Chronic Kidney Disease Before and After Partial Nephrectomy

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Purpose: We performed a multi-institutional retrospective cohort study to evaluate baseline renal function of patients who underwent partial nephrectomy for renal tumors, and determined rates of progression to higher stages of chronic kidney disease.

Materials and Methods: The Modification of Diet in Renal Disease study equation was used to estimate glomerular filtration rate. Preoperative and postoperative serum creatinine values were obtained from patients who underwent partial nephrectomy at 6 institutions with a normal contralateral kidney, and had baseline chronic kidney disease stage I (estimated glomerular filtration rate greater than 90 ml/minute/1.73 m^2), II (estimated glomerular filtration rate 60 to 89 ml/minute/1.73 m^2) or III (estimated glomerular filtration rate 30 to 59 ml/minute/1.73 m^2). The end point was change in chronic kidney disease stage at long-term followup (3 to 18 months). Multivariate logistic and Cox regression models tested the association of newly acquired chronic kidney disease stage III or greater with pertinent demographic, tumor and surgical factors.

Results: For 1,228 patients with followup creatinine data at least 3 months after partial nephrectomy median baseline glomerular filtration rate was 74 ml/minute/1.73 m^2. At baseline 19%, 59% and 22% of patients had chronic kidney disease stage I, II and III, respectively. At long-term followup for patients with baseline chronic kidney disease stage I or II median postoperative glomerular filtration rate was 67 ml/minute/1.73 m^2 with 29% having progression to chronic kidney disease stage III or greater. Increasing age, female gender, increasing tumor size, clamping of the renal artery and vein, and lower preoperative estimated glomerular filtration rate were independently associated with newly acquired chronic kidney disease stage III or greater. The presence of comorbid conditions such as coronary artery disease, diabetes mellitus or hypertension did not independently predict an increased risk of higher chronic kidney disease stage.

Conclusions: Chronic kidney disease stage III or greater will develop postoperatively in approximately a third of patients with an estimated glomerular filtration rate greater than 60 ml/minute/1.73 m^2, and this progression is associated with definable demographic, tumor and surgical factors.

Key Words: nephrectomy; carcinoma, renal cell; kidney function tests; kidney failure, chronic

Abbreviations and Acronyms

CAD = coronary artery disease
CKD = chronic kidney disease
DM = diabetes mellitus
eGFR = estimated glomerular filtration rate
GFR = glomerular filtration rate
HTN = hypertension
LPN = laparoscopic partial nephrectomy
MDRD = Modification of Diet in Renal Disease
OPN = open partial nephrectomy

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For other articles on a related topic see pages 285 and 291.

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COMPARED to radical nephrectomy, partial nephrectomy is associated with a decreased risk of chronic kidney disease, a lower risk of cardiovascular events and mortality,[1] and comparable oncologic outcomes.[2] Initially used primarily for small and exophytic tumors, partial nephrectomy rates have increased and the procedure is now acceptable for larger, more technically challenging tumors.[3] Clamping of the renal hilar vessels in open and laparoscopic partial nephrectomy renders the kidney susceptible to ischemic injury, and previous data have shown the duration of renal ischemia to be the strongest modifiable risk factor for decreased postoperative renal function.[4]

The United States National Kidney Foundation defines chronic kidney disease as an estimated glomerular filtration rate of less than 60 ml/minute/1.73 m^2 for more than 3 months with or without kidney damage.[5] Chronic renal insufficiency is a growing public health concern in the United States and in 2010 the estimated number of individuals with end stage renal disease exceeded 650,000.[6] Progressively worsening CKD is associated with a directly increased risk of cardiovascular events, hospitalization and death.[7] We retrospectively analyzed a large multi-institutional cohort to evaluate the baseline renal function of patients who underwent partial nephrectomy for localized renal tumors, progression rates to higher CKD stages and factors that independently predict progression.

MATERIALS AND METHODS

Case Selection

After obtaining institutional review board approval available patient databases were collected from the University of Chicago, Penn State University, Memorial Sloan-Kettering Cancer Center, University of Michigan, University of Texas M. D. Anderson Cancer Center and New York University. Partial nephrectomy (OPN or LPN) was the primary treatment for a localized renal mass in 2,067 patients between 1998 and 2009. Inclusion criteria were any patient older than 18 years with a normal contralateral kidney who underwent partial nephrectomy for a solitary renal tumor. Exclusion criteria included a postoperative followup of less than 3 months, incomplete baseline data, solitary kidney, multifocal tumors, absence of clamping of the renal vessels, re-clamping of the renal vessels during surgery, any previous kidney surgery (ipsilateral or contralateral), or CKD stage IV or V (baseline eGFR less than 30 ml/minute/1.73 m^2 as defined by the National Kidney Foundation).[5] Eligibility criteria were met by 1,228 (59.4%) patients, establishing the foundation of this study.

Data Collection

Preoperative and postoperative creatinine values between 3 and 18 months after surgery were extracted from the data sets. The abbreviated MDRD formula, a function of serum creatinine and demographic variables, was used to assess baseline eGFR and postoperative eGFR as GFR (ml/minute/1.73 m^2) = $186 \times [\text{serum creatinine (mg/dl)}^{-0.154}] \times (\text{age}^{-0.203}) \times (0.742 \text{ if female}) \times (1.21 \text{ if African-American})$.[4,8] The National Kidney Foundation classification was used to place eGFR values into CKD stages I to V as I—GFR greater than 90 ml/minute/1.73 m^2, II—GFR 60 to 89 ml/minute/1.73 m^2, III—GFR 30 to 59 ml/minute/1.73 m^2, IV—GFR 15 to 29 ml/minute/1.73 m^2 and V—GFR less than 15 ml/minute/1.73 m^2.[5] Patient variables including age, gender, race, body mass index, pertinent comorbidities (HTN, DM and CAD), tumor size, pathological stage, histological classification, method of clamping (artery alone or artery and vein), ischemic interval, presence or absence of renal hypothermia and estimated blood loss were collected for analyses.

Statistical Analysis

Analyses were completed using PASW® 18.0 statistical software with $p < 0.05$ considered significant. Patient outcomes were measured in terms of CKD stage. Multivariate logistic regression was used to assess which variables independently predicted the development of CKD stage III or greater 3 to 18 months after surgery. A multivariate Cox regression model was also used to predict new CKD stage III or greater after surgery.

RESULTS

Baseline Characteristics

Of the 1,228 patients CKD stage I was present preoperatively in 228 (19%), stage II in 724 (59%) and stage III in 276 (22%) (table 1). Median baseline GFR was 74 ml/minute/1.73 m^2 (range 30 to 248).

Table 1. *Baseline patient characteristics*

Mean pt age (range)	59.2 (19.3–86.1)	
No. gender (%):		
Male	764	(62)
Female	464	(38)
No. comorbid conditions (%):		
HTN	616	(50)
DM	223	(19)
CAD	212	(17)
Mean ml/min/1.73 m^2 baseline GFR (IQR)	75	(62–86)
Median mins ischemia (IQR)	34	(27–44)
Mean cm tumor size (IQR)	3.1	(2.0–3.9)
No. T stage (%):		
T0	39	(3)
T1a	860	(70)
T1b	172	(14)
T2	22	(2)
T3	83	(7)
Unknown	52	(4)
No. histological classification (%):		
Clear cell	631	(51)
Chromophobe	115	(9)
Papillary	171	(14)
Benign	179	(15)
Other	73	(6)
Unknown	59	(5)