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# Renal Cortical Neoplasms and Associated Renal Functional Outcomes

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## 1. Introduction

In 2010 alone there were an estimated 54,000 new diagnoses and 12,000 deaths attributable to renal cell carcinoma (RCC), with the vast majority of these tumors consisting of small renal masses incidentally detected on cross-sectional imaging. (2010; Chow, Dong, and Devesa, 2010) Renal cortical tumors include a complex family of neoplasms with unique histology, cytogenetic effects, and metastatic potential; the differential presentation of symptomatic, locally advanced disease as opposed to small renal tumors (median tumor size <4cm, T1a) evokes different management paradigms. (Lee et al., 2010; McKiernan et al., 2002b; Mitchell et al., 2006; Russo et al., 2002) This large subcategory of patients with localized RCC have historically been treated with radical nephrectomy, and this management has continued in many regions of the United States and the world. (Hollenbeck et al., 2006) Nevertheless, a paradigm shift has occurred in the surgical management of renal cortical tumors over the last 10 years, favoring nephron-sparing surgery or partial nephrectomy whenever this approach is feasible from a technical and oncologic standpoint. The rationale underpinning this shift has involved the observed *non-inferiority* in terms of cancer control and operative morbidity as well as the *superior* renal functional outcomes. Within the nephrology and urology communities, the last decade has also witnessed an increased understanding of how renal volume affects renal function, and how this in turn affects cardiovascular competence. It is now evident that having less renal parenchyma does not only worsen renal function, but it also is a poor prognosticator of cardiac function and overall survival. It is within this context that a review of renal functional outcomes following surgery for renal cortical tumors can be undertaken.

## 2. Renal cancer: Changing epidemiology

Approximately 75-80% of patients in the United States with renal cancer are now diagnosed incidentally and with organ-confined disease. This shift is largely attributable to the increasing use of cross-sectional imaging with the utilization of CT and MRI increasing by 73% during 1986-1994 among the Medicare population. Furthermore, depending on the histologic sub-type, the prognosis ranges from 75-100% of patients achieving long-term survival, and an estimated 30% of patients over 70 years of age dying of unrelated causes within 5 years of surgery for a renal cortical neoplasm. (Jewett and Zuniga, 2008) The increased incidence and detection of these cancers is largely due to the diagnosis of small

localized renal lesions, many of which have low metastatic potential. This finding is reflected in the fact that mortality as a result of renal cancer has not changed over time despite the increased incidence. (Figure 1)

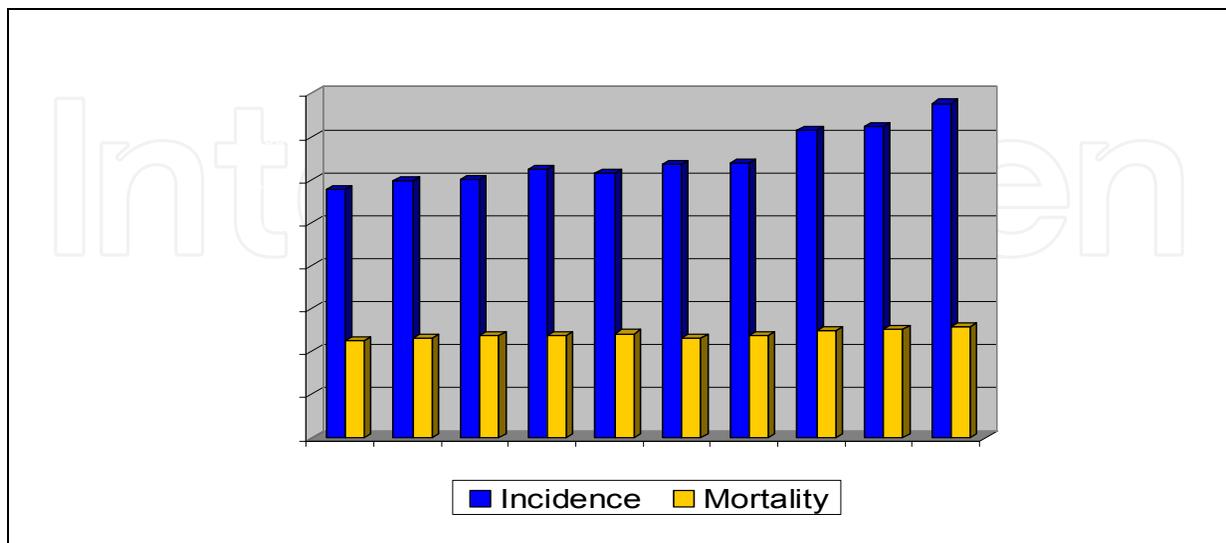


Fig. 1. Trends in Renal Cancer Over Time, American Cancer Society, Facts & Figures, 1997-2006

In parallel with the impetus underlying the increased detection of renal neoplasms, the detection of benign renal lesions, defined chiefly as oncocytoma, angiomyolipoma, and simple renal cysts, has also increased. In fact, a contemporary review of the Columbia University experience identified 775 patients with a tumor diameter of less than or equal to 7.0 cm. Of these patients the proportion of patients undergoing renal surgery for benign tumors increased annually: 5% before 1998, 15.2% from 1998-2003, and 21.2% from 2004 to 2007. The mean tumor diameter was found to decrease significantly during the study period ( $p=0.006$ ) and year of surgery and tumor diameter were found to be independent predictors of benign histologic features ( $p<0.05$ ). (Murphy et al., 2009)

This combination of observations thus underscores the changing phenomenology of renal cortical lesions, as an increase in the use of cross-sectional imaging has resulted in a higher proportion of patients with incidentally detected small renal masses and in turn the clinical recognition of benign renal pathology.

### 2.1 Renal cortical tumors: Heterogeneous presentations and oncologic implications

Renal cortical tumors are members of a complex category of histologic entities which includes the benign oncocytoma, the indolent papillary and chromophobe carcinomas, and also the potentially aggressive clear cell carcinoma. While published urological series consist predominantly of small, localized renal masses, approximately 90% of the medical oncology series reporting metastatic renal cancers consist of tumors of conventional clear cell histology. In fact, a retrospective review by McKiernan et al featured 246 consecutive partial nephrectomy specimens, and characterized the relative distribution of histologic subtypes in small renal masses. (McKiernan et al., 2002b) Within this series from Memorial Sloan Kettering Cancer Center, the most frequent finding was conventional clear cell carcinoma in 148 cases (51%), followed by papillary carcinoma in 54 (18%), oncocytoma in 32 (11%), and chromophobe in 21 (7%).

The World Health Organization (WHO)/ Heidelberg classification subdivides renal cell tumors into benign and malignant neoplasms based on documented genetic abnormalities. (Kovacs et al., 1997) In fact, studies focusing on sporadic and hereditary forms of renal cancer have suggested that abnormalities in the von Hippel-Lindau (chromosome 3p) and *met* genes are among the earliest alterations in conventional clear cell and papillary renal cancers, respectively. Table 1 highlights the major chromosomal alterations that have been implicated in different renal cortical neoplasms.

Histological Subtype	Early Genetic/ Molecular Defects	Late Genetic/ Molecular Defects	Associated Syndromes
Conventional	LOH 3p Mutation of 3p25 (VHL)	+5p -8p, -9p, -14q P53 mutation C-erB-1 Oncogene	Von Hippel-Lindau Sporadic RCC Hereditary RCC
Papillary	+7, +17 -Y Met gene mutation	+12, +16, +20 -9p, -11q, -14q, -17p, -21q PRCC-TFE3 gene fusion	Hereditary Papillary (HPRC) Sporadic Papillary
Chromophobe	-1	-1p, -2p, -6p, -13q, -21q, -Y p53 Mutation	
Collecting Duct	-18, -Y	-1q, -6p, -8p, -11, -13q, -21q C-erB-1	Renal Medullary Carcinoma
Oncocytoma	-1, -Y, 11q rearrangement		Familial Oncocytoma

Table. 1. Genetic Findings in Renal Carcinoma Subtypes. Zambrano et al. *J Urol* 1999; 163 (4): 1246-58 adapted by P. Russo, MD.

Later work demonstrated that pathologic tumor diameter may be useful in the prediction of conventional subtype in small renal cortical lesions. One retrospective review involved 393 patients who underwent radical or partial nephrectomy at one institution; logistic regression analysis demonstrated that for every 1cm increase in tumor diameter up to 4cm, the renal cortical lesion was 1.27 times more likely to be conventional clear cell ( $p=0.020$ ). (Laudano et al., 2008) These findings were extrapolated to show that a 4cm renal cortical tumor was approximately 2 times more likely to be conventional clear cell than tumors 0.6-1.5cm in size. (Figure 2)

### 3. Partial nephrectomy is the standard of care for small renal masses (T1a)

Radical nephrectomy became the standard of care for renal cortical neoplasms approximately 40 years ago. In the 1980s this approach was challenged by reports demonstrating favourable results of partial nephrectomy in imperative cases (i.e. cases in which nephron-sparing surgery was mandatory to conserve adequate renal function such as in patients with a solitary kidney). (Novick et al., 1989; Zincke et al., 1985) During the last 10 years partial nephrectomy

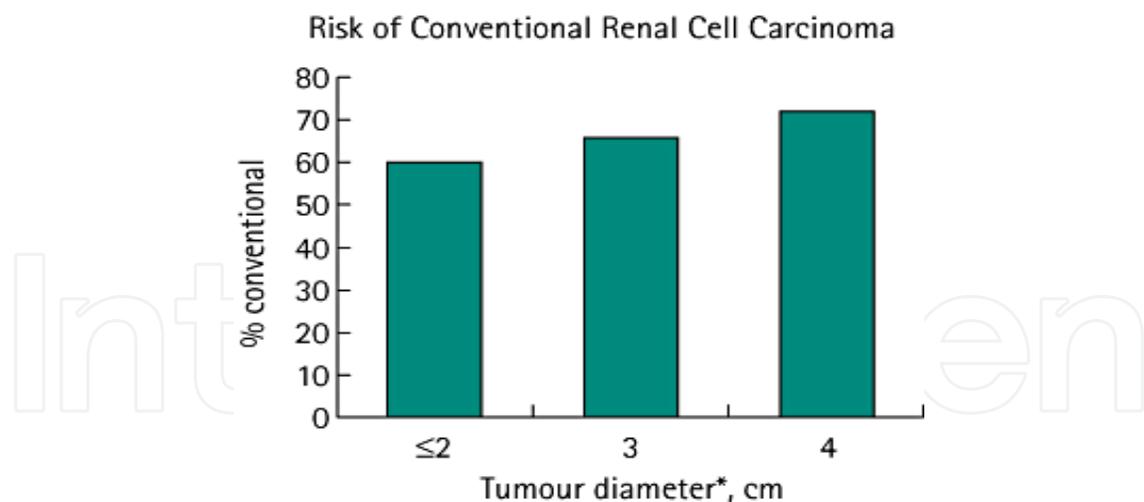


Fig. 2. The percentage of conventional clear cell renal carcinomas based on largest tumor diameter (\*rounded to the nearest cm). Laudano et al. *BJU Int.* 2008; 102 (10): 1385-8.

has become the standard of care for the management of most small renal masses even in the presence of a normal contralateral kidney.(Becker et al., 2006b; Huang et al., 2006; Patard et al., 2004; Thompson et al., 2005) In addition to the benefits of preserving renal function and preventing cardiovascular complications, topics discussed in detail in the ensuing sections, evidence strongly supports the notion that cancer control and risk of cancer-related death are not compromised when a partial nephrectomy is performed instead of a radical procedure.(Dash et al., 2006; Leibovich et al., 2004)

Although data from the National Cancer Institute SEER program demonstrated that partial nephrectomy was underutilized at the beginning of this century (2000-2002), with only 20% of patients with tumors 2-4cm in size receiving this procedure, these rates are changing in favour of a nephron-sparing approach.(Hollenbeck et al., 2006; Miller et al., 2006) In fact, a retrospective review of 1,533 patients treated with partial or radical nephrectomy between 2000-2007 at Memorial Sloan Kettering Cancer Center reported that nephron-sparing surgery was performed in approximately 90% of patients with T1a tumors.(Thompson et al., 2009) A similar analysis at the national level is documented in Figure 3, demonstrating that the use of partial nephrectomy is increasing, albeit at a relatively modest rate, with 66% of patients presenting with a renal cortical tumor  $\leq 2$ cm in size receiving a partial nephrectomy in 2007.

### 3.1 Partial nephrectomy is increasingly being utilized in medium-sized tumors (T1b)

The current size determination for renal tumors that forms the basis for the 2010 TNM staging classification was founded on the basis of several studies demonstrating improved survival in patients undergoing surgery for tumors less than 4cm as opposed to those that exceeded this dimension.(Gofrit et al., 2001; Hafez, Fergany, and Novick, 1999) More contemporary analyses have shown that regardless of the form of surgical intervention, namely partial or radical nephrectomy, patients with tumors larger than 4cm have a higher risk of relapse.(Lau et al., 2000; Lesage et al., 2007; Margulis et al., 2007; Mitchell et al., 2006; Zini et al., 2009) On the basis of these precedents, there has been a clear impetus to determine whether elective nephron-sparing surgery may be an option for patient with localized T1b (4-7cm) tumors.

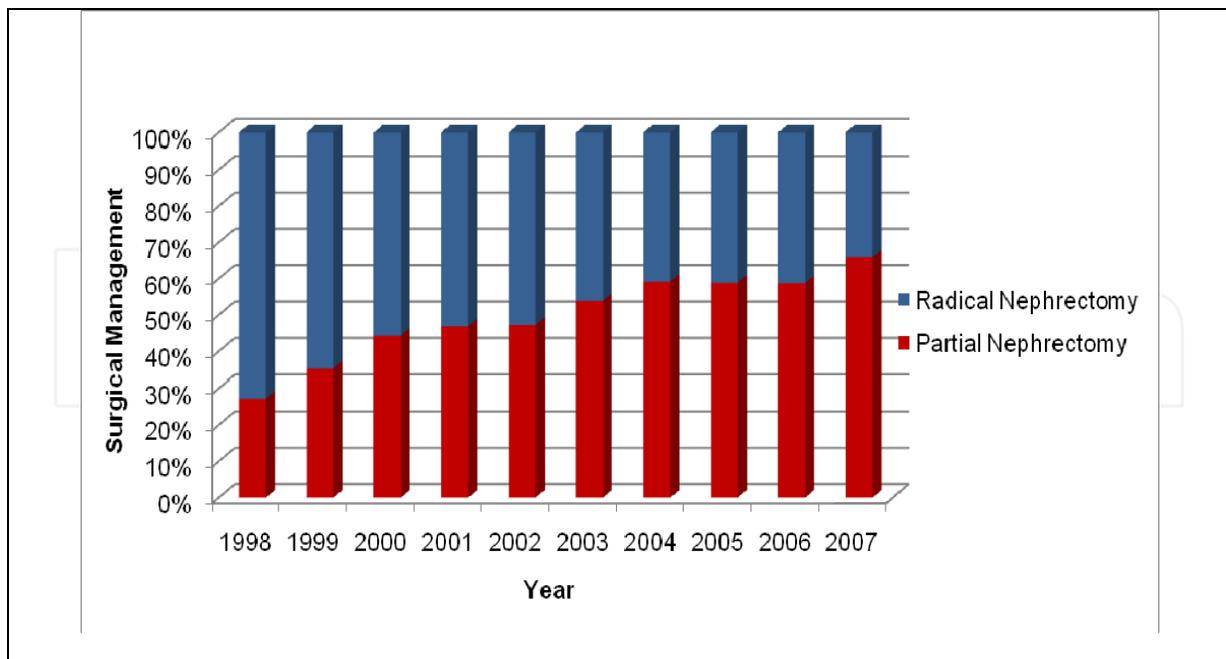


Fig. 3. The Current Standard of Care for the Treatment of Tumors  $\leq 2$ cm based on Surveillance, Epidemiology, and End Results (SEER) estimates. The use of PN steadily increased over the study period, from 27% of all cases in 1998 to 66% in 2007. Kates et al. *J Uro* 2011 *IN PRESS*.

In fact, several antecedent investigations have indicated partial nephrectomy can safely be expanded to include patients with T1bN0M0 tumors.(Becker et al., 2006a; Kim et al., 2010; Mitchell et al., 2006; Patard et al., 2004) Leibovich and colleagues reported cancer-specific survival rates at 5 years of 98% for those receiving nephron-sparing surgery and 86% for patients treated with radical nephrectomy; and, after adjusting for several covariates including tumor grade and histologic subtype, this difference was found to no longer be statistically significant (risk ratio 1.60, 95% CI 0.50-5.12,  $p=0.430$ ). (Leibovich et al., 2004) In a similar vein, Patard et al noted that 3 year disease-specific survival rates were comparable at 98% and 97% ( $p=0.8$ ) when partial nephrectomy patients were stratified by tumor size less than and greater than 4cm, respectively.(Patard et al., 2007) Last, recent work has expounded upon these findings as it pertains to the laparoscopic management of T1bN0M0 tumors, documenting comparable cancer-specific mortality (3% vs 3%) and recurrence rates RN 3% vs PN 6%, ( $p=0.40$ ) for both procedures over a median follow-up of 57 months.(Simmons, Weight, and Gill, 2009) These studies thus set the precedent that nephron-sparing surgery is a viable option from an oncologic standpoint in an appropriately selected subset of patients with a medium-sized tumors when treated at centers experienced with these techniques.

Last, a subsequent investigation by Badalato et al. extended these findings regarding nephron-sparing surgery for T1b patients to the population level, utilizing data from the Surveillance, Epidemiology, and End Results (SEER) registry.(Badalato et al., 2011) Using propensity scoring, a statistical test that controls for measured variables between partial and radical nephrectomy cohorts, this study determined that no overall survival difference was noted within a matched cohort of pT1bN0M0 patients treated with either surgical alternative. (Figure 4) These findings thus lend support to the aforementioned growing

body of evidence that partial nephrectomy may become the preferred management alternative for T1b renal tumors.

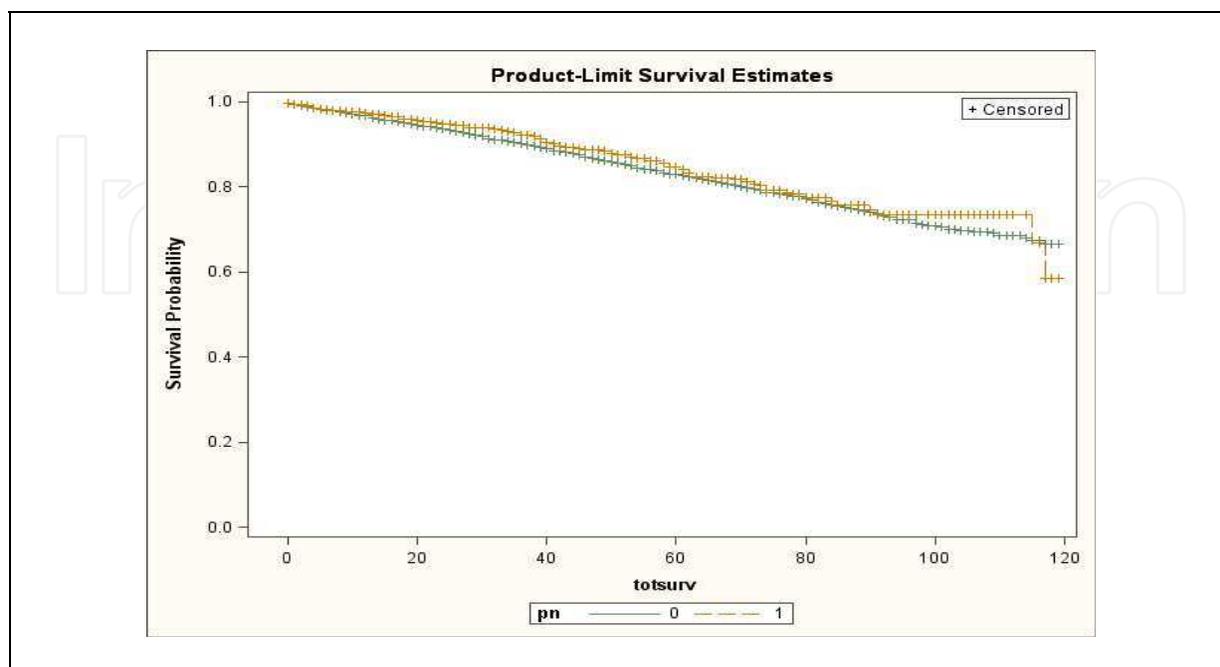


Fig. 4. Overall survival in a propensity-matched cohort of SEER patients receiving partial versus radical nephrectomy. For the entire cohort, there was no difference in survival when groups were divided based on surgical treatment. Badalato et al. *BJU Int.* 2011 *IN PRESS*

#### 4. Renal tumor patients may have unrecognized medical renal disease before intervention

Patients with renal tumors are not a screened population and tend to be older (mean age 61 years) with cardiovascular comorbidities. Accordingly, clinical and pathological evidence has shown that this population of patients has a greater degree of underlying renal disease than previously appreciated. (Bijol et al., 2006; Kaplan et al., 1975) In fact, a retrospective cohort study of patients with small renal tumors by Huang et al. showed that 26% of their patients with T1a RCC and normally functioning kidneys had pre-existing chronic kidney disease (CKD), defined as GFR <60 mL/min per 1.73 m<sup>2</sup>. (Huang et al., 2006)

The most common renal diseases found in patients with renal tumors are due to hypertension and diabetes. Bijol and colleagues reported that up to 60% of nephrectomy specimens show features of renal disease, most of which are due to changes from hypertension or diabetes. (Bijol et al., 2006) Other causes of renal disease include smoking, glomerulonephritis, cystic kidney diseases, congenital malformations, immune diseases, obstruction, and infection.

Moreover, many of the risk factors that are implicated in the pathogenesis of renal disease overlap with the risk factors that contribute to renal cell carcinoma. For example, although the pathophysiologic mechanism for this relationship is still unclear, there is a progressive increase in the risk of renal cell carcinoma in correlation with worsening hypertension. (Chow, Dong, and Devesa, 2010; Schlehofer et al., 1996; Setiawan et al., 2007) With regard to diabetes, the pre-surgical incidence of this disease ranges from 6.8% to 23%. (Hepps and

Chernoff, 2006; Lindblad et al., 1999; Schlehofer et al., 1996) Since diabetic nephropathy affects approximately one-third of patients with this condition, it is reasonable to extrapolate that a significant proportion of patients diagnosed with a renal cortical tumor will have pre-existing diabetic nephropathy. Last, smoking is another well-known risk factor prevalent within the population that contributes to an increased risk for the development of both renal disease and renal cell carcinoma. (Ejerblad et al., 2004; Hunt et al., 2005)

Recent evidence by Donin et al. also demonstrated renal tumor diameter independently predicted decreased preoperative estimated GFR when controlling for hypertension and race on multivariable analysis. (Donin et al., 2011) This study thus suggests that the growth of a renal neoplasm and perhaps the replacement of healthy renal parenchyma independently modulates renal functional deterioration to some degree.

Cumulatively, the presence of underlying renal disease in patients diagnosed with a renal cortical neoplasm is significant because renal function plays an important role in the surgical management and overall survival associated with management. Therefore, it remains prudent to be aware of the risk of underlying renal disease in patients with RCC.

#### 4.1 Chronic kidney disease poses and independent risk factor for cardiovascular-related death

Approximately 26 million adults in the United States have CKD. CKD is most commonly seen among African-Americans, Hispanics, Pacific Islanders, Native Americans, and the elderly. The National Kidney Foundation, American Heart Association, and the Seventh Joint National Committee on prevention, Detection, Evaluation, and Treatment of High Blood Pressure deemed CKD as an independent risk factor for cardiovascular disease.(2002; Chobanian et al., 2003; Sarnak et al., 2003) Similarly, cardiovascular disease is the leading cause of morbidity and mortality among patients with CKD.

The criteria for CKD is defined by The National Kidney Foundation - Kidney Disease Outcomes Quality Initiative (NKF-K/DOQI) workgroup (See Table 2).

<b>Criteria</b>
<p>1. Kidney damage for <math>\geq 3</math> months, as defined by structural or functional abnormalities of the kidney, with or without decreased GFR, manifest by <i>either</i>:</p> <ul style="list-style-type: none"> <li>• Pathological abnormalities; or</li> <li>• Markers of kidney damage, including abnormalities in the composition of the blood or urine, or abnormalities in imaging tests</li> </ul>
<p>2. GFR <math>&lt; 60</math> mL/min/1.73 m<sup>2</sup> for <math>\geq 3</math> months, with or without kidney damage</p>

Table 2. Criteria for Definition of Chronic Kidney Disease. *Am J Kidney Dis* 2002 39 (2 Suppl 1), S1-266.

Many studies have provided evidence that renal damage, assessed by markers of renal function such as serum creatinine, GFR, and albuminuria, is an independent risk factor for cardiovascular disease and cardiovascular mortality.

In a study of 1,120,295 patients in the San Francisco Bay Area, Go and colleagues demonstrated a progressively increased risk of death and/or a cardiovascular event as renal function declined. They reported that the adjusted risk of a cardiovascular event increased by 43% with an estimated GFR of 45 to 59 ml/minute/1.73 m<sup>2</sup> (HR 1.4; CI 1.4-1.5) and by 343% with an estimated GFR of less than 15 ml/minute/1.73 m<sup>2</sup> (HR 3.43; CI 3.1-3.8). The presence of proteinuria was also an independent factor that predicted the risk of a cardiovascular event (HR 1.3; CI 1.2-1.3). (Go et al., 2004)

Level I evidence from the Heart Outcomes Prevention Evaluation (HOPE) trial demonstrated that the presence of kidney disease, defined as an increased serum creatinine >1.4 mg/dL and/or microalbuminuria, independently increased the risk of cardiovascular death, myocardial infarction, or stroke (HR, 1.40; CI, 1.16-1.69 for serum creatinine) (HR 1.59; CI 1.37- 1.84 for microalbuminuria). Moreover, compared to patients with neither risk factor, patients with both increased serum creatinine and microalbuminuria were at increased risk of having a cardiovascular death or cardiovascular event (28.6% vs 13.6%); this suggests the additive nature of these risk factors. (Mann et al., 2001)

Cumulatively, the findings from these and similar studies qualify CKD alone as a risk factor for cardiovascular disease.

## 5. Partial nephrectomy preserves renal function

Emerging evidence strongly favors partial nephrectomy (PN), as opposed to radical nephrectomy (RN), for tumors that are 7cm or smaller as the best approach to preserve postoperative renal functional outcomes. The data in support of this position stemmed from early work examining the prevalence and onset of CKD among postoperative renal cancer patients. Then, as now, there is not standardized metric of renal function, although some precise mechanisms of assaying such function have gradually permeated the urologic literature. McKiernan et al published one of the early papers on this subject, selecting a cohort of 290 patients with T1a (<4cm) renal cell carcinoma and a pre-operative serum creatinine of less than 1.5mg/dl and then longitudinally tracking the onset of chronic renal insufficiency (defined in the study as creatinine >2mg/dl) following surgical intervention.(McKiernan et al., 2002a) In fact, at 5 years of follow-up the rate of freedom from CRI was 100% in the partial nephrectomy grouping and 84.8% in the radical nephrectomy cohort. Huang et al. Later validated these findings in a level 2 prospective study using eGFR of less than 60mL/min per 1.73m<sup>2</sup> as the index defining CKD Stage III or greater.(Lane et al., 2010b) In a total of 662 patients with a normal serum creatinine prior to surgery for RCC, freedom from new onset CKD was determined to be 80% after partial nephrectomy as opposed to just 35% following radical nephrectomy.(Huang et al., 2006) (Figure 5) Moreover, after controlling for relevant clinical and pathological differences between surgical groups, patients receiving a radical nephrectomy were found to be a t a four-fold higher risk of having CKD post-operatively as compared to their counterparts undergoing nephron-sparing surgery. These findings were substantiated in similar work using creatinine clearance as an alternative measure of renal function.(Clark et al., 2008)

Despite controversy related to the best metric for renal functional outcomes in the perioperative setting, the fact that partial nephrectomy results in improved long-term renal function compared to radical nephrectomy has continued to be validated in the literature.(Jeon et al., 2009; Lane et al., 2010c; Malcolm et al., 2009; Miller et al., 2008) In fact, although there was initially concern that vascular clamping at the renal hilum during partial

nephrectomy might increase the rate of renal insufficiency due to the prolonged cold ischemia time, clamp time was shown not to be associated with long-term renal functional measures in patients who had a normal renal function at baseline. Yossepowitch et al. went on to demonstrate that in healthy patients with two renal units, renal insufficiency is primarily a transient, postoperative entity.(Yossepowitch et al., 2006) While non-modifiable factors such as preoperative eGFR as well as the amount and quality of the renal parenchyma left in situ may be prognostic of postoperative renal function, there is no level 1 evidence to further inform these notions.(Lane et al., 2011; Thompson and Blute, 2007)

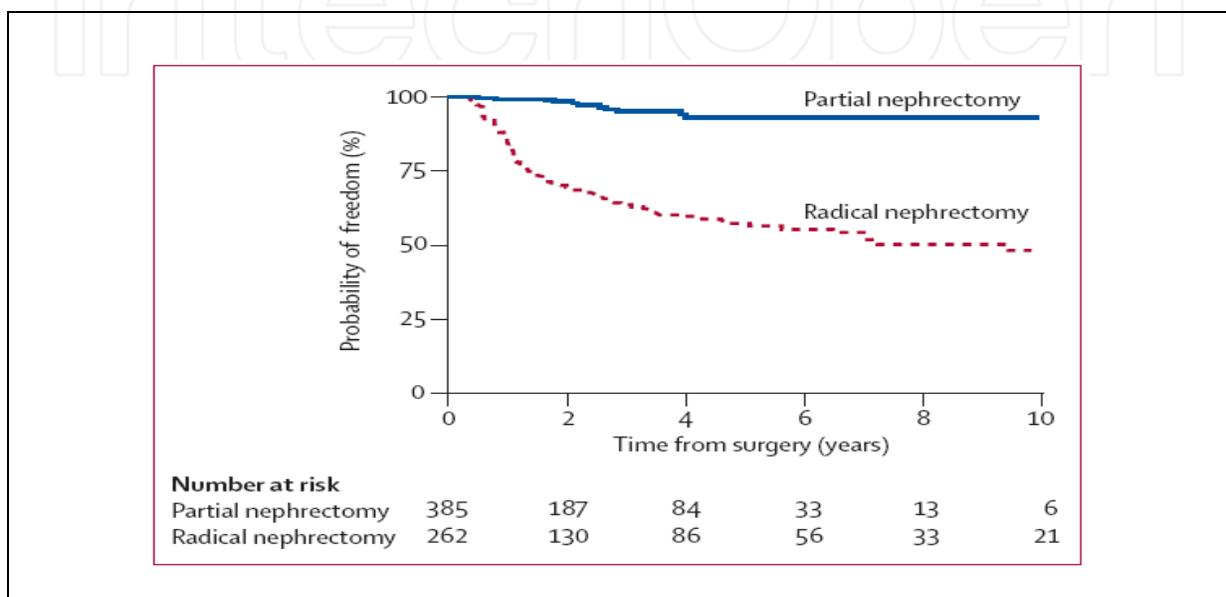


Fig. 5. Probability of freedom from new onset of GFR lower than 45 mL/min per 1.72m<sup>2</sup> by operation type. Huang et al. *Lancet Oncol* 2006; 7: 735-40.

### 5.1 Poor renal functional outcomes following nephrectomy increases the risk of cardiovascular sequelae and death

Several prior studies have demonstrated the increase in non-cancer related deaths among patients undergoing radical as opposed to partial nephrectomy.(Thompson et al., 2008; Weight et al., 2010b) Although it has been postulated that this increase in mortality was attributable to an increased rate of CKD and by extension cardiovascular disease, this theory had not been proven prior to the publication of recent work. In fact, Weight, Novick, and colleagues examined the overall and disease-specific survival outcomes in 1,004 patients with T1b RCC (4-7cm) who underwent either partial or radical nephrectomy. Over a median follow-up period of 4 years, a significantly decreased level of renal function was observed in the radical nephrectomy cohort.(Weight et al., 2010a) Furthermore, this difference in renal function correlated with a 25% increase in the risk of cardiovascular death and a 17% risk of death from any cause. In subsequent work, Huang et al corroborated the results of this single-institution study with a population-level investigation involving Medicare beneficiaries; they found that radical nephrectomy was associated with an increased risk of cardiovascular events and non-cancer mortality within this grouping.(Huang et al., 2009) Table 1 summarizes data that continues to emerge in contemporary work, substantiating the worsened overall and cardiovascular survival associated with radical as compared to nephron-sparing surgery. (Table 2)

Study	Year	Age	Tumor Size	Patients (n)		Overall Death	CV Events/Death
				RN	PN	HR	HR
Thompson [22]	2008	<65	≤4cm	140	187	2.16	—
Huang [25]	2009	>65	≤4cm	2547	556	1.38	1.4
Weight [24]	2010	—	4-7cm	480	525	1.17	1.25
Weight [23]	2010	—	≤7cm	111	388	2.5	—

Table 2. Open series outcomes: Overall and Cardiovascular Mortality. Kates et al. *Curr Opin Urol* 2011 IN PRESS

### 5.1.1 Partial nephrectomy is underutilized, within certain populations: case in point – the elderly

In the seminal articles on post-nephrectomy renal function published by McKiernan et al. and Huang et al., most of the with decompensating function were diagnosed less than 3 years following their initial surgery. (Huang et al., 2006; McKiernan et al., 2002a) Thus the concept of “long-term” benefit from a nephron-sparing approach is a fallacy, as this advantage is noted within a few years following surgical intervention. An older patient, albeit with a shorter life expectancy may thus benefit from a partial nephrectomy. This finding is especially pertinent since it has already been demonstrated that the risk of complication from a partial nephrectomy is no greater for patients over 75 years of age as compared to younger counterparts. (Lowrance et al., 2010) This understanding is especially important due to urologists’ hesitation to perform a nephron-sparing procedure in the elderly – cumulatively a historic disparity which is not substantiated by an evidence-based approach and has persisted to this decade. (Hollenbeck et al., 2006; Kates et al., 2011) (Figure 6) Recently, Lane and colleagues demonstrated that a decline in renal function associated with a radical procedure in patients 75 years of age and older resulted in a corresponding increase in the risk of cardiovascular death. (Lane et al., 2010a) In a cohort of elderly patients with local renal cell cancer 7cm or less, there was no statistically significant difference in survival for those receiving surgery, namely radical or partial nephrectomy, as opposed to those on active surveillance. This finding suggests that no surgery or the proverbial “maximal nephron-sparing procedure” may be indicated for a carefully selected subset of the elderly patient population.

## 6. Preoperative risk stratification schemata

Comprehensive pre-operative risk stratification is important for patients undergoing kidney surgery in order to help approximate the best renal functional outcomes. Remarkably, recent estimates have reported that up to one-third of patients with pre-existing Stage I or II CKD will progress to Stage II (GFR<60). (Clark et al., 2011) Accordingly, several risk factors for the post-operative development of stage III CKD have been well described; chief among them involves having a prior diagnosis of diabetes. (Lane et al., 2011) Composite risk profiles have been well-elucidated to predict a patients’ risk of CKD based on preoperative clinical parameters. One such method is the Screening for Occult Renal Disease (SCORED) tool, a modified example of which is demonstrated in figure 7. This prediction tool utilizes factors such as patient age, gender, and clinical characteristics (such as anemia, proteinuria, and cardiovascular comorbidities) to stratify patient into risk

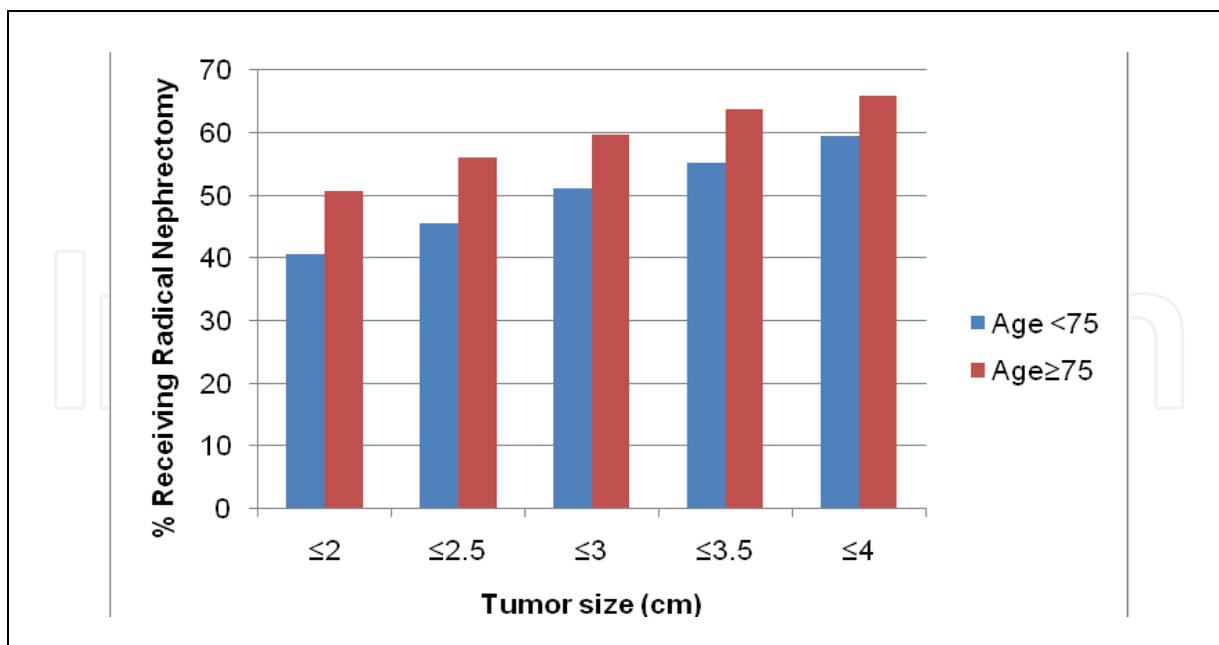


Fig. 6. Percentage of patients receiving radical nephrectomy for T1a RCC between 1998-2007 according to tumor size. A higher percentage of elderly patients consistently receive a radical nephrectomy for a given tumor size. Kates et al. *Urology* 2011 IN PRESS.

**Do You Have Kidney Disease? Take This Test and Know Your Score.**

Find out if you might have silent chronic kidney disease now. Check each statement that is true for you. If a statement is not true or you are not sure, put a zero. Then add up all the points for a total.

- Age:
    - 1. I am between 50 and 59 years of age.....Yes 2 \_\_\_\_\_
    - 2. I am between 60 and 69 years of age.....Yes 3 \_\_\_\_\_
    - 3. I am 70 years old or older.....Yes 4 \_\_\_\_\_
  - I am a woman.....Yes 1 \_\_\_\_\_
  - I had/have anemia.....Yes 1 \_\_\_\_\_
  - I have high blood pressure .....Yes 1 \_\_\_\_\_
  - I am diabetic .....Yes 1 \_\_\_\_\_
  - I have a history of heart attack or stroke .....Yes 1 \_\_\_\_\_
  - I have a history of congestive heart failure or heart failure .....Yes 1 \_\_\_\_\_
  - I have circulation disease in my legs .....Yes 1 \_\_\_\_\_
  - I have protein in my urine.....Yes 1 \_\_\_\_\_
- Total** \_\_\_\_\_

**If You Scored 4 or More Points**

You have a 1 in 5 chance of having chronic kidney disease. At your next office visit a simple blood test should be checked. Only a professional health care provider can determine for sure if you have kidney disease.

**If You Scored 0-3 Points**

You probably do not have kidney disease now, but at least once a year, you should take this survey.

Your total score from SCORED	Probability of having chronic kidney disease now	
	In general healthy individuals	In cardiovascular patients
≤1	<2 %	<6 %
2	<2 %	~10 %
3	2-3 %	10-15 %
4	5-6 %	10-15 %
5	10-15 %	20-25 %
6	15-25 %	~30 %
7	25-35 %	40-45 %
8	35-45 %	45-65 %
≥9	>40 %	>60 %

Fig. 7. Risk assessment chart for CKD using the SCORED model from Bang et al. *Arch Intern Med* 167(4), 374-81.

groupings for the development of CKD. During the course of validating this instrument in the setting of patients with small renal masses undergoing surgery, Lucas et al determined that patients in high risk categories (SCORED $\geq$ 4) were 3 times more likely to develop Stage III CKD.(Bang et al., 2007; Lucas et al., 2008) Other groups have followed suit with the proposal of alternative nomograms. For example, Sorbellini et al have described a mechanism to predict renal insufficiency, which was defined as 2 or more values of a creatinine of 2.0mg/dl at least one month following surgery.(Sorbellini et al., 2006) Nevertheless, while this nomogram accounts for the change in renal volume, it relies on creatinine and does not include known predictors of CKD such as preoperative comorbidity information.

Other systems of risk stratification have looked at the renal parenchyma in and of itself as a tool for predicting postoperative outcomes. Notably, the presence and extent of glomerulosclerosis in normal parenchyma has been shown to be commensurate with deterioration in postoperative renal function, although this trend was not noted for features such as arteriosclerosis or interstitial fibrosis/ tubular atrophy.(Gautam et al., 2010; McCann et al., 2009)

## 7. Conclusion

Among patients diagnosed with a renal cortical neoplasm, those having a radical nephrectomy are at an increased risk for the development of CKD compared to those receiving nephron-sparing surgery or no surgery. In parallel with these findings, the implications of radical nephrectomy and CKD also translate into adverse cardiovascular events and eventual end stage renal disease. Accordingly, in patients presenting with a renal cortical mass, a comprehensive assessment of current and projected renal function is paramount in determining preferred management options.

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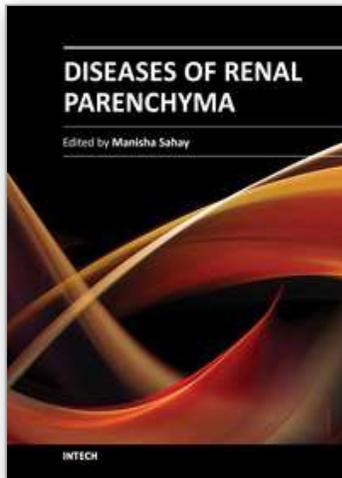
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Clinical nephrology is an evolving speciality in which the amount of information is growing daily. This book gives quick access to some important clinical conditions encountered in nephrology including the diseases of glomeruli, tubules and interstitium. It presents the latest information on pathophysiology, diagnosis and management of important diseases of renal parenchyma. The information is presented in a very user friendly and accessible manner while the treatment algorithms enable the reader to quickly access expert advice on arriving at the most appropriate treatment regimen. The book discusses the renal involvement in various systemic diseases including diabetes and autoimmune diseases. Diabetic nephropathy is fast becoming the commonest cause of end stage renal disease all over the globe and is discussed in this book. The editors believe that this book will be a valuable addition to the reader's library.

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