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Preservation of Renal Function Following Partial or Radical Nephrectomy Using 24-Hour Creatinine Clearance

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Abstract

Objective: To compare the effect on renal function of partial and radical nephrectomy using creatinine clearance measurements from 24-hr urine collection.

Methods: All patients with a solid enhancing renal mass suspicious for renal cell carcinoma, a normal contralateral kidney, and not dialysis dependent were enrolled in this prospective cohort study. Patients were treated with partial or radical nephrectomy by one urologist. Creatinine clearance (CrCl) measurements were prospectively obtained by 24-hr urine collection preoperatively, and at 3, 6, and 12 mo postoperatively. Mean change in creatinine clearance from baseline was compared at 3, 6, and 12 mo. Serum creatinine and Cockcroft-Gault calculations were also performed for comparison.

Mixed model analysis incorporating patient and tumor characteristics and the procedure type was performed in SAS Version 9.1.

Results: Sixty-three consecutive patients were enrolled in this study. The partial nephrectomy ($n = 26$) and radical nephrectomy ($n = 37$) groups were similar with respect to age, sex, presence of hypertension, vascular disease, diabetes mellitus, and angiotensin converting enzyme inhibitor or receptor blocker use. The postoperative change in creatinine clearance was significantly less (p-value < 0.0001) in the partial nephrectomy group (−0.09 mL/s, −6.1%) compared to the radical nephrectomy group (−0.56 mL/s, −31.6%). Linear regression analysis showed intervention type (partial vs. radical nephrectomy) was the most significant predictor of change in creatinine clearance (p-value < 0.0001).

Conclusions: There is significantly less deterioration in the overall renal function of patients who are treated with partial nephrectomy compared to radical nephrectomy. This highlights the importance of performing nephron-sparing surgery on appropriate patients.

Abbreviations: CrCl, Creatinine Clearance; eGFR, estimated Glomerular Filtration Rate; Cr, Serum Creatinine; NSS, Nephron Sparing Surgery; PN, Partial Nephrectomy; RN, Radical Nephrectomy; NSAID, Non-Steroidal Anti-Inflammatory Drugs; ACEI, Angiotensin Converting Enzyme Inhibitor; ARB, Angiotensin Receptor Blocker; CT, Computed Tomography; GFR, Glomerular Filtration Rate.

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1. Introduction

Surgical extirpation with radical or partial nephrectomy remains the preferred management for solid or complex cystic renal masses. In appropriate patients, it has been found that oncologic outcome is equivalent between radical and partial nephrectomy, and the incidence of adverse surgical events is similar [1–4]. As favorable outcome and safety data mature, urologists have become more aggressive in sparing kidneys which contain large tumors in patients who have a normal contralateral kidney.

Furthermore, ubiquitous use of, and improvement in, abdominal imaging modalities such as computed tomography has resulted in an increase in the detection of incidental small renal masses that now account for 60%–70% of all diagnosed renal masses [5]. These small renal masses are thought to be ideal candidates for nephron-sparing surgery. However, recent population-based studies have revealed, somewhat surprisingly, that radical nephrectomies were being performed on the great majority of patients (92% to 96%), and up to 80% of those tumors that may be amenable to partial nephrectomy [6–8]. These findings are concerning, as several studies have shown that patients who undergo partial nephrectomy have better renal function and are less likely to require renal replacement therapy [9–12]. These studies evaluated renal function using serum creatinine or calculated glomerular filtration rates (GFR), which have been shown to underestimate true kidney function and are less accurate when compared to measured creatinine clearance by 24-hr urine collection [13,14]. In this study, we compare renal function in patients who have undergone a partial or radical nephrectomy using 24-hr urine creatinine clearance, considered a superior measure for renal function estimation over the use of serum creatinine alone or GFR estimate equations.

2. Methods

Between November 2003 and November 2006, 81 consecutive patients with solid enhancing renal masses suspicious for renal cell carcinoma (RCC) were treated by a single urologic oncologist at our institution. Patients presenting with a solitary renal mass and a normal contralateral kidney were enrolled in a prospective internal review board (IRB) approved study. Patients were excluded if they had a solitary kidney, bilateral renal tumors, were on dialysis preoperatively, or had a diagnosis of renal artery stenosis. Other exclusion criteria were noncompliance with 24-hr urine collection or follow-up, postoperative NSAID use for greater than 1 wk, postoperative use of gentamicin, intravenous contrast within the first 3 mo, or postoperative shock.

Treatment with radical (RN) or partial nephrectomy (PN) was selected at the discretion of the treating surgeon. Laparoscopic or open radical nephrectomy was deemed necessary or preferred in patients with large or extensive tumors and in those with suspected lymph node involvement. Patients with tumors less than 4 cm and those with impaired renal function were predominantly treated with open partial nephrectomy.

Partial nephrectomy was performed using an open retroperitoneal approach. Cold ischemia was employed in all partial nephrectomy cases by clamping the renal vessels and packing the kidney with ice for 10 min prior to tumor excision. Radical nephrectomy was performed by either an open retroperitoneal approach or laparoscopic transperitoneal approach.

Patients' baseline demographic information was collected, including age; sex; presence of hypertension, vascular disease, and diabetes; use of angiotensin converting enzyme inhibitors (ACEI) or receptor blockers (ARB); and tumor size, histology, and stage.

Renal function evaluations were performed preoperatively and at 3, 6, and 12 mo postoperatively. Creatinine clearance (CrCl) measurements were obtained in all patients who met the inclusion criteria by 24-hr urine collection (CrCl = (24-hr urine creatinine $\times$ 24-hr urine volume)/(serum creatinine $\times$ 86400 s/day)). Routine blood work, including serum creatinine (Cr), was also collected at the same intervals for comparison. Cockcroft-Gault calculations of estimated glomerular filtration rate (eGFR) were also performed.

The mean change in 24-hr urine CrCl and eGFR was calculated for each procedure type and compared using a standard t-test. Linear regression multivariate analysis using average postoperative CrCl as the dependent variable and incorporating the recorded patient and tumor characteristics as well as procedure type was performed in SAS Version 9.1 (SAS Institute Inc., Cary, NC) to show the effect of individual risk factors on renal function. To account for correlation in responses within each patient, the spatial power covariance structure in SAS proc mixed was used.

3. Results

Of the 81 patients who underwent a radical or partial nephrectomy during the study period (Fig. 1), 18 patients were excluded. Eight patients in the RN group and 10 patients in the PN group were excluded. Sixty-three consecutive patients who had two kidneys, had unilateral tumor involvement, and were not dialysis dependent had preoperative CrCl measured by 24-hr urine collection available for analysis. Of 26 patients in the PN group, 24 patients had 3-mo follow-up, 19 had 6-mo follow-up, and 21 had 12-mo follow-up. Of 37 patients in the RN group, 35 patients had 3-mo follow-up, 29 had 6-mo follow-up, and 33 had 12-mo follow-up.

Preoperative risk factors were similar between the two groups (Table 1); however, the PN group had worse preoperative creatinine clearance measured