8 *Catheter Interventions in Chronic Renal Failure*

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Abstract: In the 21st century cardiac disease remains the single largest cause of mortality and morbidity. Despite numerous strides in the medication and technology to manage this disease, there has not been a significant change in the mortality rate. This fact is further heightened in patients with end-stage renal disease. The catheter interventions to improve the blood supply by revascularization procedures both for the cardiac and kidney revascularization have a significant role to play in the symptom alleviation, improving the quality of life and to some extent reduce the morbidity.

The Author has tried to focus the attention to the improvement in technology in various catheter procedures in patients of end-stage renal disease and brought out the benefits in reducing the mortality due to cardiovascular disease in particular and renal disease in patients of ESRD.

Cardiac diseases remain the single largest cause of mortality in ESRD population. The burden of cardiovascular morbidity and mortality in patients with chronic kidney disease, however, is not restricted to the ESRD population. It has become increasingly apparent that the presence of severe chronic kidney disease is not only a powerful independent prognostic factor for prediction of cardiovascular morbidity and mortality but also a multiplier for the risk of death.

The percutaneous intervention in case of ESRD can be divided into two broad subsets: (1) Coronary intervention (2) Renal and Nonrenal peripheral intervention.

CORONARY INTERVENTION IN ESRD PATIENTS

At dialysis initiation, the main difference between hemodialysis and peritoneal dialysis patient is the higher prevalence of CCF as a comorbid cardiovascular condition—33% for HD and 23% for PD (2003).[1]

The rate of coronary stent utilization exceeds that for other types of coronary revascularization procedures. Although ischemic heart disease is common in dialysis patient the overall utilization rate of coronary revascularization procedures actually remains low and mortality much higher than non CKD patients (Fig. 8.1).

Diabetic peritoneal dialysis patients have the highest mortality after coronary revascularization with a three years survival of approximately 22% after CABG and 17% after coronary stenting.[2] In the incident hemodialysis population two years survival after stenting procedure is 47% and 53% for those with and without diabetes and 31% and 46% for those on peritoneal dialysis.[3]

Although the use of coronary stents have increased markedly in CKD patients over the last few years, most CKD patients do not receive coronary revascularization. Patients with more severe CKD have a higher death rate and worse survival after all types of coronary revascularization. Two years survival after angioplasty and stenting in patient with CKD and those with CKD requiring dialysis are 71%, 36% and 69% and 38% respectively.[4] Age, not surprisingly is a powerful predictor of all cause mortality. Adjusted survival is somewhat better in hemodialysis patients than in patients of PD. Two year survival following a stent in patients younger than 65 years is 58% for HD and 49% on PD (Fig. 8.2).

In patients 65 years or older the difference is larger with 42% on HD and 28% on PD (Fig. 8.3). Diabetes as the cause of CRF confers even worse prognosis (Fig. 8.3).

RENAL AND NONRENAL INTERVENTION

The next largest group of patients undergoing percutaneous interventions are those patients whose CKD has resulted from renal cause and whose treatment may ameliorate to some extent the renal damage. The commonest disorder requiring interventional treatment is renal artery stenosis which causes hypertension, renal insufficiency and cardiac disturbance syndromes. Various studies have shown the prevalence of RAS to be as follows[5-9] (Fig. 8.4).

When to Intervene in Renal Artery Stenosis

Once the diagnosis of renal artery stenosis is established, particularly in patients with decreased renal functional reserve, it should be treated without delay.[10]

If there is no significant pressure gradient, easily controlled hypertension and mild stable renal dysfunction or incidentally discovered stenosis and without proper clinical evaluation, no intervention should be carried out in case of renal artery stenosis.

Criteria for intervention in renal artery stenosis (Figs 8.5 and 8.6B).

Measurement of Pressure gradient in Renal artery has to be done carefully as decision of intervention is based on its accuracy.

Methodology of Measurement and Subsequent Management

The problems in relation to renal artery stenosis are:

a. Complications not well defined in literature which may be related to extraordinary success rate.
b. Complications are related to comorbidities, especially diabetes and renal function.

Salient Facts of Intervention

a. The method of renal ostial cannulation is important.
b. Never use a lubricious (Terumo) guidewire
c. Contrast induced nephropathy is not an insignificant issue.

The problems are related to

a. Arterial access.
b. Catheterization approach.
c. The anatomic peculiarity of aorta and renal artery access orientation.
d. Methods of crossing the lesion and lesion characteristics.
e. Contrast agents.
f. Distal protection. Filters (Does data exist to justify their use despite associated risks).

Catheterization Approach

The femoral retrograde or antegrade radial/ brachial approach can be used while the axillary approach should be avoided. The brachial approach is preferred as (1) Renal arteries point cephalad which is the direction of curve of multipurpose catheter. A 6F catheter always using in forward direction enables both renal arteries to be done with this approach. Catheter engagement should be slow with deliberate maneuvers to avoid scrapping aortic wall while searching for the renal ostium. Soft recurve catheter, soft straight Bentson wire and soft tapered tip, stiff, shapable precurved shaft TADH wire for exchange are usually used. Advancement of stent or balloon through the sheath/guide catheter is coherent with the direction of applied force and precludes advancement around acute angles. Few problems arise during brachial approach that cannot be solved by arterial repairing; also it complements femoral approach.

The anatomical peculiarities of aorta and renal artery should be kept in mind. Vascular catheters with ability to change shape to fit the anatomy are being increasingly used. They have increased control and precision. The most vital aspect in renal intervention in CKD patients is pre intervention evaluation. Use of noninvasive diagnostic modalities like duplex ultrasounds, MRA to localize the level and extent of pathology ought to be done before any procedure. Pre procedure hydration strategies are also of utmost importance. The strength and limitation of noninvasive imaging are given in Table 8.1:[11-14]

Although there is no perfect imaging techniques, noninvasive imaging provides the answer and is the first step in assessment with duplex ultrasound being the most widely used initial assessment method. Intervention for hypertension in renal artery can be divided in two broad categories-renovascular hypertension and Ischemic Nephropathy; the management for these two entities follow the following general guidelines.

RENOVASCULAR HYPERTENSION

For Ischemic Nephropathy

Intervention is usually multilevel and use of road map and DSA is done so that contrast volume can be reduced. Limitation of contrast volume is absolutely imperative as contrast volume directly correlates with risk of contrast induced Nephropathy. A simple rule of thumb to limit contrast volume is to use a maximum of 300 cc of contrast or 5 cc/kg body weight of contrast (Cigarroa Am J Med '89). The 'No Touch' technique of guiding catheter approach is used (Fig. 8.9).

Thus the points to be kept in mind are:

1. Use preprocedure MR angiogram to define the brachial arch access prior to pursuing intervention.
2. Use only 50:50 contrast-saline concentrations on all injection.
3. Use road mapping technique for all renal imaging.

Outcome of Renal Revascularization in Chronic Azotemic Renovascular Diseases

While improved GFR after procedure is found in 25-30% of patient about 20% of patients experience deterioration of GFR while the remaining 45-50% have a stable GFR.

For the 20-25% of patients who experience a reduction of GFR the causes are multifactorial and can be:

a. Progressive Parenchymal injury
b. Concurrent disease
c. Atherothrombi
d. Reperfusion injury
e. Contrast Nephropathy

RISKS IN RENAL ARTERY INTERVENTION

The following are the risks that are encountered during renal intervention:

1. Cholesterol embolization.
2. Renal artery dissection, thrombosis and rupture or perforation
3. Aortic dissection
4. Contrast nephropathy.

Cholesterol emboli: The reported incidence of this complication is about 2-3%[15] although the real incidence is likely to be much higher as the quoted cases are only those which are either biopsy proven or associated with generalized systemic cholesterol embolization. Cholesterol emboli reduce the renal reserve with a more profound effect if renal function is already reduced. There is exponential rise of creatinine with loss of renal mass. Treatment is most often ineffective and though distal protection has proven role in SVG intervention its role during renal procedures is not very well defined. Anatomy may limit its utility in renal application though preliminary data suggest that it may prevent renal insufficiency after intervention. Many renal arteries are too short for optimal device placement. Also though cholesterol embolization may occur during procedure, in many cases it occurs days to months later. Embolization frequently arise from aorta during manipulation for selective renal artery catheterization. Also the size of cholesterol emboli is often < 100 μ, less than the pore size of 'filters'. Filtration or occlusion devices can be used for renal protection with filtration being more preferable. The lesser the warm ischemic time the less the nephron damage with doubling of creatinine or dialysis requirement starting at warm ischemic time of > 45 min. Angioguard percusurge, EPI or Mednova distal protection filters or balloon are commonly used (Fig 8.10).

The ideal renal protection device should be distal filter of low profile and short overall length and is yet to be developed.

CONTRAST INDUCED NEPHROPATHY

Definition: New onset or excerbation of renal dysfunction after contrast administration in absence of other cause:

___Increase by 25% or absolute increase of > 0.5 mg/dl in the level of serum creatinine from baseline.

This condition usually occurs 24-48 hrs post contrast exposure with creatinine peaking in 5 to 7 days later and normalizing within 7 to 10 days in most cases. Contrast induced nephropathy predicts mortality and is about 35% compared to < 7% in cases without RCN.[16,17]

There is exponential increase in risk of nephrotoxicity with increase of baseline creatinine. The incidence of CIN is < 1% in general population but it occurs in about 5.55% of patients with renal insufficiency. In patients with both diabetes and renal insufficiency the risk is greatly increased and about 50% of patients develop CIN.[18] The risk factors for CIN are given in Table 8.2.

Treatment

Although a large number of agents have been tried, apart from hydration and use of low osmolar contrast other therapies have not proved to be consistently effective. The different agents that have been used and the results obtained are given in Table 8.3.

Thus ,CIN is a common, predictable clinical problem and estimation of GFR is fundamental for predicting risk. A GFR < 60 ml/min is the threshold where CIN begins to occur. Baseline renal insufficiency, diabetes, dehydration and anemia predispose patients to CIN. Adequate preprocedural hydration is the key preventive measure and medical therapies to prevent CIN have been disappointing. In addition to hydration, the choice of contrast is probably the most important decision the operator can make in minimizing risk to the patient.

OUTCOMES OF RENAL INTERVENTION

Renal occlusion have a success rate of about 70% and a complication rate of 20% with mortality being 10%. Patients older than 75 years have increased requirement of dialysis post procedure (16% vs 7% in less than 75 years age group). Acute renal dysfunction occurs within 24 hours in 12% of patients with 1% having oliguria and 1 % requiring dialysis.[20]

FUTURE DIRECTIONS

The CO_2 angiography is the only proven safe imaging agent in patients with contrast allergy and renal failure and use of this modality of imaging is expected to increase in the coming years. This procedure is also very effective in visualizing the ostial positions. Gadolonium contrast agents are also very effective with no renal toxicity but at present used limitedly due to very high cost. Renal cooling, ultrafiltration and combination of gadolinium and isoosmolar contrast agents along with selective arterial infusion of renal protective compounds are the areas of current work and is expected to be the modalities that will be adopted as future interventional approach.

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