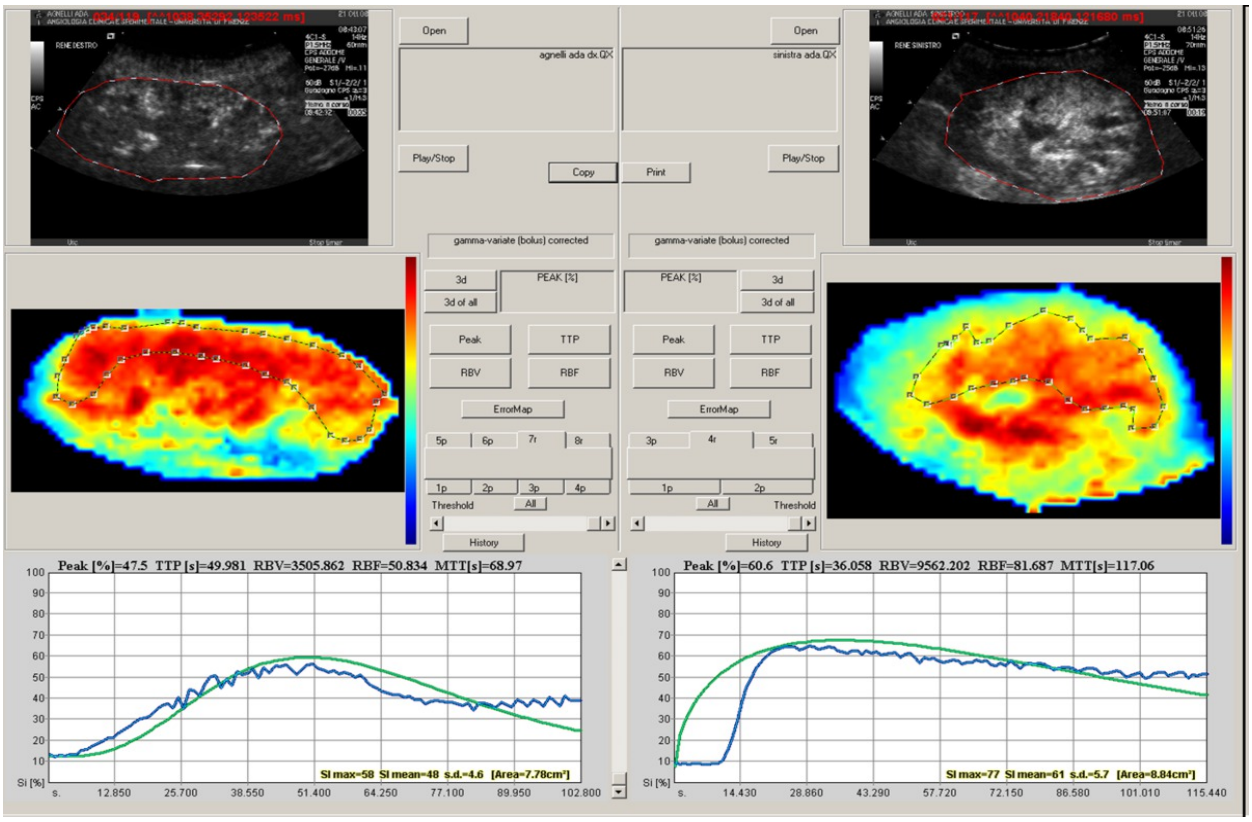


**Fig. 1:** Perfusion curves of the two kidneys were compared by "Q-Compare" analysis. Note the steep upslope of the curve in the normal kidney (right bottom panel)and the delayed peaking of the curve of the stenostic kidney (left bottom panel).

| PERFUSION PARAMETERS | STENOTIC SIDE | NORMAL SIDE | p |
|---|---|---|---|
| PEAK | 32.6 | 38.7 | 0.22 |
| TTP (seconds) | 46.5 | 28.8 | 0.006 |
| RBV | 3420.20 | 3808.50 | 0.65 |
| RBF | 40.40 | 50.43 | 0.13 |
| MTT (seconds) | 85.05 | 70.12 | 0.14 |

**Fig. 2:** Perfusion parameters PEAK:maximum signal intensity reached during the transit of the contrast bolus; TTP: Time-To-Peak, time of arrival of the contrast agent to its maximum signal intensity value; RBV: regional blood volume (proportional to the area

under the curve - A.U.C.); RBF: regional blood flow (i.e. RBV/MTT); MTT: mean transit time (circulation time of the contrast agent in the investigated renal parenchyma).

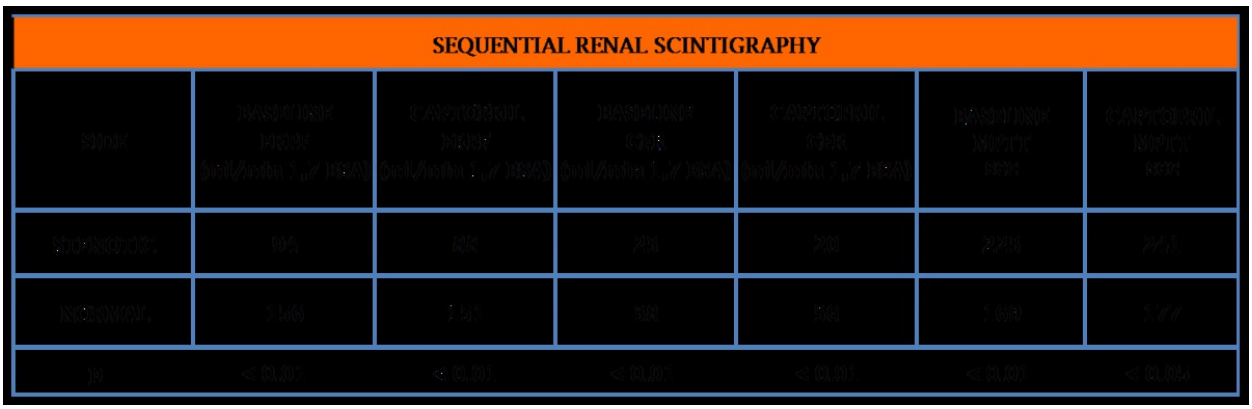


**Fig. 3:** BASELINE ERPF: Baseline Hippuran clearance. CAPTOPRIL HIPPURAN: Hippuran clearance after Captopril administration. BASELINE GFR: Baseline DTPA clearance. CAPTOPRIL DTPA: DTPA clearance after Captopril administration. BASELINE MPTT: Baseline Mean Parenchymal Transit Time. ACE MPTT: Mean Parenchymal Transit Time after Captopril administration.

## Conclusion

An increase in TTP at CEU examination can reveal a defect in cortical perfusion of the kidney with significant RAS. The finding is consistent with the hemodynamic scintigraphic results; compared to Doppler velocity and resistive indices alone, the application of CEU can provide additional perfusion data that can be considered in therapeutic decisions.

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## Personal Information