The Medical and Oncological Rationale for Partial Nephrectomy for the Treatment of T1 Renal Cortical Tumors

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KEYWORDS

- Renal cancer • Partial nephrectomy
- Chronic kidney disease

The medical and oncologic rationale for partial nephrectomy has evolved over the last 10 years and is based on the following factors: an enhanced understanding of renal tumor histology, the proven oncological equivalency of partial and radical nephrectomy for T1 renal cancers, and new concerns regarding chronic kidney disease (CKD) and its potential adverse impact on cardiovascular health and overall survival. Historically, partial nephrectomy was reserved for patients with tumor in a solitary kidney, bilateral renal tumors, or tumor in a patient with underlying medical diseases of the kidney or renal insufficiency. For the last 15 years, the concept of partial nephrectomy for patients with a renal tumor and a normal contralateral kidney (kidney sparing or nephron sparing), has generated increasing acceptance both in the United States and abroad, and, over the last 5 years, has crystallized as the treatment of choice for small renal masses. In this article we discuss the oncological and medical rationale for partial nephrectomy as the treatment of choice whenever possible for T1 (<7 cm) renal tumors.

RENAL CORTICAL TUMORS: A DIVERSITY OF TUMORS AND POTENTIAL THREATS

Renal cortical tumors (RCTs) are members of a complex family with unique histologies, cytogenetic defects, and variable metastatic potentials ranging from the benign oncocytoma, to the indolent papillary and chromophobe carcinomas, to the more malignant conventional clear carcinoma.[1] At our center, Memorial Sloan Kettering Cancer Center (MSKCC), the conventional clear cell tumor accounts for 90% of all metastatic RCTs but only 54% of the renal tumors undergoing resection. Two groups of patients with RCTs currently exist. The first group consists of patients with symptomatic, large, locally advanced tumors often presenting with regional adenopathy, adrenal invasion, and extension into the renal vein or inferior vena cava. Despite radical nephrectomy in conjunction with regional lymphadenectomy and adrenalectomy, progression to distant metastasis and death from disease occurs in approximately 30% of these patients. For patients presenting with isolated metastatic disease, metastasectomy in carefully selected patients has been associated with long-term survival.[2] For patients with diffuse metastatic disease and an acceptable performance status, cytoreductive nephrectomy, compared to cytokine therapy alone, may add several additional months of survival.[3] Cytoreductive nephrectomy also prepares patients for integrated treatment, now in neoadjuvant and adjuvant

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clinic trials, with the new multitargeted tyrosine kinase inhibitors (sunitinib, sorafenib) and mammalian target of rapamycin inhibitors (temsirolimus, RAD001).

The second group of RCTs consists of small renal tumors (median tumor size <4 cm, T1a) often incidentally discovered in asymptomatic patients during imaging for nonspecific abdominal or musculoskeletal complaints or during unrelated cancer care. A greater than 90% survival rate, depending on the tumor histology,[4] is expected following partial or radical nephrectomy. Despite vast improvements in modern CT, ultrasound, and MRI imaging of the kidney, these studies are nonspecific and between 16.4% and 23% of patients undergoing tumor resection are ultimately found to have a benign lesion, including angiomyolipoma, oncocytoma, metanephric adenoma, or hemorrhagic cyst.[5,6] Although CT-guided percutanous renal biopsy can easily be performed, the differentiation between a benign and malignant tumor and the determination of tumor histologic subtypes by current radiological and biopsy techniques alone or in combination is only 70% accurate.[7] Active research to determine if immunohistochemical and cytogenetic techniques can substantially improve the accuracy of RCT percutaneous biopsy is ongoing. An alternative strategy to image the more malignant clear cell carcinoma with a specific radio-labeled antibody that reacts to carbonic anhydrase 9 124I-cG250 is under active investigation and has shown a high sensitivity and specificity in preliminary studies. This immuno–positron emission tomographic scan may play an important role in the future for planning surgeries, selecting for active surveillance, determining the response to novel local and systemic therapies, and evaluating extent of disease.[8]

PARTIAL NEPHRECTOMY IS AS EFFECTIVE AS RADICAL NEPHRECTOMY FOR T1 TUMORS

Contemporary surgical oncology (eg, for breast cancer, soft tissue sarcoma) now favors surgical approaches that preserve organs and limbs whenever possible, and is often used in conjunction with adjuvant therapies, with resulting local tumor control and long-term survival equivalent to their more radical counterparts. Partial nephrectomy, once used only for the essential indications, is now considered a preferred alternative to radical nephrectomy for patients with T1 tumors, normal renal function, and two intact kidneys.[9] Studies from the United States and abroad have shown that partial nephrectomy for tumors of 4 cm or less provides equivalent tumor control compared with radical nephrectomy.[10,11] Previous deterrents to partial nephrectomy, including proximity to collecting system or major segmental vessels, endophytic tumor location, concern for tumor multifocality, and the desire for a 1-cm surgical margin, are now routinely managed effectively in the operating room. Tumor localization using intraoperative ultrasound for endophytic and multifocal tumors,[12] suture repair of the collecting system and blood vessels, and closed suction retroperitoneal drainage, has made open partial nephrectomy a highly effective operation. Complication rates are less than 10% and mostly relate to prolonged urinary fistula with only the rare need for reoperation or endoscopic interventions.[13] Renoprotective measures of ice slush and mannitol seem effective in limiting damage to the kidney with normalization of renal function by 12 months postoperatively. Prolonged ischemia time, increasing blood loss, and partial nephrectomy in a solitary kidney, all indicators of a more challenging operation, are associated with early declines in glomerular filtration rate (GFR) but not long-term damage.[14] It is our practice to perform partial nephrectomy with no ischemia (no renal artery cross-clamping) whenever possible to limit potential glomerular damage, which may not be detectable by serum markers or formulas that estimate kidney function. If renal artery clamping is required to limit blood loss during the resection of a large tumor or an endophytic tumor, mannitol (12.5 gm/250 mL of saline) and ice slush are routinely used with every attempt to limit cold ischemia to less than 30 minutes. In addition, careful visual inspection of the kidney and the use of intraoperative ultrasound address the small likelihood (<5%) of a previously unrecognized tumor satellite, which can also be excised at the same operation.[15]

Recent studies have demonstrated that gross resection of all tumors, as assessed by the operating surgeon, even in the presence of only microscopically negative surgical margins, provides excellent local tumor control without an increased risk of local tumor recurrence and without the need for a 1-cm margin of surrounding renal parenchyma. One-centimeter margins are easily achievable goal for an exophytic tumor, but often not technically feasible for a renal sinus tumor, a juxtahilar tumor, or an intraparenchymal tumor. Complete resection of RCTs in these less-accessible locations increases the percentage of patients eligible for kidney-sparing operations and renders an excellent prognosis with a high likelihood (>90%) of freedom from local, regional, and metastatic recurrence,[16] particularly because a significant percentage of patients with central tumors have indolent or benign histology (30.2%).[17] In the event of a positive microscopic surgical margin on final pathology, previous recommendations for a "completion" radical nephrectomy appear unnecessary. In recently published study of 1344 partial nephrectomies from MSKCC and the Mayo Clinic, 77 patients (5.5%) were found to have positive surgical margins on final pathology. This was more likely to occur during the resection of a tumor in a solitary kidney or one in a technically challenging location. Although the surgeon should make every effort to achieve a complete resection at the time of a partial nephrectomy, a final pathologic positive surgical margin was not associated with an increased likelihood of local tumor recurrence or metastatic disease.[18]

Partial nephrectomy has been safely extended to tumors of 7 cm or less, when technically feasible, with disease-free intervals equivalent to those in similar patients treated with radical nephrectomy across all histologic subtypes.[9,11] MSKCC investigators compared the results of 45 patients undergoing partial nephrectomy to 151 patients undergoing radical nephrectomy (22 of whom were originally slated to have a partial nephrectomy but were converted to radical nephrectomy) for T1b (4–7 cm) conventional clear cell carcinomas. Disease-free survival between the groups were no different, but the serum creatinine levels, a relatively crude indicator of overall renal function, were substantially better in patients undergoing partial nephrectomy at 3, 6, and 12 months.[19]

Clinical local recurrence in the partial nephrectomy bed is a rare event (<1%) and is often associated with a grossly positive surgical margin at the time of the initial resection, which is more likely to occur in patients with multifocal tumors or a large tumor in a solitary kidney. A recent publication from Pahernik and colleagues[20] from Mainz, Germany, confirmed the oncological efficacy of partial nephrectomy in tumors larger than 4 cm. New tumor formation in the operated kidney is an uncommon event, occurring at a lifetime risk, in the absence of familial or hereditary syndromes, in less than 5% of patients.[14] Following either partial nephrectomy or radical nephrectomy, the contralateral kidney also retains a lifetime risk of approximately 5% for the development of new tumor formation necessitating lifelong surveillance.[21] At some finite point, likely measured in years, the risk of a new ipsilateral or contralateral tumor formation exceeds the risk of metastatic disease development from the index tumor. In any case, long-term surveillance with a yearly renal imaging study (CT, ultrasonography, or MRI) and chest radiograph (for clear cell, chromophobe, papillary renal cancer, but not benign oncocytoma or metanephric adenoma) to assess local or systemic recurrence is recommended. With this approach, disease-free survival rates of greater than 90% are achieved using partial nephrectomy for T1 RCTs across all histologic subtypes.[22]

KIDNEY TUMOR PATIENTS AND UNRECOGNIZED MEDICAL RENAL DISEASE

A historical misconception is that radical nephrectomy, although likely to cause a detectable and permanent rise in serum creatinine because of the sacrifice of normal renal parenchyma not involved by tumor, will not cause serious long-term side effects as long as the patient has a normal contralateral kidney. The renal transplant literature is often cited as the clinical evidence to support this view since patients undergoing donor nephrectomy have not been reported to have higher rates of kidney failure requiring dialysis or resulting in death.[23] However, distinct differences between renal donors and renal tumor patients exist. Donors tend to be carefully selected, screened for medical comorbidities, and are generally young (age 40 or less).[24,25] In contrast, renal tumor patients are not screened, are older (mean age 61 years), and often have significant comorbidities that can affect kidney function, including metabolic syndrome, hypertension, obesity, vascular disease, and diabetes, alone or in combination. As patients age, particularly beyond the age of 60, nephrons atrophy and GFRs progressively decreases.[26]

A recent clinical and pathologic study from the Harvard Medical School examined the non–tumor-bearing kidney of patients undergoing resection of RCTs and demonstrated a far greater degree of unsuspected underlying renal disease in kidney tumor patients than previously appreciated.[27] The nonneoplastic renal tissue in 110 nephrectomy specimens, including 67 clear cell carcinomas of which 39 were less than 5 cm, were correlated to the patient's clinical history. Only 10% of patients had completely normal adjacent renal tissue and 28% were found to have vascular sclerotic changes. In the remaining 62% of cases, evidence of significant intrinsic renal abnormalities, including diabetic nephropathy, glomerular hypertrophy, mesangial expansion, and diffuse glomerosclerosis, was noted. In this study, 91 patients (83%) underwent radical nephrectomy for the treatment of their tumors. This study indicates that the loss of functional nephrons during radical nephrectomy, coupled with pre-existing renal diseases, which may or may not be clinically apparent but is present at the pathologic level in the vast majority of patients, causes the worsening of overall renal function.

CHRONIC KIDNEY DISEASE IS AN INDEPENDENT RISK FACTOR FOR CARDIOVASCULAR DISEASE

CKD is increasingly viewed as a major public health problem in the United States. Currently it is estimated that there are 19 million adults in the United States in the early stages of CKD and that by the year 2030, 2 million will be in need of chronic dialysis or renal transplantation.[28] CKD is defined as a GFR of less than 60 mL/min/1.73m^2. Traditional risk factors for CKD include age greater than 60, hypertension, diabetes, cardiovascular disease, and family history of renal disease. The prevalence and incidence of kidney failure requiring either dialysis or renal transplantation have increased from 1988 to 2004. Also, a significant trend has been a 10% increase in the prevalance of earlier stages of CKD, as indicated by decreased GFR, increased proteinuria, or both. These findings were determined by the National Health and Nutrition Examination Surveys, which compared 15,488 adults from 1988 to 1994 to 13,233 adults from 1999 to 2004. A higher rate of diabetes and hypertension during a later time frame in the United States is thought to be responsible for the increase in earlier stages of CKD.

Recommendations for assessing patients at increased risk for CKD include measurement of urine albumin and estimation of GFR using equations based on the level of serum creatinine.[29] In 2003, the National Kidney Foundation; the American Heart Association; and the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure classified CKD as an independent cardiovascular risk factor.[30–34] Certain serum factors, including elevated inflammatory and prothrombotic factors (C-reactive protein, fibrinogen, IL-6, and IL-8) and decreased hemoglobin levels and lipoprotein A may mechanistically contribute to the elevated cardiovascular risk. Therefore, medical interventions designed to modify well-known traditional risk factors, such as systolic blood pressure greater than 140 mm Hg, diabetes, cigarette smoking, high-density lipoprotein less than 40, low-density lipoprotein more than 130, body mass index over 30, physical inactivity, and left ventricular hypertrophy, may be effective in reducing the cardiovascular mortality risk in CKD.

Two widely used formulas, the Modification in Diet and Renal Disease (MDRD) equation and the Cockcroft-Gault equation, are superior to serum creatinine alone in estimating the GFR.[29] These formulas have been extensively evaluated in populations of patients, including blacks, whites, and Asians; people with and without diabetes or kidney disease; and transplant donors. Both equations are more accurate in evaluating kidney function in patients with CKD, as opposed to younger patients, those with type 1 diabetes without microalbuminuria, or healthy potential kidney donors.[35]

An estimated GFR of less than 60 mL/min/1.73 m^2, stage 3 CKD, is associated with a graded increase in the risk of progression to end-stage kidney disease and premature death caused by cardiovascular disease. A clinician can quickly calculate the estimated GFR using a Web site that only requires patient age, sex, race, and serum creatinine (http://www.nephron.com/MDRD_GFR.cgi). In our practice, the routine use of the MDRD equation to estimate GFR has become an essential part of the initial evaluation of the renal tumor patient and is critical for surgical planning and counseling.[36]

The adverse clinical impact of a decline in estimated GFR was reported by investigators at Kaiser Permanente in California who estimated the longitudinal GFR in 1,120,295 patients between 1996 and 2000 who had not undergone dialysis or kidney transplantation. The investigators examined the multivariable association between estimated GFR and the risks of death, cardiovascular events, and hospitalization. The median patient age was 52 years, 55% of the patients were women, and median follow-up was 2.84 years. The risk of death increased as the estimated GFR decreased below 60 mL/min/1.73 m^2 with the adjusted hazard ratios of 1.2 (GFR 45–59 mL/min/1.73 m^2), 1.8 (GFR 30–44 mL/min/1.73 m^2), 3.2 (GFR 15–29 mL/min/1.73 m^2), and 5.9 (GFR <15 mL/min/1.73 m^2) respectively. The adjusted risk of hospitalization followed a similar pattern.[37] The link between CKD and cardiovascular risk factors was also reported by Foley and colleagues,[38] who analyzed data from 15,837 noninstitutionalized adults from 1988 to 1994 in the Third National Health and Nutrition Examination Survey. Data were gathered on nine cardiovascular risk factors (smoking, obesity, hypertension, high total cholesterol, C-reactive protein, glycosylated hemoglobin, homocysteine levels, low hemoglobin, high urinary albumin to creatinine ratio) and estimated GFR. Estimated GFR was greater than 60 mL/min/1.73 m^2 in 93.3% of patients, between 30 and 59 mL/min/1.73 m^2 (stage 3 CKD) in 6.2%, and less than 30 mL/min/1.73 m^2 (stage 4 and 5 CKD) in 0.5%. As kidney function deteriorated, the percentage of subjects with two associated cardiovascular risk factors increased from 34.7% (stage 1 and 2 CKD), to 83.6% (for stage 3), to 100% for stage 4 and 5 subjects. Patients with CKD were far more likely to require medical interventions to treat cardiovascular disease than those with normal renal function. The low prevalence of patients with stage 4 or 5 CKD is attributable to their 5-year survival rates of only 30%.[38]

PARTIAL NEPHRECTOMY PRESERVES RENAL FUNCTION

Data comparing late renal functional and oncological results in over 450 patients undergoing partial nephrectomy or radical nephrectomy for tumors measuring less than 4 cm were first reported from the Mayo Clinic in 2000 and from MSKCC in 2002. The Mayo Clinic study showed that patients undergoing radical nephrectomy were more likely to have serum creatinine levels elevated to more than 2.0 ng/mL and proteinuria.[39] The MSKCC study resulted in similar findings even when study patients were carefully matched for associated risk factors, including diabetes, smoking history, preoperative serum creatinine, and American Society of Anesthesiologists score.[40] In both studies, oncological outcomes were highly favorable (>90% survival rates) whether partial nephrectomy or radical nephrectomy was done. Investigators from MSKCC later created a postoperative prognostic nomogram for renal insufficiency that used percent changes in kidney volume as calculated from CT scans, preoperative serum creatinine, American Society of Anesthesiologists score, patient age, and sex. In this study, serum creatinine of greater than 2 was described as renal insufficiency. The investigators studied 161 patients undergoing partial nephrectomy and 857 patients undergoing radical nephrectomy. A total of 111 patients (10.9%), of which 105 underwent radical nephrectomy (95%), experienced renal insufficiency at a median of 14.4 months following surgery. Using a multivariate analysis, patient age, sex, preoperative creatinine, and percent change in kidney volume were all significant factors associated with freedom from renal insufficiency with preoperative serum creatinine greater than 1.0 contributing nearly 70 points to the nomogram.[41] Skeptics pointed out that these studies failed to demonstrate an increased risk of dialysis in the radical nephrectomy patients but their comments failed to mention the cardiovascular morbidity and mortality associated with CKD for patients not yet requiring dialysis.

MSKCC investigators recently analyzed their partial nephrectomy and radical nephrectomy experience using the MDRD abbreviated formula to estimate GFR in a retrospective cohort study of 662 patients with a normal serum creatinine and two healthy kidneys that underwent either elective partial nephrectomy or radical nephrectomy for an RCT 4 cm or less in diameter. Data was analyzed using two threshold definitions of CKD: a GFR less than 60 mL/min/1.73 m^2 or a GFR less than 45 mL/min/1.73 m^2. To the surprise of the investigators, 171 patients (26%) had pre-existing CKD (GFR <60) before operation despite two intact, normal-appearing kidneys and a serum creatinine within normal limits. After surgery, the 3-year probability of freedom from new onset of GFR less than 60 was 80% after partial nephrectomy but only 35% after radical nephrectomy. Corresponding values for 3-year probability of GFR less than 45, a more severe level of CKD, was 95% for partial nephrectomy and 64% for radical nephrectomy. Multivariable analysis indicated that radical nephrectomy remained an independent risk factor for the development of new-onset CKD.[42] Also, a detectable decline in renal function also occurred in the patients undergoing partial nephrectomy. A recent study from the Mayo Clinic queried their nephrectomy registry between 1989 and 2003 and identified 648 patients treated with radical nephrectomy or partial nephrectomy for a solitary renal tumor less than or equal to 4 cm (excluding perinephric fat, nodal, and distant metastases patients) and a normal contralateral kidney. Overall survival was calculated in 327 patients younger than 65 at the time of operation and it was found that radical nephrectomy was significantly associated with an increased risk of death, which persisted after adjusting for year of surgery, diabetes at presentation, Charlson-Romano index, and tumor histology.[43] These studies, when taken together, raise serious concerns regarding the long-term effects of radical nephrectomy, particularly when used in a population of patients with small RCTs at low risk for the development of metastatic disease and a long anticipated survival who remain at risk for the common aforementioned medical diseases.

Currently, active investigation, using both institutional databases and national databases, is underway to confirm these initial reports regarding increased cardiovascular events and decreased overall survival when radical nephrectomy rather than partial nephrectomy is used in the treatment of small, favorable-prognostic renal masses. This important data strongly suggest that routine radical nephrectomy for small renal tumors is unjustified on oncological grounds and has potential adverse consequences on the long-term cardiovascular and renal health of the patient. Short-term end points stressed by some investigators in the recent laparoscopic literature regarding length of hospital stay, analgesic requirements postoperatively, and cosmetic elements while advocating laparoscopic radical nephrectomy must now be tempered with the new concerns that radical nephrectomy for the treatment of small renal tumors, by either open or laparoscopic techniques, may worsen or cause CKD and decrease overall patient survival.

PARTIAL NEPHRECTOMY IS UNDERUSED

In 2008, more than 54,390 patients will develop RCTs in the United States, according to estimates,[44] and approximately 70% of those will be incidentally detected at 4 cm or less, a size considered amenable to partial nephrectomy. At many academic centers, partial nephrectomy comprises 60% to 70% of the operations for RCTs. Yet, when investigators took a cross-sectional view of clinical practice using the Nationwide Inpatient Sample, they reported that only 7.5% of kidney tumor operations in the United States from 1988 to 2002 were partial nephrectomies.[45] Using the Surveillance Epidemiology and End Results database, investigators from the University of Michigan reported that from 2001, only 20% of all RCTs between 2 and 4 cm were treated by partial nephrectomy despite an already well-established literature supporting partial nephrectomy.[46] In England, a similar underuse of partial nephrectomy was reported in 2002 with only 108 (4%) partial nephrectomies out of 2671 nephrectomies performed.[47]

Many factors likely account for this reluctance to integrate partial nephrectomies into widespread clinic practice, despite mounting evidence of the virtues of partial nephrectomies both for local tumor control and preservation of long-term renal function. Open kidney surgery as a common element of training programs has been markedly reduced since the introduction of percutaneous, ureteroscopic, and extracorporeal approaches for the treatment of kidney stones over the last 20 years. Many of the surgical techniques employed in partial nephrectomy for tumors, including vascular isolation, ice slush, and suture repair of the collecting system, emanated from operations initially designed to treat complex kidney (staghorn) stones. Possibly, because of demographics of RCTs and regional referral patterns, only certain centers have had the numbers of extensive open renal tumor operations sufficient enough for training residents and staff.

The development of minimally invasive laparoscopic renal tumor surgery and tumor ablative techniques, such as radiofrequency and cryoablation, has been ongoing for 17 years by committed investigators in the United States and abroad. The advantages of cosmetic incisions, decreased perioperative analgesic requirements, and more rapid return to normal activity were emphasized in early publications and short-term oncologic end points seemed equivalent to those of their open-surgical counterparts. However, at centers with expertise in both open and minimally invasive surgery approaches for RCT, published experiences revealed inconsistencies in the management of small renal tumors. Open surgeons were more likely to perform partial nephrectomy, and laparoscopic surgeons were more likely to perform radical nephrectomy. These reports suggested that skills related to minimally invasive surgery were being acquired through surgery involving small renal tumors (<4 cm), despite the above-described clinical data that this was surgical overkill and deleterious to the patients' overall renal function.[48] Unique issues relative to minimally invasive surgery, such as the problem of tumor-bearing kidney retrieval (ie, morcellation vs. an open extraction incision for removal) were debated in the literature. The case load required to extend the surgical limits for minimally invasive surgery was not known and the decision to perform an open kidney procedure rather than a minimally invasive kidney procedure often depended upon the relative surgical expertise of the individual surgeon rather than more clearly defined guidelines relating to tumor size and concerns about future renal function.

By 2000, because of the well-described benefits of partial nephrectomy, several minimally invasive surgery groups began concerted efforts to develop laparoscopic partial nephrectomy techniques that would closely simulate the open procedure, initially with smaller, exophytic renal tumors and, with time and increasing experience, with more complex centrally located or cystic renal tumors. Valiant attempts to duplicate the renal protective effects of cold ischemia, readily obtained in open partial nephrectomy, were reported and included cold renal arterial and ureteral perfusions and, recently, laparoscopic ice slush placement. Nonetheless, the majority of laparoscopic partial nephrectomies (many of which are complex) continue to be performed under warm ischemic conditions with the hope that rapid completion of the operation will limit any ischemic effects on the kidney. Even for these expert surgeons, laparoscopic partial nephrectomy is currently described as a "complex" or "advanced" operation with published complication rates that are three to four times higher than those for their open counterparts.[49,50] Interestingly, laparoscopic partial nephrectomy teams report similar rates of benign lesions resected (20%–30%) and similar beneficial effects on overall renal function as described above in the open partial nephrectomy experience.

Recently, investigators from the Mayo Clinic, Cleveland Clinic, and Johns Hopkins pooled their data on 1800 partial nephrectomies, of which 771 were performed laparoscopically and 1028 were performed open for T1 tumors between 1998 and 2005. Even though the surgeons at these centers were experts in their respective laparoscopic and open operations, careful case selection was apparent. Open partial nephrectomy patients had larger tumors that were more likely centrally located and malignant; were at higher risk of perioperative complications as defined by their older age, increased comorbidities, and decreased performance status; and had decreased renal function at the time of operation, all of which may have contributed to longer hospital stays for open partial nephrectomy (5.8 days) versus laparoscopic partial nephrectomy (3.3 days). Patients in the laparoscopic partial nephrectomy group were more likely to have elective indications than imperative or absolute indications for partial nephrectomy yet laparoscopic partial nephrectomy was associated with longer ischemic time; more postoperative complications, particularly urologic; and increased number of subsequent procedures to treat complications. This comprehensive study leaves little doubt that the laparoscopic partial nephrectomy is a technically challenging operation, even in the hands of such experts, where careful case selection may decrease the chance of surgical and urological complications.[51]

As the virtues of partial nephrectomy, by any technique, are apparent, an open alternative to laparoscopy is a miniflank supra–11th rib incision, which can be in the range of 8 to 10 cm. This approach leaves an incision only 1 to 2 cm larger than the extraction incisions for laparoscopic radical nephrectomy or the hand-assist ports for hand-assisted laparoscopic surgery, avoids the painful rib resection, and is associated with a low rate of incidence of flank bulge and hernias (<5%) compared with more traditional open flank operations (30%–40%). This approach may allow urologists trained in open surgery to perform partial nephrectomy with lesser patient morbidity and without the more elaborate training and learning curve associated with laparoscopic partial nephrectomy.[52] For patients with small renal tumors, the long-lasting value of renal preservation by partial nephrectomy, whether performed by laparoscopic or open techniques, now far supersedes the rapid recovery offered by laparoscopic radical nephrectomy.

Also under active investigation are the renal tumor ablative modalities of percutaneous radiofrequency ablation and percutaneous and laparoscopic cryoablation.[53] These are offered often to patients who are old or comorbidly ill. With short overall follow-up and lack of pathologic resection to confirm the completeness of the ablation, it is not known whether ablation is as effective as surgical resection and whether or not the radiological images postablation represent complete or partial tumor destruction or simply a renal tumor, partially treated, not in active growth. In a recent report from the Cleveland Clinic, which has substantial experience in both radiofrequency ablation and cryoablation, documented recurrence rates for cryoablation were 13 of 175 cases (7.4%) and 26 of 104 cases (25%) for radiofrequency ablation whose mean preablation tumor sizes were 3.0 and 2.8 cm respectively. Repeat ablations were performed in 26 patients but 12 patients were not candidates for repeat ablation because of large tumor size, disease progression, or repeat ablation failure. Of these, 10 patients underwent attempted resection with only 2 patients being eligible for partial nephrectomy (open) and 7 patients requiring radical nephrectomy. One operation was aborted. From this data, it appears that a failed ablative procedure in a patient originally eligible for a partial nephrectomy, likely translates into a radical nephrectomy as salvage procedure because of extensive postablation scarring.[54] Carefully designed "ablate and resect" clinical protocols need to be done, much like those done in the 1990s with cryotherapy and localized prostate cancer, to determine the true effectiveness of these approaches. For this same population of elderly patients or comorbidly ill patients with small renal tumors, active surveillance is increasingly being suggested as an alternative to invasive treatments.[55,56]

SUMMARY

The value of partial nephrectomy in the management of small renal cortical tumors is gaining wider recognition thanks to (1) enhanced understanding of the biology of renal cortical tumors; (2) better knowledge about tumor size and stage migration to small tumors at the time of presentation; (3) studies indicating the oncologic efficacy of kidney-sparing surgery, whether performed by open or laparoscopic techniques, and (4) increasing awareness of the wide prevalence of CKD and its associated cardiovascular morbidity and mortality. The argument by many minimally invasive surgeons for laparoscopic radical nephrectomy and its associated rapid convalescence and cosmesis is not sufficiently compelling when iatrogenic initiation or worsening of CKD is the result. The overzealous use of radical nephrectomy for small renal tumors, whether by open or laparoscopic techniques, must now be considered detrimental to the long-term health and safety of the patient with a small RCT. Widespread training in partial nephrectomy and enhanced use, whether by open or laparoscopic approaches, is clearly indicated in the United States and abroad.

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