Cryoablation Versus Minimally Invasive Partial Nephrectomy for Small Renal Masses in the Solitary Kidney: Impact of Approach on Functional Outcomes

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Abbreviations and Acronyms

EBL = estimated blood loss
eGFR = estimated glomerular filtration rate
LTP = local tumor progression
PN = partial nephrectomy
RCA = renal cryoablation
RCC = renal cell carcinoma
sCr = serum creatinine
WIT = warm ischemic time

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Editor's Note: This article is the first of 5 published in this issue for which category 1 CME credits can be earned. Instructions for obtaining credits are given with the questions on pages 1174 and 1175.

Purpose: We evaluated the change in renal function after renal cryoablation and partial nephrectomy based on tumor complexity according to the R.E.N.A.L. nephrometry score.

Materials and Methods: We retrospectively reviewed the data of patients who had a renal tumor in a solitary kidney, and underwent renal cryoablation and partial nephrectomy between December 2000 and January 2012. Renal tumor complexity was categorized into 3 groups by R.E.N.A.L. nephrometry score as low (4 to 6), intermediate (7 to 9) and high (10 to 12). All baseline demographic data, perioperative parameters and followup data including renal function were collected. Comparisons were made among similar tumor complexities.

Results: In the renal cryoablation and partial nephrectomy groups 29 patients (43 tumors) and 33 patients were identified, respectively. In all renal tumor complexities, renal cryoablation provided a better perioperative outcome in terms of median operative time, estimated blood loss, transfusion, hospital stay and complications. The median change in serum creatinine and estimated glomerular filtration rate was slightly greater in the partial nephrectomy group. However, the differences were not statistically significant for any of the tumor complexities. Three patients (10%) in the renal cryoablation group and 2 (6%) in the partial nephrectomy group required long-term dialysis.

Conclusions: In patients with solitary kidneys, renal cryoablation is associated with superior perioperative outcomes compared to partial nephrectomy. Specifically, partial nephrectomy is not associated with greater loss of renal function than renal cryoablation regardless of the extent of tumor complexity.

Key Words: kidney neoplasms, cryosurgery, nephrectomy

CHRONIC kidney disease correlates with an increasing risk of cardiovascular events, hospitalization and mortality.[1] The risk of chronic kidney disease in patients with RCC is most associated with baseline renal function and the choice of treatment modality.[2,3] Therefore, the modern management of renal cell carcinoma combines meticulous oncologic control with optimal preservation of renal function.

Partial nephrectomy has been considered the gold standard surgical treatment for small renal masses for imperative and elective indications.[4] The introduction of minimally invasive

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PN techniques has provided advantages in terms of postoperative recovery while offering functional and oncologic outcomes equivalent to those of the open surgical option.[5]

Renal cryoablation represents another attractive alternative for patients requiring active treatment.[6,7] Mid-term cancer specific survival is greater than 90% in most published series.[8] However, local recurrence and tumor progression are more likely with RCA than with PN.[9,10]

Tumors in a solitary kidney represent a challenging clinical scenario yet provide a unique opportunity to evaluate the effect of treatment type on loss of renal function. PN and RCA potentially affect renal function in different ways. With PN, renal hilar clamping with temporary renal ischemia and parenchymal resection represent 2 etiologies of possible functional loss. With RCA, normal tissue around the cryolesion can be damaged while complete treatment of the tumor is pursued.

Tumor complexity has traditionally been recognized as a crucial factor to consider in the treatment decision process for kidney tumors. Scoring systems as surrogate measures of tumor complexity have been proposed during the last few years to predict perioperative outcomes and complications after PN.[11] However, differences in functional outcomes between PN and RCA based on tumor complexity have not been evaluated.

MATERIALS AND METHODS

Patient Selection

Our institutional review board approved prospectively maintained databases were queried to identify patients with a solitary functioning kidney who underwent RCA with a percutaneous or laparoscopic approach (59 patients) or minimally invasive PN with a laparoscopic or robotic approach (52) between December 2000 and January 2012 at our institution. Patients with multiple tumors treated in a single session, those with a tumor whose complexity could not be scored due to unavailable information and those without available information about postoperative renal function were excluded from the study.

In the RCA group 29 patients with 43 tumors and in the PN group 33 patients were included in the analysis. The complexity of each tumor was graded according to the R.E.N.A.L. nephrometry scoring system as low (4 to 6), intermediate (7 to 9) or high (10 to 12).[12] Comparisons were made of treatment groups by considering tumors of similar complexity. The impact of tumor complexity was evaluated primarily on renal functional outcomes and secondarily on treatment outcomes.

Surgical Techniques and Surveillance Protocols

RCA was performed with double freeze-thaw cycles to extend the iceball 5 to 10 mm beyond the tumor edge. Intraoperative pre-cryoablation needle biopsies were performed in all patients. The choice of laparoscopic or percutaneous approach was based on tumor location and technical capability depending on the year of treatment. Our RCA techniques have been described previously.[13,14] Patients were tentatively discharged home on the day of surgery with the percutaneous approach and on postoperative day 1 with the laparoscopic approach. Surveillance after RCA included renal function, radiological and histological study. Serial computerized tomography or magnetic resonance imaging was performed on postoperative day 1, at 3, 6 and 12 months, and then yearly. Computerized tomography guided percutaneous needle biopsy was done at 6 months postoperatively for some patients.

PN was performed with a laparoscopic or robotic approach as previously described.[15,16] A clampless procedure was selectively used by the surgeon on the basis of tumor features. After PN with pathology confirmed malignant tumor, renal function and imaging studies were performed at 6 months postoperatively and then yearly.

Outcome Measures and Statistical Analysis

Study parameters included age, gender, ASA (American Society of Anesthesiologists) score, body mass index, medical comorbidities (hypertension, diabetes, heart disease, history of other cancer), tumor size, tumor complexity by the R.E.N.A.L. nephrometry score, tumor laterality, preoperative and postoperative renal function, operative time, EBL, WIT, cryoablative time, transfusion, conversion, intraoperative and postoperative complications, and hospital stay.

Renal function outcomes were determined by sCr and eGFR calculated using the Modification of Diet in Renal Disease equation.[17] The most recent sCr within 6 months after the procedure (between 1 and 6 months) and the last followup sCr were used to represent postoperative renal function. The difference and percentage change of sCr and eGFR from the preoperative values were calculated to evaluate the impact of the procedure.

All patients were included in the analysis in an intent to treat fashion including those who underwent radical nephrectomy after RCA and PN. Postoperative complications were graded using the Clavien classification system.[18] Local tumor progression in the RCA group was defined as persistence or enlargement of an enhancing lesion on postoperative followup imaging.[19]

All categorical data were compared with the Pearson chi-square and Fisher exact tests. Continuous variables were compared with the Wilcoxon rank sum and Kruskal-Wallis test. A 2-tailed $p < 0.05$ was considered statistically significant for all analyses. Analysis was performed using JMP®9 (SAS).

RESULTS

Overall Comparison

Demographic data and tumor characteristics are summarized in supplementary table 1 (jurology.com). There was no significant difference in age, gender, body mass index, medical comorbidities and etiology of solitary kidney between the RCA and the PN groups. The most common solitary kidney etiology was contralateral RCC in both groups. Patients in the RCA group had a significantly higher ASA