

References

- Scobie JE, Maher ER, Hamilton G, et al. Atherosclerotic renovascular disease causing renal impairment—A case for treatment. *Clin Nephrol* 1989; 31:119–122.
- Bengtsson U, Bergentz S-E, Norback B. Surgical treatment of renal artery stenosis with impending uremia. *Clin Nephrol* 1974; 2: 222–229.
- Novick AC, Pohl MA, Schreiber M, et al. Revascularization for preservation of renal function in patients with atherosclerotic renovascular disease. *J Urol* 1983; 129:907–911.
- Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. *Nephron* 1976; 16:31–41.
- Rolin HA, Hall PM, Wei R. Inaccuracy of estimated creatinine clearance for prediction of iothalamate glomerular filtration rate. *Am J Kidney Dis* 1984; 4:48–54.
- Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *J Am Stat Assoc* 1958; 53:457–481.
- Dean RH, Foster JH. Criteria for the diagnosis of renovascular hypertension. *Surgery* 1973; 74:926.
- Dean RH. Renovascular hypertension. In Moore WS, ed. *Vascular Surgery: A Comprehensive Review*, 2nd edition. Orlando: Grune & Stratton, 1986, pp 561–592.
- Annual Report. NC Kidney Council, Raleigh, NC, 1986.
- Eggers PW. Effect of transplantation on the medicare end-stage renal disease program. *Transplantation and the Medicare ESRD Program*, 1988; 318:223.
- Mailloux LU, Bellucci AG, Mossey RT, et al. Predictors of survival in patients undergoing dialysis. *Am J Med* 1988; 84:855–862.
- Hansen KJ, Tribble RW, Reavis SW, et al. Renal duplex sonography: Evaluation of clinical utility. *J Vasc Surg* 1990; 12:227–236.
- Bauer JH, Brooks CS, Burch RN. Clinical appraisal of creatinine clearance as a measurement of glomerular filtration rate. *Am J Kidney Dis* 1982; 2:337–346.
- Bjornsson TD. Use of serum creatinine concentrations to determine renal function. *Clin Pharmacokinet* 1979; 4:200–222.
- Levey AS, Gassman JJ, Hall PM, Walker WG. Comparison of rates of change in glomerular filtration rate, creatinine clearance and reciprocal serum creatinine during progressive renal disease: Results from the feasibility phase of the modification of diet in renal disease study (Submitted for publication).
- Dean RH, Englund R, DuPont WD, et al. Retrieval of renal function by revascularization: study of preoperative outcome predictors. *Ann Surg* 1985; 202:367–375.

DISCUSSION

DR. CALVIN ERNST (Detroit, Michigan): Dr. Dean's manuscript is so detailed and contains so many valuable data that time does not permit comprehensive discussion of the entire study. Consequently I will focus on that portion dealing with renal revascularization and concomitant aortic reconstruction.

The 17.6% operative mortality rate for combining a renal revascularization and aortic reconstruction reported in the manuscript underscores the principle that such procedures should not be used indiscriminately. Therefore it is important to know the natural history of arteriosclerotic renal arterial stenosis before embarking on simultaneous repairs.

Clearly mere presence of a renal artery stenosis in a patient undergoing aortic reconstruction does not mandate renal revascularization. In an attempt to identify those arteriosclerotic renal arterial stenoses that progress to occlusion, at the Henry Ford Hospital we retrospectively studied 66 arteriosclerotic renal arteries in 48 patients, followed by 194 sequential arteriograms during an average interval of 4.5 years.

All 48 patients had undergone aortic reconstruction and all had renal arterial stenoses that were not repaired at the time of aortic reconstruction. By annual follow-up arteriography, the natural history of these lesions were studied. We found that 7 or 10.6% of the stenoses progressed to occlusion and presumably deterioration of renal function, although this was by no means proved. And those most likely to occlude were narrowed by 80% or more. No lesions or stenoses less than 60% on the preceding aortogram progressed to occlusion in the subsequent study.

Furthermore multiple risk factors, including change in serum creatinine, did not correlate with renal arterial occlusion.

It remains unclear then what effect renal arterial occlusions may have on patient survival or renal function. Intuitively it seems that preservation of renal parenchymal tissue by renal revascularization among patients undergoing aortic reconstruction is beneficial. But only if the operative risk is minimal and can be justified by prevention of renal failure, which may require dialysis.

Therefore, with Dr. Dean's large experience in this excellent study, I would like to ask three questions. First, what are your indications for concomitant renal revascularization and aortic reconstruction?

Second, could you identify any clinical markers in the eight patients who were on preoperative dialysis, such as progression of the renal arterial stenosis, and thereby predict which patients may develop this potentially preventable complication?

And, third, what is the effect of a unilateral stenosis on renal function, exclusive of the hypertensive damage to the contralateral unprotected kidney? Can we expect renal revascularization to improve renal function under such circumstances?

DR. GERALD LAWRIE (Houston, Texas): We looked at a group of 80 patients with creatinines greater than 2 from a series of more than 1000 patients or actually, in this series, 919 patients. I think the first thing to recognize is that most patients, in our experience, with severe renovascular hypertension do not have renal insufficiency.

These patients looked fairly similar to what Richard presented. And about 40% of our patients had bilateral disease. When we came to look at predictors of response in terms of improvement of renal function and lack of response, we had a lot of trouble coming up with any clinical or laboratory or angiographic predictor that would tell us which patients we should operate on with a view to restoring renal function.

Obviously the patient with bilateral renal stenosis with good-sized kidneys who comes in and has to be put on dialysis usually is a good candidate.

But most of these patients fall into this category of creatinines around 2 to 3. When we look at the people who had a good response and the people who had a poor response after surgery, it was about a 50–50 proposition. And bilaterality did not seem to be much of a factor.

We looked at a number of other factors and were not able to determine what patient should get this treatment. Of course it is a very complicated problem because in atherosclerotic patients we see development of renal failure and in hypotensive patients we see development of renal failure.

And then in people with limitation of blood flow to the kidney we certainly see renal insufficiencies, as Richard has so elegantly demonstrated.

So the question I have for Richard is as he looks at this data in these tests, does he really have a strong feeling of confidence that he can select patients, on the basis of these tests, who will respond with a high degree of probability, that is, the nondialyzed patients?

Considering the fact these people tend to be sicker—and we've certainly documented long-term survival is much lower in people with preoperative renal insufficiency, despite renal revascularization—is it worth subjecting them to the risk of surgery, which in most cases is significant because of their multiple-system problems, unless we have a very clear-cut test that will tell us reasonably unequivocally that they will respond well in terms of renal function?

DR. RICHARD DEAN (Closing discussion): The group of patients who came off dialysis stayed off dialysis. There were, however, patients who subsequently went on dialysis who had not been on dialysis preoperatively.

This group of patients had been followed up to 42 months. One patient in that group who recurrently became dialysis dependent several months after operation had a graft thrombosis, was operated on, and again became dialysis, independent after repeat bypass.

I appreciate the discussant's comments and I will, in essence, combine Dr. Lawrie's and Dr. Ernst's questions. In the renal insufficiency group of patients, I don't think we have good predictors up to this point to accurately identify who will respond with improvement in renal function. The data that we reviewed here does give some clue, however, to a predictor. That predictor is the rate of deterioration in function before operation. For example, a patient who has a creatinine level of 2 mg/dL today who had a creatinine level of 2 mg/dL last year is unlikely to have a return of function after operation. In contrast, a patient who had a creatinine level of 1.5 mg/dL two months ago and 4 mg/dl today has a higher probability for return of function.

Unfortunately, with the heterogeneity of the data and the small numbers, there was no critical rate of deterioration below which one did not improve, above which one did improve. I think it is a general marker that those who are deteriorating rapidly have the most likelihood of return of function and equally or even potentially more important have a higher likelihood of having a decrease in their postoperative rate of deterioration.

One can look at the effect of the renal artery lesion as producing ischemia or causing hypertension. Either of these effects can cause renal insufficiency. Renal ischemia that can cause such renal insufficiency can also be caused by atheroembolism from the renal artery lesion. Although obviously present in many of these patients, atheroembolism by itself does not appear to be an independent factor that increases the rate of deterioration.

The issue of risk of operation cannot be overstated. One should place

this into context, for this is a group of people who are rapidly deteriorating, and a group who will become dialysis dependent within months if left uncorrected.

Patients who have uncorrected renovascular disease and end-stage renal disease may have a 20% per year death rate. Our survival curve of our group is significantly better than that even when operative deaths are included. It's as though the stress of the operation is significant, but if one gets through the operation and receives a benefit from it, one has a significantly protected survival.

The final question that Dr. Ernst had concerns the indications for combining renal artery surgery with aortic surgery. I am somewhat simplistic about this, in that I do not believe that the patient who has even an angiographically severe lesion who does not have hypertension or renal insufficiency should undergo prophylactic renal revascularization. If they are azotemic or if they are hypertensive, then we would combine the renal artery procedure with the aortic reconstruction.

Finally, there are two reasons for potential benefit in the unilateral lesion where, obviously, one would expect to find bilateral arteriolar disease. One reason is the potential for return of function in the 'protected' kidney; I think that is a much less common phenomena than suggested by some nephrologists.

The second benefit of operation in the unilateral group is improved control of hypertension and its benefit to renal function in the long term.

In that regard, the use of preoperative predictors to identify who will have benefit in hypertension is valuable in assessing the patient with a unilateral renal artery stenosis.