

Renal Duplex Scanning as a Predictor of Interventional Success

By Frank Kelley, BS, RVT & Karen Harrison, MD.

Duplex ultrasound with color Doppler has been used for many years to identify patients with renal artery stenosis, but additional information that is provided by duplex ultrasound can also help to determine the best course of treatment.

Renal artery stenosis is increasingly recognized as one of the most common causes of secondary hypertension and progressive renal failure.¹ Over the last decade there has been acceptance of duplex ultrasound to identify stenosis, which is frequently treated with renal artery surgery or renal artery angioplasty with or without stenting.¹⁻³

However when vascular repair of atherosclerotic narrowing is technically successful the clinical outcome is mixed. A summary of studies done over the last decade involving 1,289 patients that underwent angioplasty with stenting (n = 556), or open surgery (n = 733), showed that only 25-30% of azotemic patients have a clinically important improvement in renal function after revascularization.^{1,3} Approximately half of the patients had no significant change in renal function although they did not have to face the immediate prospect of renal artery occlusion. In the remaining 20-25% of patients there was actually a decline of renal function as measured by a rise in serum creatinine. Some of these patients rapidly progress on to end stage renal disease.

The success rate of intervention has been shown to be more favorable for those patients treated for malignant hypertension in the absence of marked renal insufficiency. A large multi-center study involving 1,058 patients found that angioplasty and stenting was beneficial in patients with normal to mildly impaired renal function (baseline creatinine <2.0 mg/dl) (4). Data that was pooled from 13 reports of angioplasty and stenting over a follow-up period of two years found that hypertension is cured in 8% and improved in 56% of cases.^{ii,5}

Those advocating a more aggressive approach note that those patients that have undergone revascularization require less medication for blood pressure management and have a reduced chance of future decreased renal function secondary to progressive vascular occlusion. Research has also shown that renal function is stabilized following revascularization when compared to the rate of decline of renal function with medical management alone.^{3,6}

The debate between the surgical and medical approach to renovascular hypertension remains controversial without the results of well-designed, randomized trials. While the benefits from revascularization may be moderate for the patient group as a whole, there appear to be some predictors of clinical success when applied to individual patients.

Recently, the largest clinical trial examining the prognostic ability of duplex ultrasound to identify patients that will respond to revascularization was published in the *New England Journal of Medicine*. The resistance index (RI) [$1 - (\text{end diastolic velocity} / \text{peak systolic velocity})$], was obtained from the arterial waveforms in the kidneys of 131 patients that had technically successful angioplasty (62%), angioplasty with stenting (32%), and renal artery surgery (6%). This study found that in 97% (n = 34) of patients with a baseline RI of equal to or greater than .80, the mean arterial pressure did not decrease by 10mmHg following stenting. Furthermore it was noted that renal function declined (as defined by a decrease in creatinine clearance of at least 10% with no additional medications) in 80% of patients who had an EDR of .80 or greater^{iii, 7}

This confirms the experiences of earlier researchers who have studied elevated renovascular resistance in patients with similar measures of arterial intra-renal flow patterns. A small study at the University of Washington measured the end diastolic ratio (EDR) [$\text{end diastolic velocity} / \text{peak systolic velocity}$], prior to 35 interventions for hypertension and found that none of the 11 clinically successful renal revascularized patients had end diastolic ratios of lower than .30. This compared to seven patients with values lower than .30 in the 24 clinically unsuccessful interventions (P=0.05, one-tailed Fisher's exact test). They concluded that an EDR of lower than .30 correlates with clinical failure following renal revascularization, while a value above .30 has no prognostic significance.⁸ The same conclusion was reached by Cohn and colleagues in a study that evaluated renal function and blood pressure responses in 31 interventions with the same EDR threshold.⁹

These results corroborate the findings of several previous reports that have shown that resistive indices obtained from the intrarenal arterial branches are reliable indicators for the progression of renal function that correlate with histopathological data in a variety of nephropathies.^{10,11}

It should be noted that these resistive indices reflect more than structural changes in the renal vasculature; therefore a variety of conditions can dynamically change resistance values in the kidneys. Obstructive uropathy has been shown to elevate the resistive index in the kidney.¹² Decreases in the RI have been reported in patients treated with ACE-inhibition.¹³ In one study this finding was actually shown to improve the predictive ability of Doppler resistance profiles when combined with a captopril challenge.¹⁴ Other studies have noted changes in resistance measured by Doppler with aging,

intravenous fluid load, sympathetic activation (through the cold pressor test and handgrip test), as well as differences with patient scanning position.^{15,16}

In the context of these variables an EDR of ≤ 0.20 (or the equivalent RRI value of $\geq .80$) appears to be a conservative threshold for predicting clinical failure prior to revascularization.

The authors of these studies don't recommend the use of Doppler derived intra-renal flow patterns alone to determine which patients should have intervention. Available clinical predictors and other functional tests should be included when considering treatment of renal artery stenosis.

Revascularization should not be expected to restore renal function if the kidney length is less than 7.5 cm.^{1,3} Other indicators of parenchymal disease, including a urinary protein excretion of greater than 1g/day, hyperuricaemia, and a creatinine clearance of less than 40ml/min, suggests this a subgroup of patients less likely to respond to revascularization.¹ Several authors have also reported that a short history of hypertension or documented evidence of recent deterioration of renal function also predicts a favorable response to surgery.^{3, 17}

Captopril enhanced renography and scintigraphy may also predict which patients will respond to revascularization. However these tests are of limited accuracy in patients with advanced renal failure. This explains the range of the sensitivity and specificity that varies between 43% to 85% in different studies.¹⁸

The comprehensive color duplex examination provides kidney length, cortical thickness and other observations about the quality of the parenchyma (including cysts and some neoplasms) and collecting system. This modality also provides anatomic and physiological information about the significance of renal artery obstruction. Combining all this information with the end diastolic ratio can help produce optimal individualized strategies to manage hypertension, preserve renal function and improve survival.

(Endnotes)

¹ The length of follow-up and criteria for "improvement" vary between reports.

² This summary of reports did not define the term "cured" or "improved." Standards published by the Society of Interventional Radiology define a cure as a blood pressure of less than 140/90 with no hypertensive medication.¹⁹

³ The end-points for the study were blood-pressure, renal function and vital status at the time of the last follow-up. The mean (\pm SD) duration of follow-up was 32 \pm 21 months. Follow up-intervals took place at 3,6 and 12 months and yearly thereafter.

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Vascular Diagnostics is published by Pacific Vascular, Inc. Lynette Faye - editor; Keith Fujioka, RVT, FSVU - Technical Advisor; Edwin Brockenbrough, MD - Medical Director; Keith Fujioka, RVT, FSVU - President and CEO. Pacific Vascular operates noninvasive vascular laboratories throughout the Puget Sound area. For more information or for patient scheduling, please call (425) 486-8868 or 1-800-282-6516 (in WA). Visit our web site at www.pacificvascular.com. Reprints are available upon request.



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