Usefulness of R.E.N.A.L. Nephrometry Scoring System for Predicting Outcomes and Complications of Percutaneous Ablation of 751 Renal Tumors

Grant D. Schmit,* R. Houston Thompson, Anil N. Kurup, Adam J. Weisbrod, Stephen A. Boorjian, Rickey E. Carter, Jennifer R. Geske, Matthew R. Callstrom† and Thomas D. Atwell

From the Departments of Radiology (GDS, ANK, AJW, MRC, TDA), Urology (RHT, SAB) and Biostatistics (REC, JRG), Mayo Clinic School of Medicine, Rochester, Minnesota

Abbreviations and Acronyms

CT = computerized tomography

eGFR = estimated glomerular filtration rate

MRI = magnetic resonance imaging

RCC = renal cell carcinoma

RFA = radio frequency ablation

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* Correspondence: Department of Radiology, Mayo Clinic, 200 1st St. Southwest, Rochester, Minnesota 55905 (telephone: 507-284-2511; FAX: 507-266-4609; e-mail: schmit.grant@mayo.edu).

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Purpose: We applied the R.E.N.A.L. (radius, exophytic/endophytic, nearness to collecting system or sinus, anterior/posterior and location relative to polar lines) nephrometry scoring system to renal tumors treated with percutaneous ablation to determine whether this score is associated with oncological outcomes and complications.

Materials and Methods: A total of 751 renal tumors were treated at 679 percutaneous ablation sessions in 627 patients at our institution between 2000 and 2012. Of these renal masses 430 (57%) were treated with cryoablation and the remaining 321 were treated with radio frequency ablation. R.E.N.A.L. tumor scores were analyzed to determine the association of the score with ablation treatment outcomes and complications according to Clavien criteria.

Results: The mean ± SD R.E.N.A.L. nephrometry score of all ablated tumors was 6.7 ± 1.9. Those treated with cryoablation had higher scores than those treated with radio frequency ablation (mean 7.2 ± 1.9 vs 6.1 ± 1.8, $p < 0.001$). We identified a total of 28 local treatment failures (3.7%) in the 751 tumors during a mean computerized tomography/magnetic resonance imaging followup of 27.9 ± 27.8 months. There was a significant association between R.E.N.A.L. nephrometry score and local treatment failure. Mean nephrometry score was 7.6 ± 2.2 vs 6.7 ± 1.9 for tumors with vs without local treatment failure ($p < 0.001$). Of the 679 ablation treatments 38 (5.6%) major (grade 3 or greater) patient complications occurred. There was a significant association between R.E.N.A.L. nephrometry score and major complications. Patients with vs without a major complication had a mean nephrometry score of 8.1 ± 2.0 vs 6.8 ± 1.9 ($p < 0.001$).

Conclusions: The R.E.N.A.L. nephrometry scoring system predicts treatment efficacy and complications following percutaneous renal ablation.

Key Words: kidney; carcinoma, renal cell; cryosurgery; catheter ablation; forecasting

Surgical resection in the form of partial or radical nephrectomy represents the gold standard treatment for patients with clinically localized RCC. It is associated with durable cancer control (88% to 100% 10-year disease-free survival in patients with renal tumors 7 cm or less).[1] Nevertheless, less invasive treatment options are becoming increasingly popular for managing small renal tumors. This phenomenon is at least partially ex-

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plained by the increasing number of older patients with incidental renal tumors detected as a result of the increasing use of cross-sectional abdominal imaging. These incidental renal tumors are generally smaller and correspondingly more likely to represent benign lesions or more indolent RCC subtypes than the symptomatic renal tumors diagnosed in the past.[2,3]

Percutaneous ablation is a minimally invasive treatment option that has proved to be effective and safe for select patients with small renal tumors.[4–10] In fact, the American Urological Association consensus guidelines now include percutaneous ablation as a treatment option for patients at high surgical risk with T1a (4 cm or less) renal tumors.[11] To our knowledge the long-term efficacy of renal ablation has yet to be established. However, as patient interest and physician acceptance continue to grow, indications for percutaneous renal ablation are beginning to expand. With this comes the necessity for urologists and interventional radiologists to develop an understanding of the specific advantages and disadvantages of surgery vs ablation for renal tumors.

Comparing outcomes and complications among renal tumor treatments is difficult due to the heterogeneity in small renal tumor complexity, ie different sizes and locations in the kidney. Since 2009, 3 scoring systems have been introduced in the urology literature to quantify the pertinent characteristics of renal tumors as they relate to partial nephrectomy. The 3 systems are the R.E.N.A.L. nephrometry scoring system,[12] the PADUA (preoperative aspects and dimensions used for anatomical) classification system[13] and the centrality index system.[14] The primary goal of these systems is to improve how anatomical renal tumor data are recorded and analyzed for academic purposes. Standardized renal tumor scoring systems are also important because the feasibility of partial nephrectomy was previously based almost exclusively on the subjective surgeon assessment of whether tumor resection and renorrhaphy could be accomplished in an appropriate time.

Studies of the R.E.N.A.L. nephrometry system show that tumor scores correlate with surgical outcomes and complications.[15–20] A recent study of 39 patients who underwent laparoscopic and percutaneous thermal ablation suggested that R.E.N.A.L. scores might also be associated with tumor recurrence and periprocedural complications.[21] Since a reproducible, comprehensive standardized system for reporting renal tumor anatomy is critical to compare surgical and percutaneous ablation studies, we evaluated this model in 751 renal tumors treated with percutaneous ablation at our institution to determine the value of this scoring system for predicting ablation outcomes and complications.

MATERIALS AND METHODS

After receiving approval from the Mayo Clinic institutional review board we identified a total of 751 renal tumors that were percutaneously ablated at 679 separate ablation procedures in 627 patients at our institution between May 2000 and January 2012.

The R.E.N.A.L. nephrometry scoring system was applied retrospectively to all 751 treated tumors by one of 4 ablation radiologists. The R.E.N.A.L. score includes 5 critical anatomical components of a renal mass, of which 4 are scored on a 1, 2 or 3-point scale with the fifth component indicating an anterior or posterior location of the tumor in the kidney.[12] The score includes (R)adius (maximal tumor diameter)—1 point if 4 cm or less, 2 points if greater than 4 but less than 7 cm and 3 points if 7 cm or greater; tumor (E)xophytic/endophytic properties—1 point if 50% or greater exophytic, 2 points if less than 50% exophytic and 3 points if completely endophytic; (N)earness of the deepest portion to the tumor to the collecting system or sinus—1 point if 7 mm or greater, 2 points if greater than 4 but less than 7 mm and 3 points if 4 mm or less; (A)nterior (a)/posterior (p)/no designation (x) descriptor; and (L)ocation relative to the polar line—1 point if completely above the upper or completely below the lower polar line, 2 points if the lesion crosses the polar line and 3 points if greater than 50% of the mass is between the polar lines or crosses the renal midline. Low, moderate and high complexity renal tumors were considered those with a R.E.N.A.L. score of 4 to 6, 7 to 9 and 10 to 12, respectively.

Our percutaneous renal ablation methods and techniques were previously described in detail.[4,7,22] Briefly, all patients were initially seen at the urology department for formal urological consultation. If the patient and urologist determined that percutaneous ablation would be the best treatment option, an ablation radiologist was contacted to confirm that the mass was amenable to ablation. From May 2000 to March 2003 RFA was the only method used for percutaneous renal ablation at our institution. Cryoablation was introduced in our practice in March 2003. As our practice has evolved during the years, larger, central renal tumors have been primarily treated with cryoablation,[22] while smaller, peripheral renal tumors are still treated with RFA (table 1).

All renal masses were treated at a single cryoablation or RFA session with the patient under general anesthesia. No staged ablation was performed. From 2000 to 2002 renal mass biopsy was rarely done in patients treated with ablation. Since that time, it has been routine to obtain 1 or 2 core biopsies of the tumor at the time of ablation.

Abdominal CT or MRI was done in all patients within 24 hours of ablation to determine the technical success of the procedure. As adapted from the International Working Group on Image-Guided Tumor Ablation,[23] the technical success of cryoablation was defined as ice ball extension at least 0.5 cm beyond the tumor margins on monitoring noncontrast CT performed during the procedure. For cryoablation and RFA technical success was defined as extension of the ablation zone beyond the tumor margins on contrast enhanced CT or MRI done within 3 months of ablation. Local tumor recurrence was defined as a hyperenhancing or enlarging soft tissue nodule in or around the