Clin. Cardiol. 29, 494–497 (2006)

The Effect of Coronary Angiography on Residual Renal Function in Patients on Peritoneal Dialysis

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Summary

Background: The risk of intravascular radiocontrast to residual renal function (RRF) in patients on peritoneal dialysis (PD) remains largely unknown.

Hypothesis: This study sought to estimate the effect of coronary angiography on RRF in patients on PD.

Methods: All patients at the VA Pittsburgh Healthcare System and University of Pittsburgh who underwent coronary angiography between 1993 and 2005 while on PD and who had RRF measured prior to angiography were identified retrospectively. For patients without a postprocedure RRF recorded, medical records were reviewed to determine whether anuria had developed. The longer-term rate of loss of RRF among cases was compared with a composite rate of decline in RRF among cases before angiography and matched controls.

Results: Twenty-nine patients with a mean preprocedure RRF of 4.4 ± 3.2 ml/min/1.73m^2 were evaluated. Of these patients, 23 (79%) had postangiography RRF assessments (mean clearance 3.4 ± 3.0 ml/min/1.73m^2). One of the remaining six patients definitely became permanently anuric following angiography, one was lost to follow-up, and there was no postprocedure RRF assessment in four others. The rate of decline in RRF in the cases was similar to the composite rate (0.07 ml/min/1.73m^2/month vs. 0.09 ml/min/1.73m^2/month, p = 0.53)

Conclusion: The risk for permanent anuria in patients on PD undergoing coronary angiography appears to be quite small. Patients who do not develop anuria following coronary angiography have the same gradual rate of loss of RRF as other patients on PD. Providers should be vigilant in protecting RRF in patients on PD undergoing coronary angiography.

Key words: coronary angiography, residual renal function, peritoneal dialysis

Introduction

Residual renal function (RRF) is a highly important predictor of survival in patients on peritoneal dialysis (PD).[1–6] As a result, efforts to preserve RRF in this population have become increasingly important. The prevention of peritonitis and avoidance of hypotension associated with aggressive ultrafiltration may minimize the loss of RRF.[7,8] Some have advocated the avoidance of aminoglycosides for the treatment of peritonitis, although deleterious effects of short-term use have not been demonstrated consistently across studies.[9,10] Little is known about the precise risk intravascular radiocontrast poses to RRF. The substantial burden of coronary atherosclerosis in the population with end-stage renal disease has led to the routine performance of diagnostic and therapeutic coronary angiography in patients on dialysis. With the well-recognized inverse relationship between level of kidney function and risk for radiocontrast nephropathy, it is crucial that providers caring for patients on PD and performing procedures that utilize intravascular radiocontrast are able to estimate the impact of radiocontrast administration on RRF in this population. The primary aim of this study was to determine the effect of coronary angiography on RRF in patients on PD.

Methods

Study Population and Medical Record Review

This study was a retrospective review of patients on PD who underwent coronary angiography. All patients on PD at

The work was conducted at the University of Pittsburgh (Department of Medicine) and VA Pittsburgh Healthcare System (Renal Section). Dr. Weisbord was supported by a VA Health Services Research and Development Career Development Award (RCD 03-176).

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Received: June 8, 2006
Accepted with revision: August 10, 2006

the VA Pittsburgh Healthcare System and at the University of Pittsburgh are asked to participate in an Institutional Review Board approved registry that permits inspection of medical records. Using this registry, we identified patients who had been treated with PD at one of these two medical centers since January 1, 1993. We then employed electronic medical records to identify patients who had undergone coronary angiography at any time between January 1, 1993, and January 1, 2005. Following this step, one investigator (SDW) reviewed the medical records of each patient to confirm that they were being treated with PD at the time of angiography.

For the remaining patients, a detailed medical record review was conducted to determine whether RRF had been measured by 24-h urine collection as part of routine dialysis care prior to and following angiography, the dates of the RRF measurements most proximate to the cardiac procedure, and the results of these measurements. Standard protocol was to obtain 24-h urine collections for the measurement of RRF three to four times yearly in all patients with urine output of at least 100 ml/day. Residual renal function represented the average of 24-h urine urea and creatinine clearances, expressed as ml/min/1.73m^2. Patients who were anuric prior to angiography along with subjects with no documented assessment of RRF by 24-h urine prior to angiography were excluded.

For patients who had evidence of a preangiogram RRF assessment but had no documentation of a postprocedure RRF measurement, a detailed medical record review was undertaken to determine whether the patient had become permanently anuric following the angiogram based on explicit documentation of the development of anuria and the absence of any documentation of persistent urine output. This review also included an evaluation for events other than the administration of radiocontrast that could have precipitated anuria and/or the absence of a postangiography RRF assessment including (1) acute complications of angiography, (2) postangiography coronary artery bypass surgery, (3) peritonitis in the 6-month period following cardiac catheterization, (4) transfer to hemodialysis, (5) transplantation, or (6) death. Our medical record review also incorporated an evaluation of the use of measures to prevent radiocontrast nephropathy including pre- and postprocedure intravenous fluids, administration of low-osmolar radiocontrast, and the use of N-acetylcysteine among patients undergoing angiography after January 1, 2001.[11]

Control Subjects

We also sought to explore any long-term effects of coronary angiography on RRF. For secondary analysis, we generated a contemporaneous matched control group against which cases could be compared in regard to loss of RRF. All control patients had received PD at the same medical centers, but had not undergone coronary angiography. Control patients were individually matched with cases in regard to the following clinical characteristics: (1) time of initiation of PD within 3 years, (2) gender, (3) age within 5 years, and (4) diabetic status. Only controls with at least two recorded 24-h urine measurements of RRF were considered in order to ensure the generation of a slope of change in RRF over time. All 24-h urine RRF estimates present in the PD registry for cases and controls were identified, and a composite rate of decline in RRF that represented the rate of loss of RRF among case patients prior to angiography and the rate of loss in controls was generated. This composite rate was compared with the postangiography rate of loss of RRF observed among case patients who retained renal function following angiography.

Statistical Analyses

We utilized generalized estimating equations to compare the composite slope of decline in RRF with the slope of postangiography decline in RRF among cases with reported 24-h urine clearances following the cardiac procedure. These methods allowed us to account for the multiple observations of RRF in each patient and the fixed effects of matched controls. A p value of < 0.05 was considered statistically significant. All analyses were performed using STATA version 8.0 (StataCorp LP, College Station, Texas, USA).

Results

Case Patients

In all, 384 patients had been treated with PD during the target study period. Of these, 116 underwent coronary angiography, with 55 of these having been on PD at the time of the procedure. Of these patients, 20 (36%) were anuric prior to angiography and 6 (11%) had no documented preprocedure assessment of RRF. The remaining 29 patients (8% of the original 384 patients) had documented of 24-h urine urea and creatinine clearances prior to angiography and they made up our cohort of cases (Fig. 1). Seven (24%) of these 29 patients

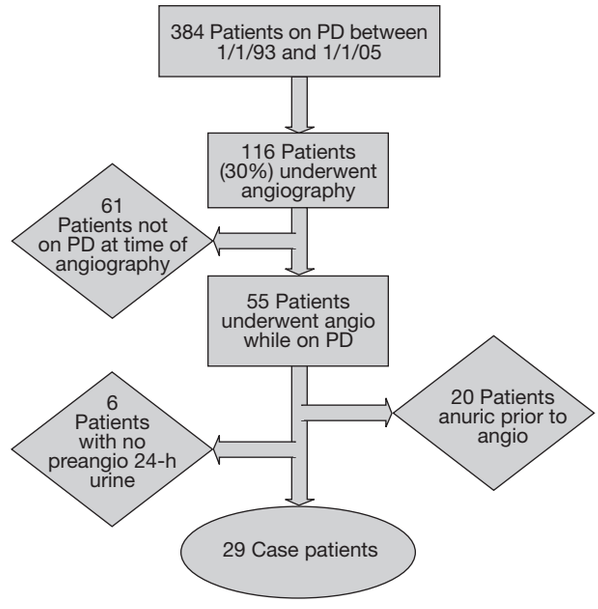

FIG. 1 Identification of case patients. PD = peritoneal dialysis.

TABLE I Demographic and clinical characteristics of cases and controls

	Cases	Controls
Number of patients	29	29
African-American (%)	14	17
Caucasian (%)	86	83
Male (%)	62	62
Mean age (mean ± SD)	55 ± 10	54 ± 12
Diabetic (%)	48	52
Treated with continuous cycler PD (%)	62	48
Treated with continuous ambulatory PD (%)	38	52

Abbreviations: SD = standard deviation, PD = peritoneal dialysis.

underwent coronary angiography at the VA Pittsburgh Healthcare System and the remainder did so at the University of Pittsburgh. Indications for coronary angiography included pretransplant work-up (8 patients), work-up for an abnormal stress test (6 patients), symptoms of angina and/or heart failure (14 patients), and acute myocardial infarction (1 patient). Table I depicts the demographic and clinical characteristics of this cohort.

The mean level of RRF in the 29 case patients prior to angiography was 4.4 ± 3.2 ml/min /1.73m^2 (range 0.4–15.7 ml/min/1.73m^2). Preangiography clearances had been measured 12.1 ± 11.0 weeks prior to the cardiac procedure (range 0–42 weeks). Twenty-three of the 29 patients had documentation of a postprocedure 24-h urine measurement of RRF; their mean postangiography RRF was 3.4 ± 3.0 ml/min/1.73m^2 (range 0.5–13.0 ml/min/1.73m^2). These postprocedure clearances had been performed on average 14.7 ± 10.4 weeks following the cardiac procedure (range 1–42 weeks). Figure 2 illustrates the differences between pre- and postangiography RRF in these 23 patients.

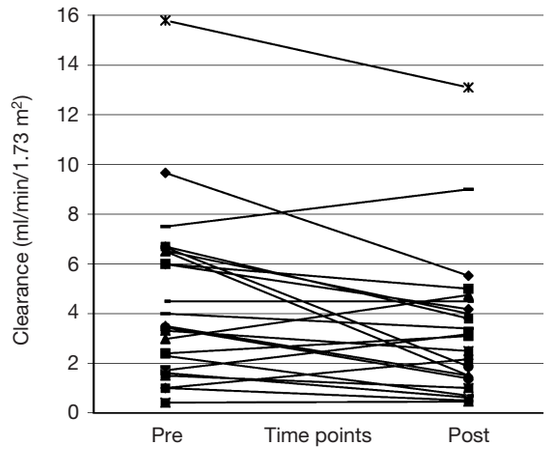

FIG. 2 Residual renal function prior to and following angiography among patients retaining residual renal function.

In 6 of 29 cases, there was no postangiography assessment of RRF. Detailed medical record review confirmed that one of these patients had become irreversibly anuric following the procedure based on explicit documentation of this complication. This patient had no evidence of angiography-related complications, did not undergo coronary artery bypass surgery following catheterization, or experience peritonitis, reinforcing the clinical impression that angiography had induced anuria. One patient transferred care 6 weeks after angiography, leaving inadequate medical record data to determine whether anuria had developed. The four remaining patients had no documented assessment of RRF following angiography, yet had no explicit documentation of the development of anuria.

Control Patients

Individual matches were identified for each of the 29 case patients (Table I). The composite rate of decline in RRF among the cases prior to angiography and matched controls was 0.09 ml/min/1.73 m^2/month. In the 23 patients with RRF assessments following angiography, the monthly postprocedure loss of RRF was found to be 0.07 ml/min/1.73 m^2, which was not statistically different from the composite rate ($p = 0.53$).

Results of Coronary Angiography

Coronary artery disease was found in 76% of angiograms, with 28% of patients demonstrating single-vessel disease, 24% having double-vessel disease, and 24% having triple-vessel disease. Three patients underwent balloon angioplasty with stent placement and one underwent coronary artery bypass surgery and aortic valve replacement following angiography. Table II shows procedure characteristics and the use of measures to prevent radiocontrast nephropathy in these patients.

Discussion

This study aimed to characterize the risk of coronary angiography to RRF in patients on PD and uncovered a series of

TABLE II Preventive care for radiocontrast nephropathy [a]

Dose of preprocedure IV fluids (ml)	371 ± 348
Dose of postprocedure IV fluids (ml)	215 ± 288
Patients receiving preprocedure IV fluids (%)	85
Patients receiving postprocedure IV fluids (%)	50
Dose of radiocontrast (ml)	74 ± 28
Patients receiving N-acetylcysteine (%) [b]	50
Patients receiving low-osmolar radiocontrast (%)	100
Patients receiving ioversol (%)	56
Patients receiving ioxaglate (%)	33
Patients receiving iohexol (%)	11

[a] Among patients with available data.
[b] Among patients who underwent angiography after 1/1/2001.
Abbreviation: IV = intravenous.

clinically important findings. First, the administration of intravascular radiocontrast during coronary angiography appears to pose a relatively small risk for permanent anuria. Only one of our study patients definitively lost all RRF following coronary angiography. This observation is consistent with the results of other recent studies. Dittrich *et al.* recently described the impact of intravascular radiocontrast on the decline in RRF among 10 patients on PD who received radiocontrast and 8 controls.[12] In this study, RRF following radiocontrast administration in the 10 case patients was similar to that seen in control subjects, with no reported cases of anuria. Similarly, Moranne *et al.* assessed RRF prior to and 2 weeks following the administration of intravascular radiocontrast in 36 patients on PD and compared the findings with 36 controls.[13] No change in RRF occurred after radiocontrast administration in case patients, and variations in RRF were similar in cases and controls. Our results are consistent with the findings of these reports and support the conclusion that the risk for anuria after coronary angiography is low.

Second, compared with estimates of decline in RRF of 0.10 to 0.34 ml/min/1.73 m^2 per month in prior studies of patients on PD who did not necessarily undergo coronary angiography, our 23 patients with postangiography RRF measurements demonstrated a mean monthly loss of RRF following angiography of 0.07 ml/min/1.73 m^2.[14, 15] This rate of decline of RRF post angiography was not different from the composite rate of decline observed among cases pre angiography and matched controls, suggesting that the performance of coronary angiography does not accelerate the gradual loss in RRF that occurs under normal circumstances in most patients on PD.

Finally, coronary angiography is performed commonly in patients on PD and the burden of coronary atherosclerosis is substantial. Fourteen percent of all patients on PD at our medical centers underwent coronary angiography while on PD, and coronary artery disease was common. These observations are consistent with the heavy burden of atherosclerosis in patients on dialysis and reinforce the importance of understanding the risk of coronary angiography to patients on PD who rely on RRF.

There are limitations to the current study related primarily to the retrospective nature of data collection. First, incomplete medical record documentation in five patients who had no postprocedure RRF assessment confounds our ability to determine conclusively whether these patients retained RRF following angiography. It is possible that these patients lost RRF, in which case the rate of anuria would have been higher than reported by us. Second, RRF was assessed at variable, and in certain cases at distant times prior to and following angiography, which weakens our conclusions on the short- and long-term effects of coronary angiography on RRF. Third, our sample size was quite small and drawn from two medical centers, limiting the generalizability of our results to the broader PD population. Finally, we may have failed to capture outcomes of patients who underwent coronary angiography at other medical institutions. However, the vast majority of procedures performed on our patients on PD take place at our institutions.

Conclusions

This study suggests that the risk for anuria in patients on PD who undergo coronary angiography is low. Among patients who do not become anuric, coronary angiography does not appear to accelerate the gradual decline in RRF that normally occurs in patients on PD. Seventy-six percent of study patients had significant coronary artery disease, underscoring the burden of atherosclerosis and diagnostic importance of coronary angiography in this population. Our findings should help providers understand the potential risks of coronary angiography to RRF in patients on PD and assist providers in discussing these risks with patients undergoing this cardiac procedure. Future prospective studies aimed at further defining the risk posed to patients on PD by radiocontrast are needed, as are efforts to determine the efficacy and safety of evidence-based preventive strategies for radiocontrast nephropathy in this patient group.

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